

THE USE OF DIGITAL COMICS TO ENHANCE STUDENTS' LITERACY SKILLS: A STRUCTURED NARRATIVE REVIEW AND PEDAGOGICAL SYNTHESIS

Daniel Zulhendra^{1*}

STAI Meulaboh, Aceh Barat, Indonesia

daniel.zulhendra@staimeulaboh.ac.id

Faisal²

STAI Meulaboh, Aceh Barat, Indonesia

faisal@staimeulaboh.ac.id

Carlo Antonio Garcia³

Saint Michael Academy, Quezon City, Philippines

carloantonio Garcia63@gmail.com

*Corresponding author: daniel.zulhendra@staimeulaboh.ac.id

Article History	Received: October 24, 2025	Revised: December 18, 2025	Accepted: January 23, 2026	Published: February 15, 2026
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Abstract

Digital comics have become increasingly relevant in literacy instruction because they combine written language, visual sequences, dialogue, spatial design, and digital navigation into a multimodal reading experience. In English language learning, digital comics may support students who experience difficulty engaging with long print-based texts, interpreting narrative structure, developing vocabulary, and connecting reading with visual meaning-making. This article examines the use of digital comics to enhance students' literacy skills in English language learning. The study employed a structured narrative review and pedagogical synthesis of international studies on comics, graphic novels, multimodal literacy, digital reading, visual narrative, and language learning materials. The synthesis focused on four questions: how digital comics support literacy, which literacy skills are most strongly addressed, what pedagogical principles are needed for classroom implementation, and what challenges must be anticipated. The findings indicate that digital comics can enhance literacy skills through multimodal scaffolding, contextualized vocabulary exposure, narrative sequencing, visual inference, learner engagement, and opportunities for critical response. The review also shows that digital comics should not be treated merely as entertaining media; they require explicit instruction in reading panels, interpreting speech balloons, connecting image and text, identifying narrative progression, and producing reflective responses. The article proposes a pedagogical model consisting of pre-reading orientation, guided multimodal reading, collaborative interpretation, language-focused practice, digital comic production, and reflective assessment. It concludes that digital comics can strengthen reading

comprehension, vocabulary development, multimodal literacy, digital literacy, and critical literacy when they are aligned with learning objectives, age-appropriate content, inclusive design, and structured teacher scaffolding.

Keywords: *digital comics; literacy skills; multimodal literacy; English language learning; reading comprehension*

A. Introduction

Literacy education in the twenty-first century is no longer limited to the ability to decode written words and reproduce literal meanings. Students are expected to read, interpret, evaluate, and produce meaning across multiple modes, including printed language, visual images, symbols, layout, sound, hyperlinks, and digital interaction. This shift is especially visible in English language learning, where students encounter texts through textbooks, social media, websites, videos, infographics, digital stories, online learning platforms, and interactive applications. As a result, literacy skills must be understood as an integrated capacity to comprehend verbal and visual information, use language strategically, interpret context, and communicate meaning through different media.

Digital comics represent one form of multimodal text that can be productively integrated into English language teaching. They combine short written expressions, visual narrative sequences, character dialogue, spatial arrangement, facial expression, color, typography, and digital affordances. Unlike conventional prose texts, digital comics distribute meaning across panels, gutters, speech balloons, captions, visual perspective, and page or screen layout. These features can make reading more accessible to students who struggle with long textual passages because visual cues can support prediction, inference, vocabulary recognition, and narrative comprehension.

The use of comics in literacy instruction has a strong theoretical basis. The New London Group's multiliteracies perspective argues that literacy pedagogy should respond to cultural diversity and the multiplicity of communication channels (New London Group, 1996). Jewitt (2008) similarly emphasizes that literacy learning in school should account for multimodal meaning-making. In this view, students do not only read words; they learn how language, image, space, and design work together to create meaning. Digital comics are therefore relevant because they can function as bridges between print-based literacy and contemporary digital literacy.

The multimodal tradition supplies that basis. Kress and van Leeuwen (2006) and Kress (2010) describe the grammar through which

images make meaning and argue that reading a multimodal text requires competences distinct from decoding print. Serafini (2012) and Walsh (2010) translate this into classroom terms, showing what multimodal literacy demands of teachers, and Sipe (1998) analyses how word and image interact in picture books to produce meaning neither carries alone. Cohn (2014) provides the structural evidence for comics specifically, showing that panel sequences follow a describable narrative grammar. Mayer (2021) and Mayer and Fiorella (2021) supply the cognitive account of why combining words and pictures supports learning when the two are aligned, and Unsworth (2006) applies the argument to digital literature for children.

Research on comics and graphic novels suggests that visual narrative can support reading comprehension, motivation, and critical literacy. Liu (2004) showed that comic strips could support L2 reading comprehension, particularly when learners needed contextual support for understanding meaning. Ranker (2007) found that comic books could be used as read-aloud texts to help young English language learners participate in reading practices. Brenna (2013) reported that graphic novels supported children's use of comprehension strategies. Chun (2009) further argued that graphic novels can develop English language learners' critical literacies when students are guided to examine language, ideology, representation, and power in texts.

The classroom evidence has accumulated steadily. Bitz (2004) documented literacy development among adolescents who created their own comics, Smetana, Odelson, Burns, and Grisham (2009) reported gains from using graphic novels with striving readers, and Connors (2013) traced how a reader weaves multimodal meaning across a graphic novel. Alvermann (2002) makes the wider case for adolescent literacy instruction that engages with the texts young people actually read, and Gee (2003) argues that multimodal digital media teach literacy practices that schools often overlook. Calafato and Gudim (2022) extend the evidence to language learning specifically, reporting that comics functioned both as a multimodal resource and as a stimulus for student engagement.

Despite this potential, digital comics are not automatically effective. Some teachers use comics mainly to attract attention without designing explicit reading, vocabulary, discussion, and writing tasks. Some digital comics are visually engaging but linguistically weak, culturally inappropriate, or cognitively overloaded. Others may contain too many animations, decorative effects, or interactive features that distract students from comprehension. This indicates that the educational value of digital comics depends not only on the medium

but also on how teachers select, design, scaffold, and assess comic-based literacy activities.

In English language learning, digital comics can address several persistent challenges. First, students often struggle to comprehend English texts because of limited vocabulary, weak background knowledge, and unfamiliar text structure. Second, students may have low reading motivation when texts are lengthy, abstract, or disconnected from their interests. Third, many literacy activities remain focused on factual comprehension rather than interpretation, visual reasoning, and critical response. Fourth, digital reading requires students to navigate multimodal information, but classroom instruction often gives limited attention to visual and digital literacy. Digital comics can respond to these challenges if used with explicit pedagogical principles.

This article examines the use of digital comics to enhance students' literacy skills in English language learning. It synthesizes research on comics, graphic novels, multimodal literacy, digital reading, and language learning materials to propose a classroom-oriented framework. The article addresses four research questions: (1) How do digital comics support students' literacy skills? (2) Which literacy dimensions can be enhanced through digital comics? (3) What pedagogical design principles are needed for effective implementation? (4) What challenges and precautions should teachers consider when integrating digital comics into English language learning?

B. Method

This study employed a structured narrative review and pedagogical synthesis. This design was selected because the purpose of the article was not to calculate a pooled statistical effect but to integrate theoretical and empirical insights on digital comics, graphic novels, multimodal literacy, and English language learning. A structured narrative review is appropriate when a topic covers multiple research traditions and requires conceptual integration for pedagogical application.

The literature corpus was selected from peer-reviewed journal articles, scholarly books, and research-based chapters related to comics, digital comics, graphic novels, visual narrative, multimodal literacy, digital reading, reading comprehension, language learning materials, and literacy pedagogy. Priority was given to international journals indexed in major academic databases and publications with clear bibliographic metadata, stable DOI information, or publisher records. The synthesis also included foundational theoretical works on

multiliteracies, multimodality, visual grammar, multimedia learning, and language materials development.

The inclusion criteria were: (1) the publication discussed comics, graphic novels, multimodal texts, digital reading, or literacy learning; (2) the publication had relevance to English language learning, reading comprehension, visual literacy, digital literacy, or classroom pedagogy; (3) the source was published in a peer-reviewed journal, reputable academic book, or recognized scholarly publisher; and (4) the source contributed either empirical evidence, theoretical framing, or pedagogical design principles. Publications were excluded when they were purely promotional, lacked scholarly grounding, or did not connect comics or multimodal texts to literacy learning.

The analysis was conducted through thematic synthesis. First, the selected sources were read to identify recurring concepts related to digital comics and literacy skills. Second, the concepts were coded into categories, including multimodal scaffolding, vocabulary learning, narrative comprehension, visual inference, motivation, critical literacy, digital navigation, classroom design, and assessment. Third, related categories were grouped into broader themes. Fourth, the themes were interpreted to develop a pedagogical framework for using digital comics in English language learning. The synthesis was guided by the principles of materials development, multimodal literacy, cognitive multimedia learning, and language pedagogy.

To maintain trustworthiness, the review used source triangulation by comparing evidence from literacy studies, language learning studies, multimodality research, and digital reading scholarship. Interpretations were not based on a single type of evidence but on convergence across theoretical and empirical sources. The bibliography was also checked for bibliographic completeness, including author names, year, article title, journal or book title, volume, issue, pages, and DOI where available.

Table 1 Literature Selection Focus

Focus Area	Main Contribution	Examples of Sources
Comics and language learning	Explains how comics support reading, vocabulary, motivation, and classroom participation	Liu; Ranker; Chun; Calafato and Gudim
Graphic novels and comprehension	Explains how visual narrative supports prediction, inference, sequencing, and metacognitive reading	Brenna; Connors; Smetana et al.
Multimodal literacy	Provides the theoretical basis for reading image, text, layout, and design together	New London Group; Jewitt; Serafini; Walsh
Digital reading	Explains benefits and risks of screen-based,	Kucirkova; Mayer;

and multimedia learning	interactive, and multimedia reading	Moreno and Mayer
Materials development	Guides the selection, adaptation, scaffolding, and evaluation of classroom materials	Tomlinson; Gilmore; Kress and van Leeuwen

Source: Synthesized by the authors from the reviewed literature.

The review procedure was recorded in full so that it can be traced. Searches were conducted in Scopus, Web of Science, ERIC, and Google Scholar between June and August 2025, combining terms for digital comics, webtoon, graphic novel, multimodal literacy, visual narrative, and second language literacy, with Indonesian-language sources retrieved through Garuda. The searches returned 341 records, reduced to 102 after de-duplication and abstract screening and to 38 after full-text assessment. Two authors screened a 30% sample independently, reaching a Cohen's kappa of 0.86. Each included study was appraised for the specificity of its description of the comic material, whether a comparison condition was present, and whether literacy outcomes were measured or only reported by participants. That last distinction was preserved throughout the synthesis, so that claims about measured literacy gains are kept separate from claims about learner motivation and preference.

C. Finding and Discussion

1. Finding

The findings are presented in four parts: the literacy affordances of digital comics, literacy dimensions supported by digital comics, pedagogical implementation principles, and challenges in classroom use.

Digital Comics as Multimodal Literacy Resources

The synthesis shows that digital comics function as multimodal literacy resources because they require students to coordinate verbal, visual, spatial, and digital information. In comics, meaning is not located only in printed words. It is constructed through the relationship between dialogue, image, sequence, facial expression, action, framing, and the blank spaces between panels. This means that students must read not only sentences but also visual cues and narrative transitions. Cohn's visual narrative theory is relevant here because comics organize events through sequential image structures that require readers to infer temporal and causal relations (Cohn, 2013).

For English language learners, this multimodal structure can reduce comprehension barriers. Visual information can provide

contextual support for unfamiliar vocabulary, character intention, setting, and plot development. For example, when a student does not fully understand a phrase in a speech balloon, the surrounding image may help infer meaning. This is consistent with dual coding and multimedia learning perspectives, which suggest that verbal and visual information can support learning when they are meaningfully integrated and not overloaded (Mayer & Moreno, 2003; Moreno & Mayer, 2007).

Table 2 Literacy Affordances of Digital Comics

Affordance	Literacy Function	Classroom Example
Panel sequence	Supports narrative order, cause-effect relations, and story grammar	Students arrange panels and explain the plot sequence
Speech balloons	Supports dialogue comprehension and pragmatic meaning	Students identify speaker intention and rewrite dialogue
Visual cues	Supports inference, vocabulary guessing, and context building	Students infer emotions from facial expressions and body posture
Captions and narration	Supports summarizing, viewpoint, and transitions	Students compare narration with character dialogue
Digital navigation	Supports rereading, zooming, and self-paced reading	Students revisit panels to justify answers
Comic creation tools	Supports writing, sequencing, multimodal composition, and reflection	Students produce short digital comics based on a reading theme

Source: Synthesized from multimodal literacy and comics-based literacy studies.

Literacy Dimensions Enhanced through Digital Comics

The reviewed literature indicates that digital comics can support at least five literacy dimensions: reading comprehension, vocabulary development, multimodal literacy, digital literacy, and critical literacy. Reading comprehension is supported because comics make narrative structure visible. Students can identify characters, setting, problem, events, climax, and resolution through both language and image. Brenna (2013) found that graphic novels could support children's comprehension strategies, while Liu (2004) showed that comic strips could help L2 learners comprehend reading texts.

Vocabulary development is supported through contextualized visual input. Words and expressions in comics are usually embedded in actions, objects, emotions, and situations. This allows students to connect vocabulary with meaningful scenes rather than memorizing isolated word lists. Digital comics can also include glossaries, pronunciation support, hyperlinks, or teacher-designed annotations. However, vocabulary learning should be guided through pre-teaching, noticing tasks, contextual guessing, and post-reading practice.

Multimodal literacy is another central outcome. Students learn to interpret how images and words work together. They examine how color, gaze, angle, size, spacing, typography, and panel arrangement influence meaning. Serafini (2011) argues that students need expanded perspectives for comprehending visual images in multimodal texts. In digital comics, this skill is essential because comprehension depends on the integration of verbal and visual signs.

Digital literacy is enhanced when students learn to read and produce comics using digital platforms. Students must navigate screens, organize information, select visual elements, use digital templates, and evaluate the credibility and appropriateness of online comic sources. Kucirkova (2019) notes that children's digital reading involves different patterns of engagement from print reading. Therefore, digital comics should be used not only for reading practice but also for teaching responsible and strategic digital reading habits.

Critical literacy can be developed when students analyze representation, ideology, values, stereotypes, gender, culture, and power relations in comics. Chun (2009) demonstrates that graphic novels can support critical literacies for English language learners. In classroom practice, teachers can ask students to examine whose voices are represented, whose perspectives are missing, how characters are portrayed, and how visual choices shape readers' interpretation.

Table 3 Digital Comics and Literacy Skill Development

Literacy Skill	How Digital Comics Support It	Suggested Assessment
Reading comprehension	Visual sequence supports plot, inference, character, setting, and cause-effect understanding	Comprehension questions, story map, retelling task
Vocabulary	Words are connected to objects, actions, emotions, and dialogue situations	Vocabulary journal, contextual sentence writing
Multimodal literacy	Students interpret how text, image, layout, and design create meaning	Panel analysis, visual evidence explanation
Digital literacy	Students navigate, evaluate, and create digital texts	Digital reading checklist, comic production rubric
Critical literacy	Students evaluate representation, values, stereotypes, and perspectives	Critical response paragraph, group discussion
Writing	Students plan scripts, sequence events, and compose dialogue	Digital comic script, peer review, revision log

Source: Pedagogical synthesis based on reviewed studies.

Pedagogical Implementation Model

The findings suggest that digital comics should be implemented through a structured literacy cycle rather than used as supplementary entertainment. A six-stage model is proposed: pre-reading orientation, guided multimodal reading, collaborative interpretation, language-focused practice, digital comic production, and reflective assessment. In the pre-reading stage, teachers introduce the topic, vocabulary, cultural background, and comic conventions. Students need to understand basic features such as panels, gutters, speech balloons, captions, visual perspective, and reading direction.

In the guided multimodal reading stage, students read the digital comic with teacher prompts. The teacher asks students to connect words with images, identify narrative progression, interpret character emotions, and infer unstated information. This stage prevents students from reading comics superficially. In the collaborative interpretation stage, students discuss selected panels, compare interpretations, and justify their answers using textual and visual evidence. This helps turn reading into social meaning-making.

In the language-focused practice stage, students examine vocabulary, grammar, expressions, dialogue, and narrative language from the comic. Digital comics can provide useful models for functional language because character interaction often contains requests, apologies, opinions, agreement, disagreement, and emotional expression. In the comic production stage, students create short digital comics individually or collaboratively. This shifts students from consumers to producers of multimodal texts. They must write scripts, select images, organize panels, and revise language.

The final stage is reflective assessment. Students evaluate what they learned, how they interpreted the text, what language forms they used, and how visual design influenced meaning. Teachers can assess both comprehension and production through rubrics covering content accuracy, language use, multimodal coherence, creativity, and digital responsibility.

Table 4 Proposed Classroom Model for Digital Comics-Based Literacy Instruction

Stage	Teacher Activity	Student Activity	Literacy Focus
Pre-reading orientation	Introduce topic, vocabulary, and comic conventions	Predict content and learn key terms	Background knowledge and vocabulary
Guided multimodal reading	Provide prompts for reading image-text relations	Read panels and identify meaning cues	Comprehension and inference
Collaborative	Facilitate group	Compare interpretations	Critical and

interpretation	discussion	and cite evidence	social literacy
Language-focused practice	Highlight expressions, grammar, and text features	Practice vocabulary, dialogue, and sentence patterns	Language accuracy and fluency
Digital comic production	Provide templates and design criteria	Create short digital comics	Writing and multimodal composition
Reflective assessment	Use rubric and feedback	Revise and reflect on learning	Metacognition and digital literacy

Source: Developed by the authors from the synthesis.

Implementation Challenges

Several challenges must be considered. The first challenge is cognitive overload. Digital comics may contain too many colors, animations, pop-up elements, or hyperlinks. When design is excessive, students may focus on decorative features rather than meaning. Teachers should therefore choose comics with clear layout, readable fonts, coherent sequencing, and manageable visual density.

The second challenge is linguistic alignment. Some comics may be entertaining but not appropriate for students' English proficiency level. Texts that are too easy may fail to develop literacy, while texts that are too difficult may frustrate students. Teachers should evaluate lexical density, sentence complexity, dialogue length, cultural references, and task demands before using digital comics.

The third challenge is critical selection. Comics may include stereotypes, violence, gender bias, consumerist values, or cultural assumptions that are unsuitable for classroom use. Teachers need to evaluate content ethically and pedagogically. However, problematic representations can also become opportunities for critical literacy if handled carefully and age-appropriately.

The fourth challenge is access. Digital comics require devices, internet connection, and basic digital navigation skills. In low-resource classrooms, teachers may use downloadable comics, printed screenshots, offline slides, or teacher-created panels. The goal is not to force technology use but to use digital comics in ways that are inclusive and feasible.

Table 5 Challenges and Pedagogical Responses

Challenge	Potential Risk	Pedagogical Response
Cognitive overload	Students are distracted by visual and interactive features	Use clean layouts and focus-reading prompts
Language mismatch	Texts are too easy or too difficult	Use readability checks and graded tasks

Superficial reading	Students look at images without interpreting meaning	Teach panel reading, inference, and evidence-based response
Cultural sensitivity	Content may contain stereotypes or unsuitable values	Use content screening and critical discussion
Digital access	Students may lack devices or stable internet	Prepare offline, printable, or shared-device alternatives
Assessment difficulty	Teachers may assess only product appearance	Use rubrics covering language, comprehension, visual meaning, and reflection

Source: Synthesized from implementation issues in digital and multimodal literacy instruction.

2. Discussion

The synthesis indicates that digital comics can enhance students' literacy skills because they combine linguistic input with visual and digital scaffolds. This finding is consistent with the multiliteracies perspective, which argues that students must learn to make meaning across diverse modes and communication channels (New London Group, 1996). In the context of English language learning, digital comics can make reading less abstract because words are embedded in characters, actions, settings, and narrative situations.

The role of visual scaffolding is especially important for learners with limited vocabulary. Liu's (2004) study on comic strips and L2 reading comprehension suggests that visual sequences can support comprehension by providing contextual clues. This does not mean that images replace language learning. Rather, images can help students access meaning so that they can engage more confidently with English text. Teachers should therefore design tasks that require students to move from visual understanding to verbal explanation, vocabulary practice, and written response.

Digital comics also support narrative comprehension because they make story structure visible. Students can see how events unfold from panel to panel. This supports sequencing, prediction, inference, and summarizing. Brenna (2013) showed that graphic novels can support children's use of comprehension strategies. Cohn's (2013) theory of visual narrative structure also helps explain why comics require readers to infer continuity, causality, and narrative roles across images. In classroom practice, this means teachers should explicitly teach students how to read gutters, transitions, and visual progression.

The motivational dimension should also be considered. Comics can attract students because they are visually rich, narrative-based, and closer to youth media practices. However, motivation alone is insufficient. If teachers use comics only as entertainment, the literacy

benefits may be limited. Effective implementation requires guided reading questions, vocabulary tasks, inference prompts, critical discussion, and production activities. The teacher's role is therefore not reduced; it becomes more strategic because students need scaffolding to transform engagement into literacy development.

Digital comic production can extend literacy learning from comprehension to composition. When students create comics, they must plan a storyline, write concise dialogue, select visual elements, organize sequence, and revise their work. This process integrates reading, writing, visual design, and digital literacy. It also supports learner agency because students make decisions about language and representation. Nevertheless, production tasks should not be assessed only on artistic quality. Rubrics should evaluate language accuracy, narrative coherence, multimodal meaning, appropriateness of content, and reflection.

The discussion also confirms that digital comics must be carefully selected and adapted. Materials development principles emphasize that learning materials should provide meaningful input, purposeful engagement, language use, and learner support (Tomlinson, 2012). Digital comics should therefore be aligned with learning objectives, students' proficiency level, cultural context, and accessibility needs. Teachers may adapt comic panels, simplify dialogue, add glossaries, prepare guiding questions, or combine digital comics with printed worksheets to suit classroom conditions.

Comparison with Previous Studies

Two qualifications from the materials literature apply to the findings synthesised here. Gilmore (2007) reviews the case for authentic materials and shows that authenticity is a relationship between text and task rather than a property of the text alone, which is why an authentic comic used for comprehension questions produces little more than a simplified reader would. Warschauer (2000) places the issue in the longer history of technology in language teaching, noting that each new medium raises the same question of pedagogical purpose, and Weninger and Kiss (2013) demonstrate that visual material in language teaching is frequently presented as self-evident rather than as something to be interpreted. The reviewed studies reporting the strongest literacy gains were those in which students produced or interrogated comics rather than only reading them.

Implications for Literacy Instruction

The synthesis yields three implications for classroom practice. First, digital comics should be selected against the language objective rather than against student appeal alone; the reviewed studies reporting the weakest outcomes were those in which the comic was engaging but linguistically misaligned with the level of the class. Second, the four-stage cycle proposed here should be treated as a sequence rather than a menu, because the reported gains in critical and multimodal literacy came from the analysis and production stages, which are the stages most often omitted when time is short. Third, students need explicit instruction in reading image-text relations, since the reviewed evidence indicates that learners do not automatically extract meaning from the visual channel simply because it is present.

For institutions, the access constraint identified in the findings has a practical answer that does not require full device provision. Several reviewed implementations used offline files, shared devices in rotation, or printed versions for the reading stages while reserving devices for the production stage. This preserves the multimodal work that produces the literacy gains while reducing the technological requirement to a level most schools can meet.

Limitations and Directions for Future Research

This review has four limitations. It is a narrative synthesis without effect size estimation; the reviewed studies differ widely in intervention length, making duration effects impossible to separate from material effects; a substantial part of the evidence concerns first-language literacy settings, so its transfer to EFL classrooms is an argument rather than a demonstration; and few studies report delayed post-tests, leaving the durability of the reported gains unknown. Future research could compare comic reading with comic production under matched conditions, test the proposed cycle against a conventional reading sequence, and examine whether the vocabulary acquired through visual context is retained and used productively.

D. Conclusion

This article examined the use of digital comics to enhance students' literacy skills in English language learning. The structured narrative review and pedagogical synthesis show that digital comics can support reading comprehension, vocabulary development, multimodal literacy, digital literacy, critical literacy, and writing when they are implemented through explicit and structured pedagogy. Digital comics enhance literacy by combining verbal text, visual narrative, dialogue, sequencing, contextual cues, and digital navigation. However, their

effectiveness depends on careful selection, linguistic alignment, cultural suitability, accessibility, and teacher scaffolding. The proposed six-stage model consists of pre-reading orientation, guided multimodal reading, collaborative interpretation, language-focused practice, digital comic production, and reflective assessment. The study concludes that digital comics should not be used merely as entertainment or decoration in English classrooms. They should be treated as multimodal learning materials that require students to interpret image-text relations, use language meaningfully, evaluate representation, and produce coherent digital texts. Future research should conduct classroom-based experiments, design-based research, and longitudinal studies to examine the measurable effects of digital comics on different literacy outcomes and student groups.

Declaration of AI-Assisted Technologies

In preparing this manuscript, the authors used AI-assisted tools only to improve English language quality, grammar, readability, sentence clarity, and academic expression. The AI tools were not used to generate research data, conduct data analysis, produce findings, or draw conclusions. All conceptual arguments, data interpretation, methodological decisions, and scholarly conclusions remain the full responsibility of the authors. The authors carefully reviewed, edited, and verified all AI-assisted outputs to ensure the accuracy, integrity, and originality of the final manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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