PJEE

Premise : Journal of English Education and Applied Linguistics
e-ISSN: 2442-482x, p-ISSN: 2089-3345
https://fkip.ummetro.ac.id/journal/index.php/english
DOI: 10.24127/pj.v15i1.14744

AUGMENTED REALITY (AR) VERSUS NON-AUGMENTED REALITY (NON-AR) FLASHCARDS ON ENGLISH AS A FOREIGN LANGUAGE (EFL)' WRITING SKILLS: A COMPARATIVE ANALYSIS

by

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(Article History: Received:23-11-2025;Reviewed1:23-01-2026;Reviewed2:13-02-2026: Accepted:20-02-2026;Published:22-02-2026).

Abstract:

Writing is the most challenging EFL skill, requiring linguistic accuracy and creativity. AR and non-AR flashcards offer different pedagogical approaches, yet no systematic comparison exists for EFL writing development. This mixed-methods systematic literature review compares both modalities' effectiveness on writing skills and motivation. Following PRISMA 2020 guidelines, eight studies (2021–2025) with 249 students were analyzed. Non-AR flashcards improved grammar and vocabulary through structured memorization, while AR flashcards enhanced motivation, engagement, and creativity via immersive interaction. Moderator analyses revealed AR flashcards yield greater affective-creative outcomes. Corpus imbalance (5 non-AR vs. 3 AR studies) and Indonesian-context dominance limit generalizability. The study validates Dual-Coding Theory and suggests that integrating both modalities optimizes EFL writing development, warranting further cross-contextual research.

Keywords: *augmented reality(AR), flashcards, writing skills, comparative analysis.*

Abstrak*:*

Menulis merupakan keterampilan EFL paling menantang yang membutuhkan akurasi linguistik dan kreativitas. Flashcard AR dan non-AR menawarkan pendekatan pedagogis berbeda, namun belum ada perbandingan sistematis untuk pengembangan menulis EFL. Tinjauan literatur sistematis mixed-methods ini membandingkan efektivitas kedua modalitas terhadap keterampilan menulis dan motivasi. Mengikuti pedoman PRISMA 2020, delapan studi (2021–2025) dengan 249 siswa dianalisis. Flashcard non-AR meningkatkan tata bahasa dan kosakata melalui memorisasi terstruktur, sementara flashcard AR meningkatkan motivasi, keterlibatan, dan kreativitas melalui interaksi imersif. Analisis moderator mengungkapkan flashcard AR menghasilkan luaran afektif-

How to cite this article:
Kamila, L. S., Tarwiyah, S., & Annury, M. N. (2026). Augmented reality (AR) versus non-augmented reality (Non-AR) flashcards on English as foreign language (EFL) ' writing skills: a comparative analysis. *Premise : Journal of English Education and Applied Linguistics*, *15*(1), 185–209. https://doi.org/10.24127/pj.v15i1.14744

kreatif yang lebih besar. Ketidakseimbangan korpus (5 studi non-AR vs. 3 AR) dan dominasi konteks Indonesia membatasi generalisabilitas. Studi ini memvalidasi Teori Dual-Coding dan menyarankan integrasi kedua modalitas untuk mengoptimalkan pengembangan menulis EFL, serta mendorong penelitian lintas konteks lebih lanjut.

Kata Kunci: *augmented reality, flashcards, keterampilan menulis, dan analisis komparatif.*

INTRODUCTION

The rapid advancement of digital technology has made its integration into foreign language education essential for boosting student competency, engagement, motivation, and academic success. Among the four core English language skills, writing is frequently seen as the most demanding. Its complexity arises not just from the need for grammatical and lexical knowledge, but also from the requirement to organize ideas logically and coherently (Mirani Desi Pratama & Puji Hastuti, 2024; Syifa et al., 2022). Despite its difficulty, writing remains one of the most critical skills in language acquisition. For learners of English as a Foreign Language (EFL), however, it poses a particular challenge, as it demands significant time and a supportive learning environment (Genidal et al., 2023). This multi-faceted challenge creates a substantial hurdle for EFL learners, who must navigate the demands of linguistic accuracy alongside creative expression. Vocabulary impacts the EFL learners' capacity to master the language, including the fundamental skill of writing (Khan et al., 2023).

Common issues in writing instruction often originate from low student participation and limited teaching materials. Traditional, teacher-centered methods and non-AR flashcard techniques have demonstrated positive results in aiding vocabulary retention and building foundational writing skills through visual and textual reinforcement (Maharani & Santoso, 2023; Puspitasari et al., 2024). Yet, their effectiveness is largely confined to rote memorization tasks, frequently failing to foster innovative thinking, analytical reasoning, or the practical application of language in real-world situations. This overreliance on conventional methods is not unique to Indonesia. In Pakistan, (Ali et al., 2024) similarly reported that "conventional methods of learning and teaching are rigorously practiced, and there are no signs of the latest technology tools in classrooms," calling for "the inclusion of modern methods" to improve ESL learning. This limitation highlights an urgent need for novel instructional approaches that address both the cognitive and affective dimensions of writing. This urgency aligns with recent bibliometric findings in technology-enhanced language learning. Hasumi and Chiu (2024) identified mobile devices and multimedia as two of the top five technologies driving contemporary language instruction. Augmented Reality

(AR) flashcards, which integrate both mobile accessibility and interactive multimedia, represent a pedagogically relevant evolution of these established tools. Comparative studies on digital flashcards demonstrate that learners using mobile platforms with spaced repetition showed significant improvements in both immediate recall and delayed retention tests, surpassing traditional word list methods (Reza Teymouri, 2024).

This article has three primary objectives: first, to examine the relative effectiveness of AR flashcards versus non-AR flashcards in enhancing the writing skills of EFL learners; second, to identify differences in motivation, engagement, and learner perceptions when using AR compared to non-AR flashcards for writing activities; and third, to develop pedagogical implications and strategic recommendations for more efficient and innovative EFL writing instruction in the digital age.

The importance of integrating technology to overcome writing barriers is supported by an extensive review by Shadiev and Yang (2020), whose study highlights that in the field of technology-enhanced language learning, writing skills and vocabulary acquisition are the two areas that receive the most significant attention due to their critical role in language proficiency. This underscores the urgency of exploring innovative tools like Augmented Reality to further support these essential skills. Systematic review evidence reveals that AR applications had a large effect on learners' language gains and a small to medium effect on their motivation (Christou et al., 2025).

The expanding technological gap in academic environments, where digital innovations frequently surpass teaching methodologies, emphasizes the critical importance of this investigation. While global educational organizations work to equip students with contemporary skills, there exists a critical demand to assess the effectiveness of new technology compared to conventional educational instruments. This demand aligns with the observation that familiarity with new technology among teachers and students has become a necessity in contemporary educational practices (Tarwiyah et al., 2024). Such an assessment becomes especially vital in EFL settings where materials might be constrained, and technology adaptation requires clear pedagogical justification. Contemporary educational frameworks emphasize that immersive technologies like augmented and virtual reality promote adaptive learning environments that foster critical thinking, creativity, and problem-solving in writing contexts (Polakova & Ivenz, 2024).

Previous studies have affirmed the effectiveness of various technological tools in language education. Research on non-AR flashcards generally confirms their utility for enhancing vocabulary and syntactic structure (Maharani & Santoso, 2023). Simultaneously, investigations into augmented reality in learning contexts indicate its potential to create immersive educational experiences (Asadi & Ebadi, 2025). AR offers numerous features that can help raise students' motivation, skills, and involvement. Specifically in language writing instruction via flashcards, AR has shown promise in three key areas: boosting motivation, increasing participation, and deepening content understanding. This enhancement is achieved through learners' direct interaction with three-dimensional models and dynamic visuals (Allagui, 2021; Meisarah et al., 2023; Rosyidah & Anugerahwati, 2024). Moreover, studies combining digital flashcards with peer feedback have also reported beneficial effects on student motivation and writing skills, particularly for recount text composition (Rahayu et al., 2025) Research demonstrates that students using pedagogical agent-supported mobile AR outperformed those in traditional learning groups in vocabulary acquisition and motivation; additionally, AR using 3D visuals helps students better visualize and retain information in English vocabulary and phonics, fostering classroom participation and building confidence (Wu et al., 2025).

A thorough analysis of existing literature reveals a significant and crucial gap in research on using flashcards for EFL writing instruction. To date, prior studies have primarily focused on examining Augmented Reality (AR) flashcards and Non-Augmented Reality (Non-AR) flashcards in isolation, with no concerted effort to directly and systematically compare the two approaches. Consequently, it is difficult to determine which method is actually more effective, especially for improving writing skills. Furthermore, cognitive aspects like writing accuracy and affective aspects such as learning motivation are often treated separately in discussions, even though they are interrelated in practice. This absence of comparative data ultimately leaves educators without practical, evidence-based guidance for selecting the most appropriate media for their specific classroom contexts. Equally important, the learning theories commonly cited as foundations, such as Dual-Coding Theory (Clark & Paivio, 1991), have not been rigorously tested for their applicability to both flashcard types within a writing instruction framework.

To address this gap, this study aims to conduct a comparative analysis between AR and non-AR flashcards. It will measure their impact on both the writing accuracy and learning motivation of EFL students, while also examining the relevance of key learning theories in this specific context. In doing so, it seeks to answer persistent questions that can guide more effective pedagogy.

The rationale for this investigation lies in its potential to provide research-based evidence for strategic educational decisions. As academic institutions face increasing pressure to adopt digital tools, there is a pressing need to determine whether innovative technologies like AR offer sufficient added value to justify their implementation costs and technical complexities. The present study meets this need by methodically comparing the learning outcomes of traditional and technology-enhanced methods in writing instruction, employing a qualitative and quantitative systematic literature review (SLR) methodology.

Unlike earlier research that examined AR and non-AR flashcards separately in isolated contexts(Ilhan Zakaria et al., 2025; Maharani & Santoso, 2023; Puspitasari et al., 2024; Dwi Permata et al., 2024; Ma'rifatul Khasanah & Sigit Yulianto, 2024; Allagui, 2021; Meisarah et al., 2023; Rizk & Al-Refaey, 2023), this study provides the first systematic comparative synthesis of both modalities specifically for EFL writing instruction. By integrating cognitive, affective, and pedagogical dimensions through a comprehensive SLR of empirical evidence from 2021 to 2025, this research moves beyond isolated findings to establish evidence-based patterns of effectiveness. Furthermore, it identifies which specific writing competencies (e.g., grammar, vocabulary, organization) and learner profiles benefit most from each flashcard type across diverse educational settings. This enables educators to make informed, context-sensitive decisions regarding technology adoption and resource allocation. Evidence from mobile AR implementations indicates that AR-based reading materials provide stronger support for EFL learners' reading comprehension and enjoyment compared to conventional book reading, suggesting parallel benefits for writing skill development (Mills et al., 2025).

The theoretical foundation of this research is Paivio's Dual-Coding Theory (Clark & Paivio, 1991), which proposes that learning is strengthened when information is processed through both verbal and visual channels simultaneously. This framework is particularly apt for comparing the visual-textual reinforcement provided by non-AR flashcards with the immersive, multimodal interaction offered by AR flashcards. The theory helps elucidate how

each flashcard type differentially supports the cognitive processes involved in writing development, from vocabulary recall to creative expression. The foundational principle that dual coding theory assumes cognition occurs in two independent but connected codes, a verbal code for language and a nonverbal code for mental imagery, has been successfully applied in digital language teaching contexts (Sadoski, 2005).

The potential contributions of this study are substantial for both practical application and empirical knowledge. Practically, it offers educators, particularly in Indonesian contexts where most of the included studies were conducted, evidence-based guidance for selecting flashcard media based on specific learning objectives, whether focused on accuracy or creativity. Empirically, it addresses a clear literature gap by delivering a systematic comparative synthesis, validates established learning theories within digital EFL writing contexts, and sets a methodological precedent for future balanced comparative research. The relevance of this research is further supported by evidence that AR groups using mobile games exhibited significant improvements in pragmatic skills compared to face-to-face and online learning approaches, demonstrating AR's potential across multiple language competencies (Moghaddam, 2025).

This research is guided by two fundamental questions;

1. How do AR flashcards and non-AR flashcards compare in their impact on EFL learners' writing skills?.
2. In what ways do motivation and learning experiences differ when EFL students use AR flashcards versus non-AR flashcards in writing activities?

METHOD

Design

This research employs a Systematic Literature Review (SLR) using the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) as the guiding methodological model (Page et al., 2021). The PRISMA 2020 framework was selected because it provides a structured and transparent protocol for identifying, screening, and synthesizing empirical evidence, which aligns with the comparative purpose of this review. The sequential process for identifying and selecting relevant studies is visually outlined using the PRISMA 2020 flow diagram (Figure 1).

The independent variable is defined as the category of flashcard medium (AR or non-AR). The dependent variables under investigation are learners' writing performance and their learning motivation. Writing performance is assessed based on metrics documented in the original studies, which may include specific scores in areas like grammar, vocabulary use, sentence construction, and overall writing proficiency in genres such as descriptive or recount texts. Learning motivation is gauged from data on student engagement, interest levels, self-confidence, and perceptions, as captured through instruments like surveys, observational notes, or interview transcripts in the reviewed articles.

It is important to acknowledge that certain procedural elements recommended by the full PRISMA 2020 standard were not feasible within the scope of this study. Specifically, the review protocol was not pre-registered in PROSPERO or any equivalent registry, and all screening and selection stages were conducted independently by the principal researcher rather than by two independent reviewers. These deviations are consistent with the constraints of individual academic research and are transparently reported in the Limitations section. Despite these constraints, the study adhered to the core principles of PRISMA 2020, including explicit inclusion and exclusion criteria, a structured multi-keyword search strategy, systematic quality appraisal using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist, and narrative synthesis informed by methodological transparency (Page et al., 2021).

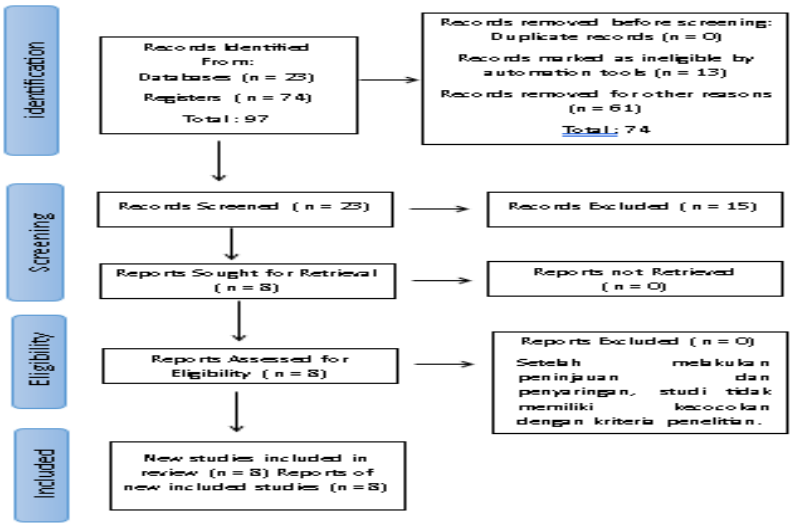

Figure 1. Procedures of the systematic literature review process

This systematic review identified and analyzed eight empirical studies published between 2021 and 2025 that investigated the use of flashcards in EFL writing instruction. The search and selection process, detailed in the PRISMA flow diagram (Figure 1), yielded five studies on non-AR flashcards and three studies on AR flashcards. The included studies encompassed diverse educational levels, from elementary to university students, and employed various research designs, including Classroom Action Research (CAR), experimental, and qualitative case studies.

Data search protocol and selection criteria

A systematic search was conducted across two electronic databases: Google Scholar and Taylor & Francis Online. Google Scholar was selected for its broad accessibility and wide coverage of Indonesian educational research publications, while Taylor & Francis was included for its indexed, peer-reviewed international journals in applied linguistics and educational technology. The search was conducted between January and March 2025, covering publications from 2021 to 2025. A total of 97 records were initially identified: 74 from Google Scholar and 23 from Taylor & Francis.

Search strings were specifically constructed for each database to optimize retrieval. For Google Scholar, the following Boolean search strings were applied: (1) "Augmented Reality Flashcards" AND "Writing Skills" AND "EFL"; (2) "Augmented Reality Flashcards" AND "Comparison" AND "Writing Skills" AND "EFL"; and (3) "Flashcards" AND "Traditional Writing Skills" AND "EFL". For Taylor & Francis, broader phrase-based searches were used, given the platform's internal search interface: (1) Augmented Reality Flashcards for EFL Learners; (2) Augmented Reality Flashcards in Writing Skills; (3) Using Flashcards for EFL Learners; and (4) Using Flashcards on Writing Skills for EFL Learners. These search strings were designed to ensure comprehensive coverage of both AR-specific and general flashcard-based interventions in EFL writing contexts, as detailed in Table 1.

Table 1. Search strings and databases used for literature retrieval

No.	Databases	Keywords
1.	Taylor and Francis	1. Augmented Reality Flashcards for EFL Learners. 2. Augmented Reality Flashcards in Writing Skills 3. Using Flashcards for EFL learners 4. Using Flashcards on Writing Skills for EFL Learners.

2.	Google Scholar	1. "Augmented Reality Flashcards" AND "Writing Skills" AND "EFL" 2. "Augmented Reality Flashcards" AND "Comparison" AND "Writing Skills" AND "EFL" 3. "Flashcards" AND "Traditional Writing Skills" AND "EFL"

Inclusion and exclusion criteria

A total of 97 records were retrieved from the initial database search (74 from Google Scholar and 23 from Taylor & Francis). Following the removal of duplicate entries and an initial title-level screening, all 97 records proceeded to the first eligibility phase. In the first screening stage, assessing the suitability of title, research variables, and subject population against the predefined inclusion criteria, 74 records were excluded due to misalignment with the research focus (e.g., studies not involving EFL learners, not examining flashcard interventions, or not measuring writing skills outcomes). This yielded 23 remaining records that proceeded to the second phase.

In the second screening stage, evaluating abstract content and direct topical relevance, particularly the explicit comparison or application of AR and/or non-AR flashcards in EFL writing contexts, a further 15 records were excluded for insufficient topical fit or failure to meet methodological inclusion criteria (e.g., non-empirical studies, absence of measurable writing outcomes). Full texts of the remaining candidates were subsequently assessed for eligibility using the criteria detailed in Table 2. Following this assessment, eight studies met all quality benchmarks, including an empirical research design, measurable EFL writing skill outcomes, and adequate methodological reporting, and were included in the final synthesis.

Table 2. Inclusion criteria and exclusion criteria

No.	*Inclusion Criteria*	*Exclusion Criteria*
1.	*Empirical studies published between 2021-2025*	*Non-empirical studies (e.g., theoretical papers, editorials).*
2.	*Studies involving EFL learners AR any educational level.*	*Studies not specifically focused on writing skills.*
3.	*Research investigating the use of AR flashcards or non-AR flashcards in writing instruction.*	*Publication without full-text availability.*
4.	*Studies measuring writing skills outcomes and/or motivational factors.*	*Studies not involving EFL learners.*

Instrument

The primary data collection instrument in this review was a Structured Data Extraction Form developed specifically by the researchers to systematically record information from each included study, covering: study characteristics (author, year, country, research design), participant information (sample size, education level), intervention details (type of flashcards, duration, implementation), outcome measures (writing skill indicators, motivational factors), and key findings. This form ensured consistency in data extraction across all eight studies. Search strategy and keywords are detailed in the Data Search Protocol section (Table 1), while the quality appraisal instrument (adapted JBI Critical Appraisal Checklist) is described in the Risk of Bias and Study Quality Assessment section.

Data sources and ethical considerations

This review synthesizes data from participants in the selected empirical studies, not from new experimental subjects. It consolidates findings on EFL learners' writing performance and motivation from eight studies published between 2021 and 2025. The participants represented various educational stages, including elementary, junior high, senior high, and university students. Most studies were set in Indonesian educational contexts (e.g., public schools, Islamic schools, universities), with one conducted in the Middle East. While the primary studies did not uniformly specify participants' English proficiency levels, all learners shared the common context of being EFL students developing their writing skills. Study selection followed the PRISMA 2020 framework (see Figure 1 and Table 2), not direct participant sampling.

Primary searches utilized Google Scholar for its accessibility and broad coverage in this research area, though this may have limited access to studies in specialized databases. This limitation is acknowledged here for transparency and is further discussed in the Limitations section.

As a systematic literature review without direct human subject interaction, this synthesis did not require separate ethical clearance. Ethical responsibility remains with the researchers of each primary study analyzed. The main inclusion criteria targeted primary empirical studies. Although some systematic review articles appeared in search results due to topical relevance, they were excluded from the core comparative analysis of flashcard

effectiveness, as this review focuses on synthesizing direct evidence from intervention studies. Insights from these reviews were used sparingly, only to provide field context in the introduction and discussion.

Risk of bias and study quality assessment

A dedicated quality appraisal was conducted to assess the methodological rigor and risk of bias of the included studies. This appraisal employed an adapted version of the Joanna Briggs Institute (JBI) Critical Appraisal Checklist, selected for its flexibility and established validity in evaluating diverse study designs common in educational research, such as quasi-experimental studies, case studies, and classroom action research. The adaptation focused on criteria most relevant to intervention studies in EFL contexts, including: (1) clarity of research aims and alignment with design, (2) appropriateness of participant selection and context description, (3) detailed description of the flashcard intervention (AR or non-AR), (4) validity and reliability of outcome measures for writing and motivation, (5) appropriateness of data analysis methods, and (6) logical connection between results and conclusions.

Each of the eight studies was independently evaluated. A scoring system was not used to categorically exclude studies, as the field is nascent and the corpus was small. Instead, the appraisal served two key purposes: first, to ensure a minimum threshold of methodological credibility for inclusion (all studies demonstrated basic coherence); and second, to inform the narrative synthesis by identifying strengths and limitations, allowing for a more nuanced interpretation of findings. The assessment revealed that the included studies generally exhibited a moderate risk of bias, primarily due to the common use of non-randomized designs, the absence of blinding, and potential confounding variables in classroom-based research. These limitations are considered in the discussion of the findings.

Data analysis technique

Data analysis was conducted in three sequential stages, employing both qualitative thematic analysis and basic quantitative synthesis. First, in the Comprehensive Reading and Data Extraction stage, all eight included studies were thoroughly reviewed, and pertinent data were extracted and organized using the structured extraction form. This included recording numerical data on participant counts, pre-post test scores where available, and qualitative findings on motivation and engagement.

Second, during the Thematic Analysis and Categorization stage, extracted findings were systematically coded and grouped into recurring thematic categories: (1) Effectiveness on specific writing components (grammar, vocabulary, organization), (2) Impact on motivational and affective factors (engagement, interest, confidence), and (3) Pedagogical efficiency and learner experience. Third, in the Comparative Analysis stage, the thematic findings across AR and non-AR flashcard studies were systematically juxtaposed to identify patterns of complementary or divergent effectiveness. This involved comparing reported outcomes, effect magnitudes (where quantifiable through reported statistics), and consistency of results across studies. Due to methodological heterogeneity across included studies, varying research designs, measurement instruments, and treatment durations, a formal meta-analytic statistical synthesis was not feasible; instead, a narrative synthesis approach was adopted to interpret patterns across studies, with interpretive priority given to studies demonstrating greater methodological rigor as identified through the quality appraisal process.

RESULT AND DISCUSSION

Finding

This section presents the findings of the systematic review based on the two research questions: (1) the comparative effectiveness of AR versus non-AR flashcards on EFL writing skills, and (2) differences in motivation and learning experience between the two modalities.

a. Comparative effectiveness on writing performance

A synthesis of five empirical studies on non-AR flashcards revealed consistent improvements in the mechanical aspects of writing following intervention.

Table 3. Effectiveness of non-augmented reality flashcards on EFL writing skills

No	*Researcher*	*Year*	*Research Design*	*Key Outcomes*	*Results*
1.	*Maharani & Santoso*	*2023*	*Classroom Action Research (CAR)*	*Writing Skills (Verbs)*	*Significant improvement in post-test scores.*
2.	*Zakaria et al.*	*2025*	*Qualitative Case Study*	*Vocabulary, Past Tense, Sentence Structure*	*Effective in overcoming vocabulary limitations and improving sentence structure.*
3.	*Puspitasari*	*2024*	*Collaborative*	*Writing Skills,*	*Significant*

	et al.		*CAR*	*Student Engagement*	*improvement in writing skills and student engagement.*
4.	*Dwi Permata, A., Juniardi, Y., & Baihaqi, A.*	*2024*	*Quantitative approach*	*Students' writing ability (Simple Past Tense)*	*The study found that flashcards have a significant impact on students' writing abilities.*
5.	*Ma'rifatul Khasanah and Sigit Yulianto.*	*2024*	*Quantitative experimental method*	*Writing Performance*	*Significantly improved writing skills.*

In contrast, the two studies focusing on AR flashcards (Allagui, 2021; Meisarah et al., 2023), summarized in Table 4, reported positive effects on writing skills but through a different lens. (Allagui, 2021) noted improved writing skills in descriptive paragraphs, and Meisarah et al. (2023) found a positive influence of AR features on descriptive text writing ability. However, the quantitative data from these studies did not isolate gains in discrete grammatical or vocabulary items as prominently as the non-AR studies. Instead, improvements were often reported holistically in relation to task completion and descriptive ability.

Table 4. Effectiveness of augmented reality flashcards on EFL writing skills

No	*Researcher*	*Year*	*Research Design*	*Key Outcomes*	*Results*
1.	*Allagui*	*2021*	*Pre-assessment + AR Treatment*	*Writing Skills, Attitudes*	*Improved Writing Skills*
2.	*Meisarah et al*	*2023*	*Quantitative Experimental (Post-test-only control design)*	*Descriptive Text Writing Ability*	*An influence between using augmented reality features and students' writing abilities.*

The analysis reveals a clear pattern of complementary effectiveness. The five non-AR studies consistently demonstrate efficacy in improving discrete, accuracy-based components of writing, such as specific grammar points (e.g., verbs, tenses) and vocabulary recall. Conversely, the AR studies highlight strengths in fostering holistic descriptive ability and idea generation. This dichotomy suggests that non-AR tools are optimal for building linguistic precision, while AR tools excel as a catalyst for creative fluency and contextual language use. This differentiated effectiveness aligns with digital flashcard research showing smartphone-based platforms demonstrated the most pronounced improvements through statistically significant vocabulary learning gains (Zarrati et al., 2024a)

b. *Impact on motivation and learning experience*

The analysis of affective outcomes revealed a distinct focus between the two flashcard modalities. Studies on non-AR flashcards primarily measured writing performance, with motivational aspects such as increased student activity and confidence often mentioned as secondary observations. For instance, (Puspitasari et al., 2024) reported enhanced student engagement alongside improved writing skills.

Conversely, research on AR flashcards placed motivational and experiential factors at the core of their investigation. (Allagui, 2021) reported that the AR tool significantly improved students' motivation, engagement, and attitudes toward writing, with students expressing high satisfaction and a desire to use the tool again. Similarly, Rizk and Al-Refaey (2023) in their quasi-experimental study found a statistically significant positive effect of Mobile Augmented Reality (MAR) applications on students' engagement during writing tasks.

Table 5. Impact of augmented reality flashcards on EFL student motivation and learning experience

No	*Researcher*	*Year*	*Research Design*	*Key Outcomes*	*Results*
1.	*Dr. Samah Rizk R. Al-Refaey*	*2023*	*Quasi-Experimental Approach using a two independent group design with pre-post administration.*	*Engagement in Writing Skills*	*A significant positive impact of Mobile Augmented Reality (MAR) Applications on both student motivation (Engagement) and writing learning experience was found.*
2.	*Allagui*	*2021*	*Pre-assessment + AR Treatment*	*Attitudes and Motivation*	*AR significantly improved students' motivation, engagement, and attitudes toward writing.*

These findings show that AR flashcards do more than support writing cognitively; they transform the affective experience of learning. By fostering greater engagement and intrinsic motivation, AR sustains writing practice beyond the classroom, enabling long-term development. While non-AR flashcards effectively build mechanical accuracy, AR flashcards act as motivational catalysts, addressing both the skill and will of writing. This distinction is

critical in EFL contexts, where student motivation and willingness to write in English are often key to learning success and language retention.

Discussion

This systematic review demonstrates a strong complementary relationship between AR and non-AR flashcards in teaching EFL writing, as elucidated by Dual-Coding Theory (Clark & Paivio, 1991). The evidence does not suggest newer technology is inherently superior; instead, each tool excels in distinct aspects of writing development. The following discussion is organized into three main sections: cognitive outcomes, affective-motivational outcomes, and pedagogical efficiency, all consistently framed within the chosen theoretical lens and compared with relevant international literature.

1. *Cognitive outcomes*

Analysis of five studies on non-AR flashcards consistently confirms their effectiveness in enhancing the mechanical components of writing, such as grammar, vocabulary, and sentence accuracy. For instance, research by Maharani and Santoso (2023) reported significant improvements in verb writing scores, while Permata et al. (2024) demonstrated measurable gains in Simple Present Tense mastery. These findings support Dual-Coding Theory (Paivio, 1971), which posits that simultaneous verbal and visual processing strengthens memory. This mechanism aligns with the concept introduced by Clark and Paivio (1991), who argued that individual elements can be merged into a single, unified mental representation, where recalling one part is sufficient to trigger the retrieval of the entire memory structure. Non-AR flashcards operationalize this principle through static image-text pairing, enabling accurate recall of discrete grammar rules. AR flashcards extend redintegration further by generating dynamic, interactive, unified images that trigger richer descriptive detail and contextual language use. This dual presentation creates strong memory connections that are particularly effective for learning discrete linguistic elements such as grammar rules and vocabulary items, as evidenced by Luo (2022). The static nature of non-AR flashcards allows learners to focus their cognitive resources on encoding these specific linguistic forms without distraction, explaining why these studies consistently report improvements in vocabulary retention and sentence structure accuracy

Conversely, the cognitive benefits of AR flashcards are broader, particularly in idea development, descriptive elaboration, and contextual language application. (Allagui, 2021) noted improved skills in writing descriptive paragraphs, and Meisarah et al. (2023) observed the positive influence of AR features on descriptive text quality. This theoretical framework, which posits that cognition occurs through independent but connected verbal and nonverbal codes, has been validated across multiple digital language learning contexts, demonstrating its applicability to both traditional and technology-enhanced instructional approaches (Mark Sadoski, 2005) These results also align with the principles of Dual-Coding Theory (Clark & Paivio, 1991) where the dynamic and interactive visual representations in AR provide richer and more varied memory traces, thereby supporting deeper information processing. Consistent with this, international research by Shadiev and Yang (2020) concluded that technological tools can significantly aid idea organization and contextual language use in descriptive and narrative writing tasks.

2. *Affective–motivational outcomes*

The motivational advantages of AR are distinctly evident across the reviewed studies. (Allagui, 2021) found more positive attitudes and higher motivation levels when students used AR for descriptive writing. Quantitatively, Rizk and Al-Refaey (2023) provided evidence that Mobile Augmented Reality applications had a highly significant positive impact on student engagement in writing tasks. This finding aligns with broader research in mobile-assisted language learning (MALL), which confirms that mobile technologies consistently yield "increased motivation, engagement, or enjoyment of language learning" (Hampel et al. 2024)**.** These affective benefits can be explained through the lens of Dual-Coding Theory: the more immersive and interactive visual-verbal integration in AR heightens perceptual interest, reduces monotony, and makes learning tasks more appealing, ultimately fostering greater engagement and positive emotion among learners.

In contrast, non-AR flashcards, while effective for language accuracy, are less capable of eliciting the same level of emotional involvement. Improvements in motivation in non-AR studies were often secondary outcomes, whereas in AR contexts, affective factors were central drivers of learning success. This pattern indicates that the immersive quality of AR not only strengthens dual-coding cognitively but also enriches its affective dimension, making the learning experience more enjoyable and motivationally sustainable over time.

3. *Pedagogical efficiency*

Pedagogical efficiency refers to the alignment between instructional tools, learning objectives, and teaching contexts. The findings of this review indicate that no single flashcard type is universally superior; instead, both types fulfill distinct and complementary functions. When instructional goals center on linguistic accuracy, non-AR flashcards prove to be highly effective, especially in settings with limited resources. Their straightforward design, affordability, and ease of implementation make them well-suited for reinforcing vocabulary recall and sentence structures through a basic dual-coding mechanism.

Conversely, AR flashcards demonstrate greater efficiency in learning environments that emphasize creativity, active participation, and sustained motivation. Nevertheless, their successful integration depends on sufficient technological infrastructure, adequate teacher preparation, and deliberate curriculum planning. The evidence points to AR flashcards being most beneficial in situations where a richer and more immersive dual-coding experience is needed to foster descriptive writing, idea generation, and intrinsic motivation among students. This nuanced view supports the notion that the value of an instructional tool is determined not by its technological sophistication but by how well it aligns with the principles of Dual-Coding Theory (Luo, 2022) and the specific goals of teaching and learning.

The foundational premise of this research is anchored in Paivio's (1971) Dual-Coding Theory. This framework elucidates that human information processing occurs through distinct yet synergistic verbal and nonverbal (imaginal) systems. The concurrent stimulation of these pathways via combined textual and visual inputs, as seen in flashcards, is posited to fortify memory retention and recall. Supporting this theory, Paivio's research demonstrates that the fastest recognition occurs through the dual activation of visual and verbal memory codes, where images and words work together to facilitate rapid recall (Filieri et al., 2021). This theoretical foundation explains why both non-AR and AR flashcards, which combine textual vocabulary with visual representations, effectively facilitate learning. However, AR extends this dual-coding process by providing immersive, interactive, and contextually rich visual experiences, thereby enhancing both cognitive encoding and affective engagement in writing tasks.

This study reinforces and extends Dual-Coding Theory (Luo, 2022) in the context of technology-enhanced language learning. It validates the theory in both static and dynamic

visual aids, showing that while non-AR flashcards strengthen verbal-visual associations for memorization, AR flashcards enrich these associations through interactive and immersive experiences, leading to improved creative expression and motivation.

Moreover, this research introduces a complementary effectiveness model for flashcard media in EFL writing, arguing that tool selection should be objective-aligned rather than technology-driven. This model is grounded in Dual-Coding Theory, offering a coherent framework for understanding how different media support different phases of writing instruction from mechanical accuracy to creative fluency.

The differentiated effectiveness observed in this review echoes findings from broader international research. In line with a recent study by Wang et al. (2025), Mobile Augmented Reality-based Vocabulary Learning (MARVL) consistently outperforms traditional methods in language assessments due to its high levels of satisfaction and usability. This efficacy is further supported by Zarrati et al. (2024b), who emphasize the superior effectiveness of smartphone devices in facilitating academic vocabulary acquisition. Although Theodorou et al. (2023) suggest that AR interventions do not always yield drastic performance differences, the data in this study demonstrate that the visual stimulation provided by AR flashcards assists students in overcoming barriers in descriptive writing through stronger vocabulary retention, as validated by Karimi and Amiri (2025).

It is essential to acknowledge that the findings presented here should be interpreted with awareness of certain methodological constraints identified in the quality assessment. The included studies primarily employed non-randomized designs such as classroom action research and quasi-experimental approaches, which, while appropriate for authentic classroom contexts, introduce inherent risks of selection bias and limit causal inference. Furthermore, the absence of blinding in these instructional interventions means that both instructors and learners were aware of the treatment condition, potentially influencing outcomes through expectancy effects or differential effort. Additionally, classroom-based research naturally involves confounding variables such as teacher experience, class dynamics, and prior student ability that are difficult to control fully. These limitations do not invalidate the reported findings but do suggest that the observed effects should be viewed as indicative rather than definitive, and that replication in more controlled, randomized settings would strengthen confidence in the comparative effectiveness patterns identified in this review.

In conclusion, the effectiveness of AR in this context is measured not only by final test scores but also by its ability to build intrinsic motivation, which serves as a foundation for sustainable writing development among EFL learners.

CONCLUSION AND IMPLICATION

Conclusion

This systematic review synthesizes evidence to advance a pivotal, theory-informed argument: AR and non-AR flashcards serve complementary yet distinct pedagogical functions in EFL writing instruction. The analysis reveals that non-AR flashcards are demonstrably more effective for developing linguistic accuracy, such as grammatical structures and vocabulary mastery, a finding that robustly aligns with Paivio's Dual-Coding Theory concerning verbal-visual association. In sharp contrast, AR flashcards prove superior as an effective and creative engine, significantly enhancing student motivation, engagement, and descriptive fluency through enriched and interactive dual-channel processing. This clear demarcation culminates in a principle of complementary effectiveness, which posits that the optimal instructional tool is not inherently superior but is determined by the specific learning objective, whether it targets cognitive precision or creative-affective outcomes.

The primary theoretical takeaway from this principle is the validation of Dual-Coding Theory as a comprehensive framework for understanding educational technology in EFL writing, where media affordances directly activate specific verbal and visual processing mechanisms. Consequently, a critical practical implication for curriculum design and teaching policy is the necessity for objective-aligned media selection. Beyond indiscriminate technology integration, educators and institutions should strategically deploy non-AR tools for accuracy-focused practice and reserve AR interventions for tasks explicitly designed to foster creativity, reduce writing apprehension, and cultivate sustained motivational investment to ensure that pedagogical choices are both evidence-based and purposefully efficient.

Limitation

The present investigation acknowledges several limitations that warrant consideration. Although the literature search was conducted across two databases, Google Scholar and Taylor & Francis Online, all eight studies that met the inclusion criteria were sourced exclusively from Google Scholar, with no studies from Taylor & Francis passing the full

screening process, suggesting a potential source bias that may affect the representativeness of the synthesized evidence. Furthermore, the use of only two databases limits the overall scope of the search, as relevant studies indexed in specialized databases such as ERIC, Scopus, or Web of Science may not have been captured. Beyond the database constraints, the notable corpus imbalance between AR (n=3) and non-AR (n=5) studies limits the robustness of the comparative analysis and may skew the interpretation of differential effectiveness, while methodological variations across the included studies, including diverse research designs (e.g., CAR, experimental, qualitative), measurement instruments, and treatment durations further complicate direct comparisons of effect sizes and outcomes. Finally, the predominant Indonesian context of the analyzed studies may restrict the generalizability of findings to other cultural, linguistic, and educational settings, highlighting a need for more geographically diverse research.

Implication

The findings offer theoretical validation of Dual-Coding Theory within digital EFL writing contexts, while practically guiding educators toward objective-aligned media selection: non-AR flashcards for accuracy-focused instruction, and AR flashcards for motivation and creativity. However, the corpus imbalance between AR and non-AR studies, coupled with the predominance of Indonesian contexts and methodological variations, necessitates cautious generalization of these findings. To overcome the identified limitations, future research should prioritize experimental comparative studies with balanced designs, mixed-method classroom trials to capture pedagogical dynamics, and cross-cultural replications to test generalizability beyond the Indonesian context, ultimately informing evidence-based, context-sensitive integration of both flashcard types.

ACKNOWLEDGEMENT

The author expresses sincere gratitude to the supervisor who has accompanied me during the writing process and the members of the academic community of Walisongo State Islamic University, Semarang, for their invaluable support.

Special appreciation is extended to all researchers and educators whose pioneering work in educational technology made this comparative analysis possible. Constructive

feedback from peers and mentors throughout the research and writing process is also deeply appreciated.

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