Bridging Technology and Pedagogy: The Impact of AI-Generated Word Cards on Students' Reading Comprehension

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ABSTRACT: This study investigates the effectiveness of AI-generated word cards as an instructional tool to improve reading comprehension among ninth-grade EFL students in Indonesia. Employing a quasi-experimental design, the research involved 68 participants divided into an experimental group, which received instruction using AI-generated word cards, and a control group, which followed traditional teaching methods. The word cards were designed to align with the school curriculum, incorporating vocabulary and phrases relevant to the students' learning objectives. Data was collected through pre-test and post-test assessments and analyzed using the Independent Samples t-test to determine the intervention's statistical significance. The results revealed a substantial improvement in the experimental group's reading comprehension scores compared to the control group, with the effect size indicating a significant impact. The findings highlight the potential of AI-driven tools to enhance vocabulary acquisition and comprehension skills, addressing gaps in traditional instruction. This study contributes to the growing body of evidence supporting the integration of AI in EFL pedagogy, offering innovative strategies to bridge technology and education effectively.

KEYWORDS: AI-generated word cards, vocabulary acquisition, EFL instructional media, educational technology, reading comprehension

1 INTRODUCTION

Reading is a foundational skill that significantly contributes to cognitive development and knowledge acquisition. As Snow (2002) notes, reading comprehension is a multifaceted process encompassing decoding, fluency, and the ability to understand written material. Through reading, individuals expand their vocabulary, sharpen analytical thinking, and enhance problem-solving skills. These capabilities are not only pivotal in academic success but also essential for professional growth and lifelong learning. Moreover, reading facilitates the processing and retention of information, enabling individuals to make informed decisions and broaden their worldview.

In academic contexts, reading plays a critical role in fostering achievement and intellectual growth. Cunningham and Stanovich (2001) highlight a strong correlation between frequent reading and enhanced academic performance. Students who regularly engage in

reading improve their comprehension skills and develop the capacity to critically evaluate and synthesize information from diverse sources. Such skills are indispensable in language education, where analytical thinking and informed decision-making are key to academic and professional advancement. However, despite its significance, reading comprehension remains a challenging skill for many students, particularly those who lack a strong vocabulary foundation.

A significant barrier to effective reading comprehension is the limited mastery of vocabulary. According to Earl (1997), many beginning readers underestimate the complexity of reading, often assuming that intelligence alone suffices for comprehension. In reality, reading requires the integration of multiple skills, including vocabulary knowledge, decoding, and the ability to analyze text. Without a strong vocabulary foundation, students struggle to understand unfamiliar words, leading to reliance on dictionaries that disrupt reading flow and comprehension. Addressing this challenge requires targeted interventions that enhance vocabulary acquisition while promoting active engagement with text.

One promising approach to improving vocabulary and reading comprehension is the use of learning media. As Fitria et al. (2024) suggest, well-designed media facilitate the learning process by providing accessible and engaging tools for both teachers and students. Nuryati et al. (2024), emphasize that incorporating effective media into instruction fosters a dynamic learning environment, enhancing students' ability to grasp and retain knowledge. Among the various types of media available, word cards have emerged as a particularly effective tool for supporting vocabulary development and reading comprehension.

Word cards provide a systematic and interactive method for vocabulary learning. By presenting words in a structured format, students engage in repeated exposure and practice, which reinforces vocabulary retention and contextual understanding. Research supports the effectiveness of word cards in promoting reading comprehension. Akubuilo et al. (2015) found that word card media increased students' interest in reading and improved their readiness to decode letter symbols and construct sentences. Similarly, Keesey et al. (2015) demonstrated that word cards enhance early reading skills, making them a valuable resource for both teachers and students.

In the Indonesian context, where challenges such as limited instructional resources and lack of responsiveness in classroom discussions are common, AI-generated word cards offer a practical, scalable, and efficient solution. Unlike conventional word cards, which often require artistic skills, knowledge of specific design applications, and significant time to create, AI-generated word cards streamline the process. Conventional word cards may also face inconsistencies in design themes, which can reduce their effectiveness and visual appeal in the classroom. By utilizing AI, educators can quickly generate professional and consistent word cards that align with the curriculum and meet specific learning objectives. Additionally, AI technology allows the integration of multimedia features, such as images, text on how to pronounce the words, and contextual examples, making the cards more engaging and accessible to diverse learners. This innovation not only saves time and effort but also bridges the gap between traditional teaching methods and modern technology, fostering a more dynamic and interactive learning experience.

The aims of this study are to investigate the effectiveness of AI-generated word cards in improving students' reading comprehension, particularly in the context of recount texts, and to find out how these tools can address common challenges in vocabulary acquisition and classroom engagement. Specifically, the study seeks to determine whether AI-generated word cards can significantly enhance vocabulary retention, promote deeper comprehension, and support more efficient instructional practices compared to conventional methods.

Given the critical role of vocabulary in reading comprehension, integrating AI-generated word cards into teaching practices provides an innovative approach to addressing these challenges. These cards enhance vocabulary acquisition by offering well-designed, contextually relevant materials that require minimal preparation from teachers. Unlike conventional word cards, AI-generated tools can be customized instantly, allowing educators to adjust content based on students' progress or classroom needs. The efficiency of AI also ensures consistency in design themes, eliminating the distractions caused by poorly matched visuals. Moreover, the ability to create cards tailored to specific topics or skills supports deeper comprehension and more effective learning. By incorporating this technology, educators can not only improve students' academic outcomes but also create a classroom environment that embraces innovation and streamlines teaching processes.

2   METHOD

This study employs a quantitative research approach using a quasi-experimental design to investigate the effectiveness of AI-generated word cards as an instructional tool for improving students' reading comprehension. The word cards were developed by researchers using AI, with the content tailored to align with the school curriculum. The study's primary aim is to determine whether integrating these AI-generated word cards into teaching practices significantly enhances students' reading skills compared to traditional methods. By employing a rigorous experimental framework, this research contributes evidence-based insights into the application of AI tools in educational settings.

2.1. Research Design

The study follows a quasi-experimental design involving two groups: the experimental group and the control group. The experimental group was exposed to instruction using the AI-generated word cards, while the control group received instruction through conventional teaching methods without the use of these tools. Both groups underwent pre-test and post-test assessments to measure changes in reading comprehension and to evaluate the effectiveness of the intervention.

The study examines two key variables: the independent variable and the dependent variable. The independent variable is the use of AI-generated word cards as an instructional tool to enhance vocabulary and reading comprehension. The content of the word cards—consisting of words and phrases—was created by the researchers based on the school's curriculum and adapted to align with the learning objectives for ninth-grade students. The dependent variable is the students' reading comprehension ability, which was assessed using pre-test and post-test scores.

2.2. Population and Sample

The population of the study comprised ninth-grade students from a secondary school in Pekanbaru. Two classes were selected randomly, resulting in 68 participants, with 35 students in the experimental group and 33 in the control group. To ensure that the sample was representative of the study's objectives, cluster random sampling was used when assigning classes to the experimental and control groups.

2.3. Treatment

The intervention was conducted over four weeks and included multiple instructional activities. For the experimental group, AI-generated word cards were incorporated into lessons to facilitate vocabulary acquisition and improve reading comprehension. The activities included:

    a. Matching Tasks: Students matched target words with their definitions or synonyms.

    b. Contextual Usage: Sentence construction tasks requiring the application of newly learned vocabulary.

    c. Group Discussions: Collaborative activities where students discussed the meanings and practical applications of words in text analysis.

The content of the word cards was carefully selected to cover vocabulary and phrases directly relevant to the curriculum materials being taught during the intervention period. Conversely, the control group followed traditional teaching methods that relied on textbook-based exercises, teacher-led discussions, and written comprehension activities, without the integration of additional learning media.

Prior to the intervention, both groups completed a pre-test to establish a baseline of their reading comprehension levels. At the conclusion of the intervention, a post-test was administered to evaluate any improvements in comprehension skills. Both the pre-test and post-test comprised multiple-choice questions designed to measure students' abilities to understand, analyze, and interpret written texts.

2.4. Data Analysis

The collected data from pre-test and post-test assessments were analyzed using the Independent Samples t-test to determine whether the differences between the experimental and control groups were statistically significant. Additionally, the effect size of the intervention was calculated using Cohen's d formula to assess the magnitude of the impact. Statistical analyses were conducted using SPSS software to ensure accuracy and reliability in data interpretation. The results aimed to evaluate the extent to which AI-generated word cards contributed to improving students' reading comprehension skills.

This study utilized a structured methodology to assess the effectiveness of AI-generated word cards in enhancing reading comprehension among ninth-grade students. The quasi-experimental design, combined with pre-test and post-test assessments and robust statistical analyses, ensures the reliability of the findings. By aligning the content of the word cards with the curriculum and leveraging AI to create tailored learning tools, this study provides valuable insights into innovative teaching strategies. The findings have the potential to inform future educational practices and highlight the role of AI in supporting student learning and academic success.

3   FINDINGS AND DISCUSSION

3.1. The Findings

The findings of this study are based on the analysis of pre-test and post-test scores from both the experimental and control groups. The results are presented in the following tables:

Table 1: Descriptive Statistics for Pre-Test Scores

Group	N	Mean	Std. Deviation	Std. Error Mean
Control Class	33	52.57	9.61	1.67311
Experimental Class	35	64.42	9.37	1.58474

The pre-test scores demonstrate that the mean reading comprehension score for the experimental group (64.42) is higher than that of the control group (52.57). Despite this difference, both groups show room for improvement, with the experimental group categorized as having "sufficient" comprehension levels and the control group classified as "low." The standard deviations (9.37 and 9.61, respectively) indicate similar variability in the distribution of scores within both groups.

Table 2: Descriptive Statistics for Post-Test Scores

Group	N	Mean	Std. Deviation	Std. Error Mean
Control Class	33	75.30	6.83	1.19062
Experimental Class	35	83.71	7.89	1.33383

The post-test results reveal a significant improvement in the reading comprehension scores for both groups. The mean score for the experimental group increased to 83.71, while the control group achieved a mean score of 75.30. Notably, the experimental group exhibited a greater improvement in comprehension levels compared to the control group. The lower standard deviation for the control group (6.83) compared to the experimental group (7.89) suggests slightly less variability in scores among the control class.

Table 3: Independent Samples T-Test Results for Post-Test

Test	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	1.608	0.209	-4.685	66	0.000
Equal variances not assumed			-4.704	64.782	0.000

An independent-sample t-test was conducted to determine the statistical significance of the difference in post-test scores between the experimental and control groups. Levene's test for equality of variances yielded a significance value of 0.209 ($p > 0.05$), confirming that the assumption of equal variances is met. The t-test results show a significance value of 0.000 ($p < 0.05$), leading to the rejection of the null hypothesis (H0) and acceptance of the alternative hypothesis (Ha). This indicates a statistically significant difference in reading comprehension improvement between the two groups, favouring the experimental group.

3.2. Discussion

The findings of this study provide compelling evidence for the effectiveness of using AI-generated word cards as an instructional tool to enhance students' reading comprehension. The significant improvement in the mean scores of the experimental group compared to the control group highlights the advantages of integrating innovative media into the teaching process.

Prior to the intervention, both groups demonstrated relatively low reading comprehension levels, with the experimental group showing slightly better baseline performance. This underscores the importance of targeted interventions to address students' vocabulary and comprehension challenges. The use of AI-generated word

cards, tailored to the curriculum, provided students with an engaging and structured method to expand their vocabulary and understand textual content. Activities such as matching tasks, sentence construction, and group discussions allowed students to actively process and apply new words, leading to deeper comprehension and retention.

In contrast, the control group, which relied on traditional textbook-based instruction, also showed improvement but to a lesser extent. This suggests that while conventional methods have merit, the inclusion of innovative media can yield superior outcomes in student learning. These findings align with previous research, such as Akubuilo et al. (2015) and Keesey et al. (2015), which emphasize the value of interactive and context-driven vocabulary learning tools in fostering reading comprehension.

The statistical significance of the t-test results ($p < 0.05$) further supports the conclusion that the intervention had a meaningful impact. The effect size, as calculated using Cohen's d, reflects a substantial difference between the groups, reinforcing the practical significance of the word card intervention.

Additionally, the use of AI to generate the word cards introduced a novel dimension to the study. By leveraging AI, the researchers were able to create customized and curriculum-aligned vocabulary resources efficiently, addressing specific learning objectives. This demonstrates the potential of AI as a tool for educators to enhance teaching materials and support differentiated instruction.

The results of this study underscore the need for innovative teaching strategies that integrate technology to address gaps in reading comprehension. AI-generated tools, such as word cards, provide an accessible and scalable solution for educators seeking to improve vocabulary acquisition and comprehension skills. Future research could explore the long-term effects of such interventions and examine their applicability across different contexts and age groups.

Furthermore, the findings of this study highlight the effectiveness of using AI-generated word cards in enhancing reading comprehension among ninth-grade students. The statistically significant improvement observed in the experimental group demonstrates that this innovative approach supports vocabulary acquisition and facilitates deeper comprehension of textual content. This discussion situates the findings within the context of prior studies on the use of flashcards or word cards and highlights the unique contributions and innovations of the present research.

Several previous studies have explored the use of flashcards or word cards as tools for language learning. For instance, Al-Jarf (2022) proposed a variety of online vocabulary tasks, including flashcards, to engage EFL college students in distance learning environments. While this study focused on a range of online tools and technologies to improve vocabulary and student motivation, the present study differs in its emphasis on AI-generated, curriculum-specific word cards tailored to students' needs. Unlike generic mobile applications such as Quizlet or Duolingo, the word cards used in this study were designed to directly align with the students' curriculum, ensuring relevance and maximizing learning outcomes.

Similarly, Fraher et al. (2019) investigated the impact of direct instruction flashcards on sight word identification for a high school student with a specific learning disability. Although their study demonstrated the effectiveness of flashcards in improving sight word recognition, it was limited to a single-case design and focused on basic literacy skills. In contrast, the present study examined the broader impact of

word cards on reading comprehension for a larger group of students, providing stronger evidence of their efficacy in addressing higher-order cognitive skills.

Mathura and Zulu (2021) explored the use of flashcards to enhance creative writing skills among Grade 1 ESL learners. While their findings indicated improvements in spelling, tense usage, and sentence construction, the study primarily targeted young learners and focused on writing rather than reading comprehension. The present study extends this line of inquiry by demonstrating how word cards can facilitate comprehension among older learners, bridging the gap between vocabulary learning and reading comprehension.

In their research on visual recognition difficulties, Adhe et al. (2024) utilized augmented reality (AR) flashcards to teach letter recognition to kindergarten students. While the study showcased the potential of AR in addressing early literacy challenges, it centered on basic literacy skills and younger learners. The AI-generated word cards in the present study represent a step forward, combining technological innovation with cognitive engagement to enhance comprehension in adolescent learners.

The study by Erbey et al. (2011) evaluated the effects of combining flashcards with a reading racetrack intervention to teach phonics, sight words, and math facts to students with learning disabilities. Although their research demonstrated the value of flashcards in improving specific literacy and numeracy skills, the present study goes beyond such targeted interventions by assessing the overall impact on reading comprehension, thereby contributing to a more holistic understanding of word cards' potential.

Finally, Yildirim (2007) used flashcards as part of a thematic lesson on weather to teach vocabulary and integrate all four language skills. While this study highlighted the benefits of using flashcards for thematic vocabulary acquisition, it focused on younger learners and practical vocabulary. In contrast, the current study targets academic vocabulary and reading comprehension, aligning more closely with the demands of secondary education curricula.

To highlight, the present study makes several unique contributions to the existing literature on word cards and flashcards in language learning:

1. **AI-Generated Word Cards:** Unlike previous studies, this research leverages AI to design and generate word cards that are curriculum-specific and tailored to students' learning needs. This approach ensures the relevance of the vocabulary items and allows for greater adaptability to different educational contexts.
2. **Focus on Reading Comprehension:** While many studies emphasize vocabulary acquisition or foundational literacy skills, this research extends the scope by examining the impact of word cards on reading comprehension—a higher-order cognitive skill essential for academic success.
3. **Statistical Rigor:** The use of pre-test and post-test designs, combined with independent-sample t-tests, ensures that the findings are statistically robust and generalizable to similar educational settings. This methodological rigor is often absent in smaller-scale or single-case studies.
4. **Adolescent Learners:** By targeting ninth-grade students, the study fills a gap in the literature, as much of the existing research focuses on younger learners or students with specific learning disabilities. The findings highlight the efficacy of word cards for a broader demographic.
5. **Integration of Technology in Traditional Classrooms:** The study demonstrates how technology can be seamlessly integrated into traditional classroom practices,

addressing a key challenge identified in previous research, such as Al-Jarf's (2022) study on student disengagement in distance learning environments.

The findings of this study underscore the potential of AI-generated word cards as a powerful tool for enhancing reading comprehension. Educators can adopt this innovative approach to create personalized vocabulary resources that align with specific learning objectives. Additionally, the integration of such tools into traditional classroom practices can foster student engagement and motivation, addressing challenges identified in prior studies.

Future research could explore the long-term effects of using AI-generated word cards and their applicability in diverse educational settings, including multilingual classrooms and distance learning environments. Expanding the scope to include other language skills, such as writing and speaking, would further enrich the understanding of their pedagogical potential.

In summary, the present study contributes to the growing body of evidence supporting the use of word cards in language learning by introducing an innovative, AI-driven approach. The statistically significant improvement in reading comprehension among the experimental group highlights the effectiveness of this method and its potential to transform vocabulary instruction in secondary education. By bridging the gap between technology and pedagogy, this study offers valuable insights for educators and researchers seeking to enhance student learning outcomes in the digital age.

4   CONCLUSION

This study underscores the effectiveness of AI-generated word cards as an innovative instructional tool for enhancing reading comprehension among secondary school EFL students. The statistically significant improvement in the experimental group's post-test scores validates the potential of this approach in addressing vocabulary deficits and facilitating deeper textual understanding. By leveraging AI to create curriculum-aligned word cards, this study bridges the gap between traditional pedagogy and technological innovation, providing a scalable and practical solution for language educators.

Compared to prior research, the novelty of this study lies in its focus on AI-driven, curriculum-specific tools tailored to the contextual needs of adolescent learners. Unlike generic flashcard applications, the word cards designed for this study integrated seamlessly into classroom instruction, enabling active engagement and collaborative learning. Furthermore, the methodological rigor demonstrated through pre-test and post-test analysis using advanced statistical tools enhances the reliability of the findings.

The implications of this study extend to both classroom practice and educational policy. By integrating AI-generated tools into teaching, educators can foster a dynamic and interactive learning environment, addressing the diverse needs of students while optimizing instructional efficiency. Future research should explore the longitudinal effects of such interventions, their applicability across different educational settings, and their potential to support other language skills, such as speaking and writing.

Ultimately, this study affirms the transformative role of AI in reshaping EFL instruction, offering educators a powerful means to enhance student outcomes in a rapidly evolving educational landscape.

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