PTI JOURNAL
LPPM Universitas Putra Indonesia YPTK Padang
Lubuk Begalung Highway, Padang, Sumatera Barat, Indonesia
Volume: 13, Issue: 1, Page: 45 - 49, 30/05/2026, e-ISSN: 2685-3914

The Effect of Using Interactive Digital Storytelling Media on Students' Narrative Writing Skills and Cognitive Load

Zuhad[1]✉, Muhammad Rinov Cuhanazriansyah[2], Salsabilla Zetia Ramadhani[3], Permata Ayu Rahmawati[4]
[1,2,3]Information Technology Education Study Program, Faculty of Teacher Training and Education, IKIP PGRI Bojonegoro, Indonesia
[4] IKIP PGRI Bojonegoro, Indonesia
zuhad@ikippgribojonegoro.ac.id

Abstract

Narrative writing requires high-order cognitive processing, yet conventional static instruction frequently fails to provide adequate cognitive scaffolding, resulting in student writer's block and cognitive overload. This study investigates the impact of an Interactive Digital Storytelling (IDS) platform on secondary students' narrative writing performance and cognitive load allocation using a quantitative true experimental pretest-posttest control group design ($N = 70$). Participants were randomly assigned to an experimental cohort utilising IDS or a control cohort receiving conventional text-based instruction. Outcomes were evaluated via analytic writing rubrics, a tri-dimensional cognitive load scale, and multivariate analysis of variance. Results revealed a statistically significant overall treatment effect for IDS ($\Lambda = 0.382, p < 0.001, \eta_p^2 = 0.618$). The experimental group achieved significantly higher posttest writing scores ($M = 84.57$) than the control group ($M = 71.14$), demonstrating marked improvements in plot organisation and lexical diversity. Crucially, while intrinsic cognitive load remained equivalent between groups, the IDS platform significantly reduced extraneous cognitive load ($M = 2.86$ vs 5.91) and increased germane cognitive load ($M = 7.14$ vs 4.63). In conclusion, ergonomically designed interactive media act as cognitive amplifiers by streamlining interface mechanics and optimizing human working memory for creative schema construction in language pedagogy.

Keywords: interactive digital storytelling, narrative writing, cognitive load, extraneous load, language pedagogy

1. Introduction

In the contemporary landscape of digital transformation, educational paradigms have progressively shifted towards the integration of technology to optimise students' cognitive processing [1]. Within the domain of Language and Literature Pedagogy, narrative writing represents a crucial foundational competence, fostering imaginative capacity, creative expression, and structured thinking [2]. Nevertheless, the act of narrative writing inherently demands high-order cognitive processing, requiring learners to manage ideation, plot organisation, lexical selection, and syntactic coherence simultaneously [3]. In practice, conventional, static instructional media frequently fail to offer adequate cognitive scaffolding [4]. Consequently, learners regularly encounter cognitive impediments, such as writer's block, fragmented narrative arcs, and a restricted lexical repertoire [5].

To address these challenges, the field of Information Technology Education offers a promising innovation through Interactive Digital Storytelling (IDS) [6]. By fusing multimedia components such as dynamic visual, auditory, and branching narrative paths-IDS provides learners with agency to actively navigate and shape the storytelling experience [7]. Theoretically, the integration of IDS within language instruction is underpinned by two complementary frameworks: the Hayes and Flower Writing Model, which emphasises continuous cognitive monitoring during planning, translating, and reviewing [3], and Mayer's Cognitive Theory of Multimedia Learning (CTML) alongside Sweller's Cognitive Load Theory (CLT) [8], [9]. Through dual-coding stimulation [10], the structured visual and auditory processing facilitated by interactive media is posited to assist learners in conceptualising abstract ideas prior to transcribing them into written prose [11].

Whilst prior empirical literature demonstrates that digital storytelling can enhance learner engagement and motivation [6], [12], the majority of existing studies evaluate digital media in isolation [13]. Pedagogical research predominantly measures final linguistic outputs such as writing scores whereas information technology research tends to focus on user interface usability [14]. Consequently, a notable research gap

Accepted: 21-03-2026 | Revision: 12-04-2026 | Publication: 30-05-2026 | doi: 10.35134

remains regarding how the interactive complexity of digital media influences a learner's mental architecture-specifically across the three dimensions of cognitive load: intrinsic load (the inherent difficulty of the writing task), extraneous load (the mental effort expended due to poorly designed interfaces), and germane load (the productive cognitive processing dedicated to constructing narrative schemas) [9], [15]. Failing to assess cognitive load alongside writing performance risks deploying interactive tools that inadvertently induce cognitive overload, thereby stifling creative expression [16].

In light of these considerations, the present study endeavours to empirically examine the influence of Interactive Digital Storytelling media on students' narrative writing skills alongside their cognitive load dimensions. Employing a true experimental pretest-posttest control group design [17], this investigation specifically evaluates whether statistically significant differences emerge in plot structure, lexical diversity, and narrative coherence between learners instructed via IDS and those receiving conventional tuition. Furthermore, the study assesses the degree to which an ergonomically designed interactive interface can mitigate extraneous cognitive load while maximising germane cognitive load during the creative writing process. A multivariate analysis of variance (MANOVA) is deployed to rigorously evaluate the simultaneous impact of the media across both dependent variables [18].

This research offers significant theoretical, methodological, and practical contributions to the intersection of Educational Technology and Language Pedagogy. Theoretically, it extends the application of the Cognitive Theory of Multimedia Learning into the realm of creative writing instruction [8]. Methodologically, by coupling analytic writing rubrics with validated cognitive load instruments-specifically the Paas Cognitive Load Scale [15]-it furnishes robust quantitative evidence regarding media efficacy. Practically, this work provides cognitive ergonomics guidelines for instructional designers and language educators, facilitating the creation of digital learning tools that are visually engaging whilst remaining mindful of the constraints of human working memory [1], [9].

2. Methods

To empirically evaluate the causal impact of Interactive Digital Storytelling (IDS) on students' narrative writing performance and cognitive load allocation, this study adopted a quantitative true experimental pretest-posttest control group design [17]. In this experimental framework, baseline measurements (O_1 and O_3) for both narrative writing proficiency and cognitive load capacity were gathered prior to treatment. The experimental group was subsequently exposed to the custom-designed Interactive Digital Storytelling learning environment (X), whereas the control group received conventional text-based instruction. Posttest measurements (O_2 and O_4) were administered immediately following the instructional intervention. The target population comprised tenth-grade secondary school students enrolled in the Indonesian Language and Literature curriculum (Pendidikan Bahasa dan Sastra Indonesia). A total sample of N = 70 students was drawn using a cluster random sampling technique to preserve ecological validity and avoid disrupting intact classroom settings [17]. The participants were randomly divided into two equal cohorts of 35 students each: an experimental cohort instructed via the IDS platform and a control cohort instructed through conventional static text prompts and slide presentations. An a priori power analysis conducted using G*Power software confirmed that this sample size was sufficient to detect a medium effect size ($f^2 = 0.15$) with statistical power $1 - \beta = 0.80$ at an alpha level of $\alpha = 0.05$ for multivariate analysis of variance. Preliminary demographic checks indicated no statistically significant differences between the cohorts regarding age, gender distribution, or baseline digital literacy levels ($p > 0.05$). The proposed IDS model is built upon a three-tier software architecture specifically engineered to align with Mayer's Cognitive Theory of Multimedia Learning and principles of cognitive ergonomics [8], [11]. At the front end, the presentation layer provides a dynamic visual canvas displaying story nodes, multimodal visual and auditory cues, and branching decision points that require active mental schema construction from the learner. Underlying this interface, the logic and engine layer executes a segmenting and signalling algorithm that decomposes complex narrative arcs into manageable micro-learning nodes, effectively mitigating extraneous cognitive load. This layer also incorporates contextual scaffolding logic that delivers real-time vocabulary prompts when students encounter key narrative complications. At the foundational level, the content and data layer houses curriculum-standardised narrative scenarios based on Indonesian cultural themes while continuously logging student interaction analytics. Both cohorts underwent four instructional sessions totaling 8x45 minutes, addressing identical curricular objectives including characterisation, plot escalation, climax resolution, and lexical enrichment. While the experimental group navigated story arcs, made choices affecting plot trajectories, and completed scaffolded writing exercises within the digital system, the control group received traditional teacher-led lectures, read printed short stories, and completed identical narrative writing tasks using conventional paper-based media. Data collection relied on two rigorously validated measurement instruments to evaluate the dual dependent variables. The first was a standardised narrative writing test administered in 60-minute pretest and posttest sessions, where student essays were evaluated using an analytic narrative rubric adapted from Hayes and Flower [3]. This instrument assessed four weighted sub-dimensions

on a 100-point scale: plot organisation and structure (30%), ideation and creative expression (25%), lexical diversity and coherence (25%), and grammatical and orthographic accuracy under standard Indonesian orthography (20%). Content validity for this rubric was established by language pedagogy experts (Aiken's $V = 0.88$), while inter-rater reliability demonstrated high consistency between independent evaluators (ICC = $0.86, p < 0.001$). The second instrument was a tri-dimensional cognitive load scale adapted from the Paas Cognitive Load Scale [15], administered immediately post-task using a 9-point Likert scale. This instrument measured intrinsic load across three items addressing topic complexity, extraneous load across four items gauging interface and instructional processing effort, and germane load across three items measuring productive cognitive processing dedicated to schema construction. Construct validity was confirmed via exploratory factor analysis (KMO $= 0.82, p < 0.001$) and internal consistency was verified through satisfactory Cronbach's alpha values across all three sub-scales (alpha = 0.84, 0.87, and 0.81, respectively). The quantitative data were systematically processed through a four-stage statistical analysis pipeline using IBM SPSS Statistics. Initially, descriptive statistics, mean scores, standard deviations, and normalised gain scores (g) were calculated across both experimental conditions [20]. Prior to inferential testing, statistical assumptions were evaluated; multivariate normality was examined via the Shapiro-Wilk test and Mardia's kurtosis, homogeneity of variance-covariance matrices was assessed using Box's M test (p > 0.001), and univariate homogeneity of variance was verified through Levene's test (p > 0.05) [22]. Following assumption verification, a one-way Multivariate Analysis of Variance (MANOVA) utilizing Wilks' Lambda (Lambda) was conducted to determine whether exposure to the IDS platform produced statistically significant simultaneous differences across the vector of dependent variables, including narrative writing scores and cognitive load dimensions [18]. Finally, univariate follow-up Analyses of Variance (ANOVA) with Bonferroni adjustments were executed to isolate the specific individual contributions of each dependent variable to the overall multivariate effect, with effect magnitudes quantified using Partial Eta Squared (η_p^2) [19].

3. Results and Discussions

The statistical evaluation began with verification of all parametric assumptions required for multivariate inferential testing. The Shapiro-Wilk test confirmed multivariate normality across all dependent variables ($p > 0.05$). Box's M test yielded a statistic of $M = 14.82$ ($p = 0.118$), confirming the homogeneity of variance-covariance matrices across experimental conditions, while Levene's test established univariate homogeneity of variance for each dependent variable ($p > 0.05$). The primary multivariate analysis of variance (MANOVA) revealed a statistically significant overall treatment effect for the Interactive Digital Storytelling (IDS) platform across the combined dependent variables ($\Lambda = 0.382, F(3,66) = 35.54, p < 0.001$). The magnitude of this effect was substantial, with a partial eta squared ($\eta_p^2 = 0.618$) indicating that approximately 61.8% of the total variance in student performance and cognitive load allocation was attributable to the instructional media intervention.

3.1 Impact on Narrative Writing Performance

The first major finding demonstrates that students instructed through the Interactive Digital Storytelling platform achieved significantly higher overall narrative writing proficiency compared to those receiving conventional text-based instruction. At pretest, baseline writing scores between the experimental group ($M = 54.12, SD = 7.31$) and the control group ($M = 53.86, SD = 7.18$) showed no statistically significant difference, establishing initial equivalence. Following the intervention, the experimental cohort demonstrated a marked increase in posttest narrative writing performance ($M = 84.57, SD = 6.22$), yielding a high normalised gain score ($g = 0.66$). Conversely, the control group achieved a more modest posttest score ($M = 71.14, SD = 7.85$), corresponding to a medium normalised gain ($g = 0.37$). Follow-up univariate analysis confirmed that the main effect of instructional media on narrative writing scores was statistically significant ($F(1,68) = 62.41, p < 0.001, \eta_p^2 = 0.479$). Detailed examination of the narrative rubric sub-dimensions reveals that the most substantial gains occurred in plot organisation and structure alongside lexical diversity and coherence. Students utilizing the interactive platform excelled at constructing well-articulated narrative arcs containing clear orientations, escalating complications, and logical resolutions. This outcome directly answers the first research question and aligns with the Hayes and Flower writing model, which posits that external cognitive scaffolds facilitate the planning and translating phases of composition. The visual branching nodes and real-time plot tracking features provided learners with a structural mental model, preventing narrative fragmentation. Furthermore, the embedded contextual vocabulary hints enriched students' active lexical selection, resulting in greater stylistic variety. These empirical results corroborate prior literature on computer-assisted language learning, reinforcing the assertions of Robin and Smeda regarding the capacity of digital storytelling to enhance creative composition and structural thinking in language acquisition.

3.2 Cognitive Load Allocation and Ergonomic Efficacy

The second major finding addresses the cognitive mechanism underlying these performance gains by

evaluating the tri-dimensional distribution of cognitive load. Univariate ANOVA testing for intrinsic cognitive load revealed no statistically significant difference between the experimental group ($M = 5.11, SD = 0.82$) and the control group ($M = 5.23, SD = 0.79; F(1,68) = 0.38, p = 0.541$). This finding confirms that the inherent task difficulty of narrative writing remained equivalent across both conditions, validating the experimental control. However, dramatic variations emerged across extraneous and germane cognitive load dimensions. The experimental group experienced a statistically significant reduction in extraneous cognitive load ($M = 2.86, SD = 0.73$) relative to the control group ($M = 5.91, SD = 1.12; F(1,68) = 181.33, p < 0.001, \eta_p^2 = 0.727$). Simultaneously, germane cognitive load was significantly higher among experimental participants ($M = 7.14, SD = 0.81$) than control participants ($M = 4.63, SD = 0.94; F(1,68) = 143.12, p < 0.001, \eta_p^2 = 0.678$).

These cognitive load outcomes provide vital empirical support for Sweller's Cognitive Load Theory and Mayer's Cognitive Theory of Multimedia Learning within language pedagogy. In conventional instruction, static prompts and unguided composition forced students to expend excessive mental effort managing task organisation and searching for narrative ideas, resulting in high extraneous load that exhausted working memory capacity. In contrast, the segmenting and signalling algorithms integrated into the presentation and logic layers of the IDS platform successfully streamlined user interactions, thereby minimizing mental effort spent processing interface mechanics. By suppressing extraneous cognitive load, the digital system freed finite working memory resources, allowing students to redirect their mental capacity toward germane cognitive processing-specifically, constructing deep narrative schemas, refining characterisation, and polishing sentence structure. These results refute critics who suggest that interactive multimedia induces cognitive distraction, proving instead that ergonomically designed software acts as a cognitive amplifier during creative writing.

3.3 Limitations and Future Work

While this investigation offers robust empirical insights into the intersection of educational technology and language pedagogy, several methodological constraints must be acknowledged. First, the study sample was drawn exclusively from tenth-grade secondary school students within a single geographic education district, which may constrain the immediate generalisability of the findings to primary, tertiary, or adult language learning contexts. Second, the instructional intervention was conducted over a four-week period comprising eight class sessions, meaning the observed outcomes reflect short-to-medium-term learning gains rather than long-term skill retention. Third, cognitive load was measured using self-reported post-task rating scales; although these instruments exhibited high internal reliability and construct validity, they represent subjective retrospective estimations rather than continuous, real-time neurophysiological data.

Future research should expand upon these findings by addressing these identified constraints through extended longitudinal research designs that monitor skill retention and transfer across multiple academic semesters. Scholars are encouraged to replicate this instructional model across diverse demographic cohorts, including foreign language learners and university-level creative writing students. Methodologically, subsequent studies could integrate objective, real-time cognitive monitoring techniques-such as eye-tracking pupillometry or electroencephalography-to continuously map cognitive load fluctuations during specific interactive decision points. Furthermore, expanding the software architecture to incorporate Generative AI engines capable of delivering adaptive, automated textual feedback represents a highly promising avenue for future interdisciplinary research in computer-assisted language instruction.

4. Conclusions

This study empirically investigated the causal impact of Interactive Digital Storytelling (IDS) on secondary students' narrative writing performance and cognitive load allocation, bridging the disciplines of Language Pedagogy and Educational Technology. Utilizing a quantitative true experimental pretest-posttest control group design, the findings directly answer the research questions by demonstrating that instruction mediated through the IDS platform yields statistically significant superior improvements in narrative writing proficiency-most notably in plot organisation, structural coherence, and lexical diversity-compared to conventional text-based methods. Crucially, the multivariate results elucidate the cognitive mechanisms driving these linguistic gains, proving that the software effectively optimizes human working memory architecture. Whilst intrinsic cognitive load remained equivalent across experimental conditions, the ergonomically engineered IDS platform successfully suppressed extraneous cognitive load by streamlining interface mechanics, thereby enabling learners to redirect finite cognitive capacity towards germane processing dedicated to creative schema construction and stylistic refinement. Theoretically, these findings extend Mayer's Cognitive Theory of Multimedia Learning and Sweller's Cognitive Load Theory into the domain of creative writing, establishing that interactive digital media, when designed with cognitive ergonomics in mind, serve as cognitive amplifiers rather than sources of mental distraction. Practically, this work offers educational technology developers and language educators a

validated blueprint for constructing digital learning environments that harmonize interactive visual scaffolding with cognitive constraints. Although limited by a short-term intervention period and retrospective self-reported cognitive measures, this investigation provides a robust foundation for future interdisciplinary research. Future studies are encouraged to explore long-term skill retention, incorporate real-time neurophysiological measures such as eye-tracking, and integrate adaptive artificial intelligence to further advance computer-assisted language instruction.

References

[1] N. Selwyn, *Education and Technology: Key Issues and Debates*, 2nd ed. London: Bloomsbury Academic, 2016.

[2] S. Graham and D. Perin, "A meta-analysis of writing instruction for adolescent students," *Journal of Educational Psychology*, vol. 99, no. 3, pp. 445–476, 2007.

[3] J. R. Hayes and L. S. Flower, "Identifying the organisation of writing processes," in *Cognitive Processes in Writing*, L. W. Gregg and E. R. Steinberg, Eds. Hillsdale, NJ: Lawrence Erlbaum Associates, 1980, pp. 31–50.

[4] R. T. Kellogg, "Training writing skills: A cognitive development perspective," *Journal of Writing Research*, vol. 1, no. 1, pp. 1–26, 2008.

[5] C. Docherty and F. Barker, *Language Assessment for Educational Purposes*. Cambridge: Cambridge University Press, 2012.

[6] B. R. Robin, "Digital storytelling: A powerful technology tool for the 21st century classroom," *Theory Into Practice*, vol. 47, no. 3, pp. 220–228, 2008.

[7] [N. Smeda, E. Dakich, and N. Sharda, "The role of digital storytelling in new learning environments," *E-Learning and Digital Media*, vol. 11, no. 1, pp. 73–86, 2014.

[8] R. E. Mayer, *Multimedia Learning*, 3rd ed. Cambridge: Cambridge University Press, 2021.

[9] J. Sweller, P. Ayres, and S. Kalyuga, *Cognitive Load Theory*. New York: Springer, 2011.

[10] A. Paivio, *Mental Representations: A Dual Coding Approach*. Oxford: Oxford University Press, 1986.

[11] R. Moreno and R. E. Mayer, "Interactive multimodal learning environments," *Educational Psychology Review*, vol. 19, no. 3, pp. 309–326, 2007.

[12] Y. T. C. Yang and W. C. I. Wu, "Digital storytelling for enhancing student academic achievement, critical thinking, and learning motivation," *Computers & Education*, vol. 59, no. 2, pp. 339–352, 2012.

[13] K. F. Hew and T. Brush, "Integrating technology into K-12 teaching and learning: Current knowledge and gaps in underlying conditions," *Educational Technology Research and Development*, vol. 55, no. 3, pp. 223–252, 2007.

[14] H. Al-Samarraie and N. Saeed, "A systematic review of cloud computing tools for collaborative learning: Opportunities and challenges," *Computers & Education*, vol. 124, pp. 77–91, 2018.

[15] F. Paas, J. E. Tuovinen, H. Tabbers, and P. W. Van Gerven, "Cognitive load measurement as a means to advance cognitive load theory," *Educational Psychologist*, vol. 38, no. 1, pp. 63–71, 2003.

[16] P. A. Kirschner, J. Sweller, and R. E. Clark, "Why minimal guidance during instruction does not work: An analysis of the failure of constructivist teaching," *Educational Psychologist*, vol. 41, no. 2, pp. 75–86, 2006.

[17] J. W. Creswell and J. D. Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 5th ed. Thousand Oaks: SAGE Publications, 2018.

[18] B. G. Tabachnick and L. S. Fidell, *Using Multivariate Statistics*, 7th ed. New York: Pearson, 2019.

[19] J. Cohen, *Statistical Power Analysis for the Behavioral Sciences*, 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates, 1988.

[20] R. R. Hake, "Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses," *American Journal of Physics*, vol. 66, no. 1, pp. 64–74, 1998.

[21] J. Leppink, F. Paas, C. P. Van der Vleuten, T. Van Gog, and J. J. Van Merriënboer, "Development of a cognitive load measure for in-process learning," *Biometrical Journal*, vol. 55, no. 5, pp. 709–724, 2013.

[22] A. Field, *Discovering Statistics Using IBM SPSS Statistics*, 5th ed. London: SAGE Publications, 2018.