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Empowering Higher-Order Thinking Skills in Writing through Gamification and Multimodal Learning within PBL

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ABSTRACT

This study explores the integration of gamification and multimodal learning within a Project-Based Learning (PBL) framework to enhance higher-order thinking skills (HOTs) in writing instruction. HOTs—encompassing critical thinking, creativity, and problem-solving—are vital for equipping students to navigate academic and real-world complexities. Employing a mixed-methods approach, the study collected quantitative data through surveys assessing engagement, motivation, and writing proficiency, while qualitative data from focus groups and reflective journals provided deeper insights into student experiences. By incorporating real-world projects, gamified elements (e.g., challenges, rewards), and multimodal resources (visual, auditory, and kinesthetic tools), the intervention created an engaging and inclusive learning environment. Results revealed significant increases in engagement (90%), motivation (87%), and writing proficiency (22%), as well as marked development in critical thinking, creativity, and collaboration skills. This study highlights the effectiveness of combining PBL with gamification and multimodal strategies to empower students in writing tasks through diverse forms of expression. The findings offer actionable insights for designing inclusive writing curricula and underscore the need for further research on the scalability and adaptability of this approach in diverse educational settings.

Keywords: Higher-Order Thinking Skills (HOTs); Gamification; Multimodal Learning; Project-Based Learning (PBL)

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1. Introduction

Higher-Order Thinking Skills (HOTs)—including critical thinking, creativity, and problem-solving—are vital for preparing students to address the complex challenges of the 21st century. As the demand for these skills grows across academic and professional spheres, education systems are under increasing pressure to cultivate them effectively [1]. However, many students struggle to develop HOTs in traditional writing instruction due to the emphasis on grammar accuracy and surface-level corrections rather than fostering analytical and creative thinking [2]. Educators face additional challenges, including insufficient training in innovative teaching methods and limited access to resources for integrating diverse instructional tools. These issues often result in disengagement and hinder students' ability to develop critical thinking, creativity, and problem-solving skills, which are essential for real-world applications. Efforts to integrate HOTs into education are gaining international momentum, with many countries emphasizing the need for innovative teaching practices to address 21st-century challenges [3]. For instance, research highlights the success of active learning strategies, such as Project-Based Learning (PBL), in fostering critical and creative thinking by situating tasks within real-world contexts [4]. Similarly, global initiatives advocate for the integration of digital tools and gamification to enhance engagement and scaffold the development of analytical skills, particularly in under-resourced educational settings [5].

Writing instruction, a cornerstone of education, serves as a unique platform to develop these skills by fostering analysis, evaluation, and creative problem-solving. Through writing, students not only organize and articulate their thoughts but also engage in analytical, evaluative, and creative processes. Writing instruction serves as an ideal medium for fostering these skills, as it demands analytical thought, creativity, and the ability to communicate effectively across various contexts [6, 7]. However, traditional writing pedagogies often emphasize grammar accuracy and surface-level corrections over deeper cognitive engagement, limiting students' potential. Expanding on the potential of writing instruction, research emphasizes that it not only enhances students' communication skills but also cultivates metacognitive abilities, enabling them to reflect on their thought processes and improve their problem-solving strategies [8]. Additionally, incorporating collaborative writing tasks and multimodal tools has been shown to deepen students' engagement with the material and foster creativity by encouraging diverse forms of expression [9]. However, a lack of integration between traditional and innovative approaches often results in missed opportunities to fully develop students' HOTs, particularly in contexts where critical and analytical writing is essential for academic and professional success [10].

Advancements in instructional strategies, particularly gamification and multimodal learning, offer innovative solutions to these challenges. Gamification, defined as the use of game elements in non-game contexts, has been shown to increase student engagement and intrinsic motivation, making the learning process more interactive and enjoyable [11–13]. Gamification enhances engagement and motivation through elements like challenges, rewards, and progress tracking, while adaptive frameworks personalize learning by leveraging real-time feedback. Gamification can transform writing tasks into dynamic and interactive experiences, making them less monotonous and more meaningful for students. Adaptive gamification frameworks play a crucial role in creating personalized learning experiences by leveraging real-time feedback and adjusting game elements to match learners' needs, thereby enhancing engagement and learning efficacy. This approach has significant implications for writing instruction, where tailored gamified activities can address individual skill gaps and foster deeper cognitive engagement [14].

In recent years, gamification has emerged as a powerful pedagogical tool to enhance learning engagement and motivation across various educational domains. Studies highlight the importance of designing adaptive gamification frameworks tailored to specific subject areas, such as physics, which can dynamically adjust to learners' needs and abilities to optimize learning outcomes [15]. The potential of educational games, shows how gamified environments can foster interactive and collaborative learning. These findings underscore the growing importance of integrating gamification strategies into diverse learning contexts, including writing instruction, as they promote critical thinking, problem-solving, and collaboration—key components of HOTs. The principles of gamification in these studies can be effectively extended to writing tasks, where they have the potential to enhance engagement and facilitate deeper cognitive engagement. Research illustrates the interplay between academic self-efficacy and motivation, suggesting that gamified tools

and adaptive frameworks can alleviate learning anxieties and improve outcomes, particularly in high-stakes subjects like mathematics[16]. These insights are also relevant to writing instruction, where students often face challenges in developing critical and creative skills. Additionally, mobile learning applications play a pivotal role in scaffolding complex cognitive skills. Papadakis highlighted their potential in promoting computational thinking and creativity, even in early childhood education[15]. These findings emphasize the broader significance of multimodal and gamified tools in fostering critical thinking and problem-solving across various age groups and disciplines.

Similarly, multimodal learning—using visuals, audio, and interactive tools—accommodates diverse learning styles and improves comprehension and creativity, making instruction more inclusive and engaging. It has been found to support diverse cognitive styles and improve student comprehension and creativity[17–19]. When integrated into a PBL framework, these approaches have the potential to transform writing instruction by promoting real-world problem-solving, fostering collaboration, and encouraging critical and creative thinking within authentic learning contexts. These strategies framework offer a synergistic approach to enhancing HOTs. PBL emphasizes real-world problem-solving, collaboration, and student agency, providing a fertile environment for deeper learning. Studies have highlighted the effectiveness of multimodal and PBL in fostering critical thinking and creative problem-solving by engaging students through diverse tasks and modes of expression[20–22]. Gamified and PBL has also been found to sustain motivation and foster collaboration, key components for cultivating HOTs in writing education[13]. Despite evidence supporting the effectiveness of gamification, multimodal learning, and PBL individually, limited research explores their combined impact on writing instruction. Many students struggle to develop HOTs due to traditional pedagogical approaches that fail to foster critical and creative thinking or engage diverse learners effectively. The lack of structured integration between these methodologies creates challenges for educators seeking evidence-based, inclusive strategies. This study addresses this gap by proposing and exploring an integrated framework that leverages gamification and multimodal learning within PBL to enhance HOTs in writing tasks. Specifically, the study seeks to:

(1) Investigate the impact of this integrated approach on student engagement, motivation, and writing proficiency.
(2) Examine how the combination of gamified and multimodal elements fosters critical thinking, creativity, and problem-solving in writing tasks.
(3) Provide actionable recommendations for educators to design and implement writing instruction strategies that address diverse learning needs.

The study hypothesizes that integrating gamification and multimodal learning within PBL will significantly improve students' engagement, motivation, and writing proficiency, while also fostering the development of HOTs. The scope of this research encompasses both quantitative and qualitative analyses, focusing on the effectiveness of the intervention in real-world classroom settings. It emphasizes practical applications for diverse educational contexts and aims to provide a scalable framework for enhancing writing instruction.

2. Materials and Methods

2.1. Participants

This study involved 150 university students from two campuses in Indonesia: Nusantara PGRI Kediri University in East Java and PGRI Semarang University. The inclusion of two campuses was intended to capture diverse educational settings and academic contexts, enhancing the study's representativeness and generalizability. A total of 22 participants, comprising one class from the English Study Program, were selected from PGRI Semarang University, while the remaining participants were drawn from two study programs at Nusantara PGRI Kediri University. Stratified random sampling was employed to ensure proportional representation across study programs and gender.

It is important to note that this study was not designed to compare participants from the two campuses. Instead, data from both campuses were combined and analyzed as a single dataset, focusing on the overall effectiveness of the intervention. This approach ensured a comprehensive evaluation without emphasizing differences between the two locations, as the goal was to assess the intervention's applicability and impact across diverse educational settings rather than to highlight regional or institutional variations.

2.2. Research Design

This study utilized a mixed-methods approach, combining surveys, writing assessments, and qualitative insights to assess how gamification and multimodal learning impact student outcomes within a PBL framework. The mixed-methods design was chosen for its ability to combine quantitative and qualitative insights, providing a holistic understanding of the intervention's effectiveness[23]. This approach allows for the triangulation of data, enhancing the reliability of findings by corroborating quantitative results with qualitative insights. Mixed-methods research is particularly suited for educational studies as it captures both measurable outcomes and contextualized participant experiences, offering a comprehensive evaluation[24, 25]. The instruments utilized in this study were carefully selected to ensure accurate data collection and analysis. Quantitative data were collected through structured surveys that measured engagement, motivation, and writing proficiency. These surveys were developed and validated using established psychometric methods, achieving a Cronbach's alpha of 0.85, which indicates high reliability. Writing performance was assessed using pre-test and post-test scores evaluated with a standardized rubric focusing on creativity, coherence, grammar, and critical thinking. This rubric was based on established frameworks and reviewed by subject-matter experts for content validity.

Qualitative data were gathered through semi-structured focus group discussions and reflective journals. The focus group discussions followed a protocol with open-ended questions aligned with the study's objectives, ensuring consistency and depth. Reflective journals provided individual perspectives on learning experiences, offering rich, contextual insights into the participants' engagement with the intervention[25–27].

The gamification tool, Quizizz, was utilized for interactive quizzes targeting grammar, vocabulary, and sentence construction. Its functionalities, such as progress tracking, immediate feedback, and leaderboard systems, were instrumental in fostering engagement and motivation. For multimodal learning, Canva was employed to facilitate visual brainstorming and organization of writing drafts. These tools were chosen for their accessibility, ease of use, and proven effectiveness in educational settings.

2.3. Data Analysis

The data analysis employed in this study combined quantitative and qualitative methods to ensure a comprehensive evaluation of the intervention's impact. Quantitative data, including pre-test and post-test writing scores, were analyzed using paired t-tests to measure significant improvements in writing performance across key components such as creativity, coherence, grammar, and critical thinking. Statistical significance was established at $p < 0.05$ to validate meaningful changes. Surveys measuring engagement, motivation, and collaboration were analyzed descriptively to summarize trends, while inferential statistics, including factor analysis, were applied to uncover underlying constructs influencing these variables.

Qualitative data were analyzed through thematic analysis, following Braun and Clarke's framework to identify patterns and recurring themes[18]. Data from focus group discussions and reflective journals were systematically coded and categorized, providing rich insights into participants' experiences with the gamification and multimodal tools. To ensure robustness, triangulation was employed by cross-referencing themes derived from qualitative data with trends observed in the quantitative findings. This integrative approach provided a nuanced understanding of the intervention's effectiveness, highlighting measurable improvements in technical writing skills as well as deeper cognitive and motivational outcomes. The rigorous combination of statistical and thematic analysis ensured that the study captured both objective and subjective dimensions of the learning process.

2.4. Research Procedures

The research procedures were carefully structured to ensure the systematic implementation and evaluation of the intervention. The process consisted of four distinct phases: Preparation, Intervention, Data Collection, and Analysis. Each phase was designed to align with the study's objectives and to integrate gamification and multimodal tools within a Project-Based Learning (PBL) framework. Below is a detailed explanation of each phase:

(1) Preparation Phase:

- Participants were randomly assigned to project-based writing activities designed to include gamified and multimodal elements.

- Initial orientation sessions were conducted to familiarize students with the gamified tools (e.g., progress trackers, leaderboards) and multimodal resources (e.g., visual, auditory, and interactive materials).

(2) Intervention:
- Students participated in weekly writing tasks integrated within real-world PBL scenarios.
- Gamified elements such as rewards, challenges, and progress tracking were implemented to maintain engagement.
- Multimodal resources, including videos, podcasts, infographics, and interactive platforms, were incorporated to cater to diverse learning styles.

(3) Data Collection:
- Surveys were administered at the beginning and end of the study to measure changes in engagement, motivation, and writing proficiency.
- Reflective journals were maintained weekly by participants to document their experiences.
- Focus group discussions were conducted at the end of the study to gather in-depth qualitative insights.

(4) Analysis:
- Quantitative data were analyzed using descriptive and inferential statistics to determine the effectiveness of the intervention.
- Qualitative data were subjected to thematic analysis to identify recurring themes and patterns in students' experiences.

2.5. Ethical Considerations

This study adhered to the ethical standards outlined in the Declaration of Helsinki. Ethical approval was obtained from the Institutional Review Board (IRB) of *Nusantara PGRI Kediri University*, approval number [001.01/PENST/LPPM UNPGRI-kd/A/VII/2024]. Participants were fully informed of the study's objectives and procedures, and written informed consent was obtained prior to participation. Anonymity and confidentiality were maintained throughout the study, ensuring that participants' identities and data were protected. Additionally, participants were assured of their right to withdraw from the study at any time without penalty.

2.6. Intervention Procedure

During the preparation phase, participants were introduced to Quizizz and Canva through guided orientation sessions. Quizizz was utilized for creating gamified quizzes focusing on grammar and sentence construction, ensuring active participation through competitive elements like leaderboards and rewards. Canva was employed as a multimodal platform to develop mind maps, outlines, and other visual aids that supported students in organizing and refining their ideas creatively.

The intervention was designed as a four-week structured program, progressing through distinct phases—preparation, implementation, and reflection—each targeting specific objectives to enhance writing skills and Higher-Order Thinking Skills (HOTs). These phases were underpinned by the integration of gamification and multimodal tools within the Project-Based Learning (PBL) framework, ensuring active engagement, collaboration, and contextualized learning experiences. Each week introduced new tasks and tools, allowing participants to build on their skills iteratively. The intervention's systematic approach ensured that all participants engaged with both the gamified elements and multimodal tools, fostering motivation and creativity while addressing diverse learning styles.

The procedure emphasized a balance between individual and collaborative activities, providing students with opportunities to reflect, receive feedback, and continuously improve their writing. Through guided tasks and scaffolded learning experiences, the intervention sought to enhance technical writing skills such as grammar and coherence, alongside fostering creativity, critical thinking, and problem-solving. The four phases were structured to ensure seamless integration of learning tools and strategies into the PBL framework, creating a dynamic and inclusive environment for skill development. The intervention was structured into four key phases—Preparation, Implementation, Feedback and Revision, and Final Submission and Reflection—each designed to progressively build students' technical writing skills and HOTs. Below is a detailed description of each phase:

(1) Preparation Phase:
- Participants were briefed on the objectives and structure of the study, including an overview of gamified and multimodal elements.

- Baseline data were collected through pre-test writing assessments, evaluating creativity, coherence, grammar, and critical thinking.

(2) Implementation Phase:

- Week 1: Introduction and initial writing task
  In the first week, the intervention began with an introduction to the study's framework, incorporating Project-Based Learning (PBL), gamification, and multimodal learning. Participants were guided on using Quizizz as a gamification tool to engage in interactive writing-related quizzes focused on grammar, vocabulary, and sentence structure. These quizzes encouraged active participation and built foundational skills for the subsequent tasks. These tasks were designed to enhance engagement through immediate feedback, competition, and rewards, fostering intrinsic motivation and sustained participation. Additionally, students were introduced to Canva as a multimodal tool to visually organize their ideas. They were taught to create digital mind maps and outlines on Canva to brainstorm and structure their initial writing drafts. This helped students organize and refine their ideas creatively and also draft outlines that linked key arguments to supporting evidence, ensuring coherence in their writing. By the end of the week, participants completed their first writing task, combining insights from the Quizizz quizzes and the visuals developed on Canva to draft their ideas effectively.
- Week 2: Collaboration and refinement
  In the second week, participants engaged in collaborative activities to develop and refine their initial drafts. Using Quizizz, students participated in group challenges focused on sentence improvement and coherence, fostering teamwork and critical thinking. Canva was utilized to enhance their drafts visually, with students creating visual representations of their narratives, such as infographics and flowcharts, to better organize their ideas and strengthen the structure of their writing. Group discussions allowed students to provide and receive peer feedback, encouraging a collaborative learning environment. By the end of the week, participants revised their drafts, incorporating feedback and utilizing the insights gained from the gamified and multimodal tools to enhance the quality of their work.
- Week 3: Individual feedback and writing revision
  In the third week, the focus shifted to individualized feedback and revision of the participants' drafts. Each participant received detailed feedback from instructors on their initial drafts, addressing aspects such as coherence, grammar, creativity, and critical thinking. Using Quizizz, students engaged in personalized quizzes tailored to their specific areas of improvement, such as advanced grammar rules or enhancing sentence variety. Simultaneously, participants refined their drafts with the help of Canva, creating visually engaging layouts and storyboards to better structure their writing. This phase emphasized self-reflection, with students reviewing their progress and revising their drafts to address feedback and further enhance their work. By the end of the week, participants submitted updated drafts demonstrating significant improvements based on both peer and instructor feedback.
- Week 4: Final submission and reflection
  In the fourth week, participants finalized their writing tasks and reflected on their learning journey. They completed their final drafts, incorporating all feedback and revisions from previous weeks. The use of Quizizz continued with final quizzes designed to reinforce writing strategies, such as transitions, clarity, and advanced sentence construction. Participants also utilized Canva to prepare polished visual presentations of their writing, such as infographics or digital posters, to accompany their final submissions. After submitting their work, students participated in reflective activities, including group discussions and individual journal entries, to evaluate their progress, the effectiveness of

gamification and multimodal tools, and their overall experience. This week concluded with the collection of post-test writing scores and surveys to measure improvements in writing skills, motivation, and engagement throughout the intervention.

(3) Reflection and Feedback Phase:
- Students participated in focus group discussions to share their experiences and perceptions of the intervention.
- Reflective journals were collected to provide additional insights into individual progress and learning challenges.

(4) Evaluation Phase:
- Data from pre-test and post-test writing scores, surveys, and qualitative reflections were analyzed to assess the effectiveness of the intervention on HOTs and writing performance.

The weekly intervention followed a structured plan over four weeks. Week 1 involved orientation and familiarization with gamification tools and multimodal platforms. Week 2 introduced students to writing tasks integrated with PBL scenarios, focusing on collaboration and creativity. Week 3 emphasized refining drafts and incorporating feedback, while Week 4 focused on final submissions and reflective discussions on learning experiences.

3. Results

The results section addresses the core research questions guiding this study: (1) How does the integration of gamification and multimodal tools within a Project-Based Learning (PBL) framework improve writing performance? (2) What is the impact of gamification and multimodal learning on student engagement and motivation in writing tasks? (3) How does the use of gamification and multimodal tools in PBL foster Higher-Order Thinking Skills (HOTs), including critical thinking, creativity, and problem-solving, in writing? By examining quantitative and qualitative data, the findings provide insights into the effectiveness of the intervention and its influence on student learning outcomes.

3.1. Writing Performance Results

The results of this study demonstrate significant improvements in students' writing performance following the implementation of gamification and multimodal learning strategies within a Project-Based Learning (PBL) framework. Writing performance was evaluated across four key components: grammar, coherence, creativity, and critical thinking. Pre-test and post-test scores were analyzed to assess the effectiveness of the intervention in enhancing these aspects. The findings revealed substantial increases in all components, indicating that the combination of gamified activities and multimodal tools effectively supported students in developing both technical and higher-order writing skills. The detailed results are presented in **Table 1**.

Table 1 demonstrates significant improvements in writing performance across five key components, highlighting the effectiveness of the intervention in enhancing Higher-Order Thinking Skills (HOTs). Grammar and coherence showed substantial improvements of 30.41% and 28.48%, respectively, reflecting enhanced technical accuracy and logical organization in students' writing. Creativity and critical thinking both improved by approximately 28–30%, indicating that the use of gamification and multimodal tools encouraged students to generate original ideas and construct well-reasoned arguments. The highest improvement was observed in problem-solving (33.56%), showcasing the ability of students to analyze real-world scenarios and integrate solutions effectively into their writing tasks. These results underscore the intervention's success in fostering both technical skills and HOTs in writing.

The qualitative analysis of students' responses during focus group discussions revealed significant improvements in their writing skills and overall learning experience. Students reported that gamification tools such as Quizizz boosted their motivation, particularly through the engaging and competitive features of the quizzes. They also highlighted Canva as a valuable tool for organizing ideas visually, which helped them structure their drafts more effectively. Many students expressed that the combination of these tools improved their creativity and critical thinking, with one stating, "*The brainstorming templates in Canva helped me see connections between ideas, which made my arguments stronger*." Others shared that the feedback-driven process and collaborative activities fostered deeper engagement and confidence in their writing abilities. These reflections underscore the effectiveness of the intervention in enhancing both technical skills and higher-order thinking in writing.

Table 1. Improvements in writing components across components.

Writing Components	Pre-Test Mean	Post-Test Mean	Improvement (%)
Grammar	60.2	78.5	30.41
Coherence	62.5	80.3	28.48
Creativity	58.8	75.6	28.57
Critical thinking	61.0	79.4	30.16
Problem solving	57.5	76.8	33.56

Student reflections revealed several key themes. Many participants reported increased motivation due to the gamified elements, citing rewards and challenges as driving factors. Another prominent theme was the collaborative aspect of the PBL framework, which participants valued for improving their communication and problem-solving skills. However, challenges included initial unfamiliarity with the tools and time management issues during group tasks. These nuanced insights highlight both the strengths of the intervention and areas for improvement.

To further validate the observed improvements in writing performance, statistical analysis was conducted on the pre-test and post-test scores across the four components: grammar, coherence, creativity, and critical thinking. The analysis revealed a significant increase in mean scores from the pre-test to the post-test, supported by paired t-tests. The results showed that the improvements were not only consistent across all components but also statistically significant, with p-values below 0.001. These findings confirm that the intervention effectively enhanced students' writing abilities, demonstrating the impact of gamification and multimodal strategies on their performance. Detailed statistical measures are presented in **Table 2**.

Table 2. Statistical analysis results.

Measure	Grammar	Coherence	Creativity	Critical Thinking	Problem Solving
Mean (Pre-Test)	60.63	62.5	58.8	61.0	57.5
Mean (Post-Test)	78.45	80.3	75.6	79.4	76.8
Standard Deviation (Pre-Test)	1.57	3.8	3.7	3.9	3.6
Standard Deviation (Post-Test)	1.80	4.1	4.3	4.0	4.2
t-statistic	−15.36	−14.88	−14.59	−15.45	−15.02
p-value	<0.001	<0.001	<0.001	<0.001	<0.001

Table 2 provides statistical evidence supporting the significant improvements in writing performance across key components. The mean scores for all components—grammar, coherence, creativity, critical thinking, and problem-solving—showed substantial increases from pre-test to post-test, with improvements ranging from 28% to 34%. The low standard deviations in both pre-test and post-test scores indicate consistency in performance among participants. The paired t-tests reveal highly significant results for all components ($p < 0.001$), confirming that the observed improvements were not due to chance. These findings validate the effectiveness of the intervention, demonstrating that the integration of gamification and multimodal tools within the PBL framework had a statistically significant impact on fostering HOTs and improving writing outcomes.

The qualitative data from focus group discussions revealed that the integration of gamification and multimodal tools significantly enhanced students' engagement, motivation, and writing skills. Many students highlighted the interactive nature of Quizizz, stating that the gamified quizzes made learning grammar and sentence structure more enjoyable and less intimidating. Canva was praised for its ability to help students visually organize their ideas, which improved their ability to create coherent and well-structured drafts. Students also noted that collaborative activities and feedback processes fostered creativity and critical thinking, as they were encouraged to explore new perspectives and refine their arguments. Overall, participants reported feeling more confident in their writing abilities and found the intervention both effective and engaging. These reflections underscore

the impact of combining gamification and multimodal strategies in improving technical skills and higher-order thinking in writing. **Figure 1** below showcases the significant improvements in writing performance across key components—grammar, coherence, creativity, critical thinking, and problem-solving—before and after the intervention. These enhancements underscore the effectiveness of integrating gamification and multimodal tools within a Project-Based Learning framework to foster both technical and higher-order thinking skills in writing.

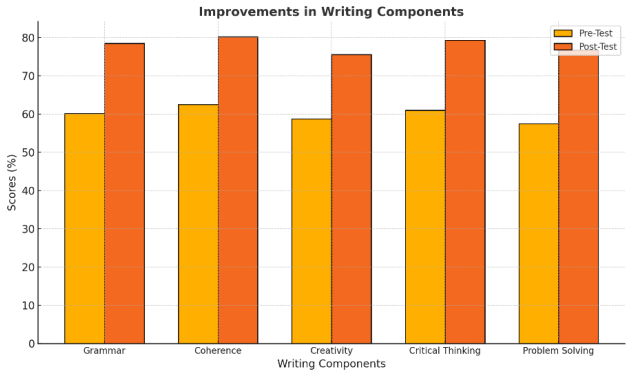

Figure 1. Improvements in writing components.

3.2. The Impact of Gamification and Multimodal on the Engagement and Motivation in Writing

The results from surveys and focus group discussions reveal significant improvements in student engagement, motivation, and key elements of Project-Based Learning (PBL), including collaboration and task relevance. These findings highlight the positive impact of integrating gamification and multimodal tools within the PBL framework. Students reported higher levels of interest and active participation, enhanced teamwork during group writing tasks, and a stronger connection between the activities and real-world contexts. The detailed results are summarized in **Table 3**.

Table 3 illustrates the significant impact of the intervention on student engagement, motivation, and key elements of Project-Based Learning (PBL), including collaboration and task relevance. Engagement increased by 30.77%, reflecting the effectiveness of gamified tools like Quizizz in maintaining student interest and active participation. Motivation, with the highest improvement at 36.67%, demonstrates the role of multimodal tools such as Canva in fostering creativity and personal investment in writing tasks. Collaboration within PBL improved by 34.48%, indicating that the structured group activities and peer interactions were effective in enhancing teamwork and shared accountability. The improvement in task relevance (29.03%) underscores how the real-world focus of PBL tasks made the activities more meaningful for students, encouraging deeper cognitive engagement. These findings validate the use of gamification and multimodal strategies in creating an engaging, collaborative, and practical learning environment that supports higher-order thinking and writing skill development.

Students shared that the intervention was highly engaging and effective in enhancing their writing skills during reflective discussions. Many participants highlighted the motivational impact of gamification tools like Quizizz, noting that the competitive quizzes helped them stay focused and made learning grammar and structure enjoyable. Canva was praised for its ability to organize ideas visually, which students said improved the coherence and creativity of their drafts. Collaborative PBL activities were frequently mentioned as beneficial for developing critical thinking and teamwork, with students valuing peer feedback and group discussions for refining their writing. Additionally, students expressed that the real-world relevance of tasks inspired them to think critically and approach writing with greater purpose. Overall, the discussions underscored the intervention's success in fostering engagement, collaboration, and higher-order thinking skills.

3.3. How the Use of Gamification and Multimodal Tools in PBL Foster HOTs in Writing

The results for Research Question 3 highlight the development of Higher-Order Thinking Skills (HOTs) in writing, including critical thinking, creativity, and problem-solving. The integration of gamification and multimodal tools within the PBL framework significantly enhanced students' ability to analyze, synthesize, and evaluate information, as well as generate original ideas and address real-world challenges. The detailed improvements in HOTs are summarized in **Table 4**.

Table 4 highlights significant improvements in Higher-Order Thinking Skills (HOTs), demonstrating the effectiveness of the intervention in fostering critical thinking, creativity, and problem-solving. Critical thinking showed a 30.16% improvement, reflecting students' enhanced ability to analyze, evaluate, and construct well-reasoned arguments in

Table 3. Results of engagement and motivation based on survey.

Category	Pre-Survey Mean (%)	Post-Survey Mean (%)	Improvement (%)
Engagement	65	85	30.77
Motivation	60	82	36.67
Collaboration	58	78	34.48
Relevance	62	80	29.03

Table 4. Higher order thinking development.

Category	Pre-Intervention Mean (%)	Post-Intervention Mean (%)	Improvement (%)
Critical Thinking	61	79.4	30.16
Creativity	58.8	75.6	28.57
Problem Solving	57.5	76.8	33.56

their writing. This growth is attributed to the use of gamified challenges, such as Quizizz, which encouraged deeper cognitive engagement and systematic reasoning during writing tasks.

Creativity improved by 28.57%, showcasing students' ability to generate original ideas and express themselves innovatively. The use of Canva as a multimodal tool was particularly impactful, helping students visually map out their ideas and explore unique perspectives before drafting their work. This enabled a more structured and creative approach to their writing. The highest improvement, 33.56%, was observed in problem-solving, highlighting how Project-Based Learning (PBL) scenarios encouraged students to address real-world challenges and integrate solutions into their writing. Collaborative group tasks and peer feedback sessions further enhanced this skill by fostering brainstorming and critical reflection on possible solutions.

These findings collectively emphasize that the integration of gamification and multimodal tools within PBL not only enhanced technical writing skills but also developed the cognitive processes essential for higher-order thinking. This demonstrates the transformative potential of the intervention in equipping students with essential skills for academic and real-world success.

4. Discussion

The results demonstrate significant improvements in key writing components, particularly problem-solving skills, which benefited from the intervention's gamified and collaborative elements. This highlights the intervention's capacity to address both technical and higher-order skills while fostering motivation and engagement. Studies have shown that gamified activities enhance motivation and engagement through elements like rewards and challenges. This is consistent with studies that highlight the motivational power of gamification in sustaining student engagement and enhancing task completion rates [5, 11–13]. The use of Quizizz gamified quizzes provided immediate feedback, helping students identify and correct errors while fostering technical writing accuracy [28, 29]. The improvements in grammar and coherence also highlight the role of gamified learning in reducing the cognitive load for students [14]. By breaking down complex writing tasks into smaller, manageable challenges, gamification not only enhances engagement but also allows students to focus incrementally on technical accuracy. This finding aligns with cognitive load theory, which suggests that well-structured, gamified activities support deeper learning by distributing effort effectively [14, 30]. Moreover, the competitive element of gamified quizzes motivated students to revisit and revise their understanding of grammatical structures, promoting mastery through repetition and feedback loops, as suggested by Deci and Ryan's Self-Determination Theory [28].

Similarly, multimodal tools like Canva have been shown to improve creative thinking and idea organization by accommodating diverse cognitive styles [9, 11, 13]. When applied within a PBL framework, these tools support the development of critical and creative thinking skills [8, 17]. The research clearly highlights the effectiveness of combining project-based learning (PBL) with multimodal tools in enhancing creativity, critical thinking, and problem-solving skills. The collaborative nature of PBL allowed students to engage with real-world tasks, requiring them to analyze

information, synthesize solutions, and present arguments. This is consistent with Patel and White, who found that problem-based learning (PBL) fosters deeper cognitive engagement by linking learning to practical contexts [7]. Canva further amplified these effects by enabling students to visually organize ideas, supporting creativity and structured problem-solving [18]. The role of multimodal tools like Canva in fostering creativity goes beyond simply organizing ideas. Visual tools allow students to externalize abstract thoughts, making them easier to refine and communicate. This finding resonates with dual-coding theory, which posits that combining verbal and visual information enhances memory and problem-solving. Moreover, Canva's design flexibility gave students the freedom to experiment, leading to greater originality in their writing outputs. The improvements in creativity reflect the capacity of multimodal resources to address diverse cognitive styles, as highlighted in Mayer's work on multimedia learning, which emphasizes that integrating multiple modes of representation fosters deeper conceptual understanding [22].

The highest improvement in problem-solving (33.56%) underscores the impact of group collaboration and feedback, which are central to PBL. The significant improvement in problem-solving skills compared to other components may reflect the specific strengths of the intervention. Gamification elements such as challenges and progress tracking, coupled with the collaborative nature of the Project-Based Learning (PBL) framework, likely provided students with ample opportunities to engage in iterative problem-solving tasks. Additionally, multimodal tools facilitated diverse modes of expression and cognitive engagement, enabling students to approach problems from multiple perspectives. This synergy between gamification and multimodal learning may explain the pronounced gains in problem-solving abilities. The relevance of tasks connected to real-world scenarios made learning meaningful, as theorized by Dewey's experiential learning framework, which posits that authentic tasks enhance critical engagement [19]. From a practical perspective, these findings suggest that incorporating similar interventions in writing instruction could help educators foster critical thinking and creativity while addressing specific skill gaps like problem-solving. For educators in resource-limited settings, adopting low-tech alternatives, such as group-based activities or offline gamified exercises, can still leverage the collaborative and motivational principles underlying the intervention. Such adaptations ensure broader applicability and inclusivity, making the benefits of gamification and multimodal learning accessible even in contexts with limited access to advanced tools. Additionally, reflective practices, such as journals and focus group discussions, allowed students to internalize their learning processes, aligning with Kolb's experiential learning cycle. The marked improvement in problem-solving highlights the role of PBL in creating authentic learning experiences that mimic real-world challenges. By engaging students in tasks with practical relevance, PBL aligns with constructivist learning theories, such as those proposed by Vygotsky, where collaborative problem-solving scaffolds higher-order cognitive processes [31]. The peer feedback mechanism, integral to PBL, encouraged students to evaluate different perspectives and refine their arguments. This collaborative dynamic also mirrors Bandura's social learning theory, where observation and interaction with peers enhance skill acquisition, also fosters critical thinking by encouraging students to evaluate different perspectives, analyze ideas collaboratively, and construct well-reasoned arguments through reflective discussions and feedback [32]. Additionally, solving real-world tasks helped students build transferable skills, suggesting that PBL can bridge academic learning with workplace demands.

Overall, the study validates the integration of gamification and multimodal tools as effective strategies for fostering both technical and higher-order writing skills. These findings suggest that combining innovative technologies with PBL can address diverse learner needs, providing a model for inclusive, engaging, and cognitively stimulating writing instruction. Future research could explore long-term impacts and scalability across various educational contexts. A notable limitation of this study is the absence of a control group, which restricts the ability to attribute observed improvements solely to the intervention. Future studies could incorporate a control group to establish a more robust causal relationship between the intervention and the outcomes. Additionally, while the four-week duration was sufficient to observe immediate effects, it may not fully capture the intervention's long-term impact on HOTs and writing performance. Extending the intervention over a longer period or conducting follow-up assessments could provide valuable insights into the sustainability of the observed benefits. These enhance-

ments would strengthen the evidence base and offer a more comprehensive understanding of the intervention's effectiveness. The study's findings also align with transformative learning theory, which emphasizes critical reflection as a pathway to deep learning. Reflective practices embedded in the intervention, such as journals and focus group discussions, not only helped students internalize their cognitive development but also fostered metacognition, enabling them to assess their learning strategies. This suggests that PBL combined with gamification and multimodal tools has the potential to address not just immediate learning outcomes but also long-term cognitive growth. Furthermore, these results contribute to existing literature by providing empirical evidence of how technology-driven PBL can cater to diverse educational needs, particularly in developing countries like Indonesia, where equitable access to innovative tools can narrow learning gaps.

This study advances the field by integrating gamification and multimodal learning within a Project-Based Learning (PBL) framework to enhance Higher-Order Thinking Skills (HOTs) in writing instruction. While existing studies have explored the individual benefits of gamification and multimodal tools, this research is novel in its combined application of these strategies, creating a cohesive and scalable approach to fostering critical thinking, creativity, and problem-solving in a real-world educational context. Compared to traditional methodologies, which often focus narrowly on grammar accuracy or surface-level writing skills, this intervention promotes deeper cognitive engagement through tailored, interactive activities that align with diverse learner needs. Furthermore, the integration of gamified elements with multimodal resources addresses limitations in earlier approaches by providing both motivational and cognitive support. This synthesis offers a practical, evidence-based model for writing instruction that bridges theoretical gaps and has broad applicability across educational settings. Future research could compare this integrated approach to conventional methods to further establish its efficacy and scalability.

5. Conclusions

This study demonstrates that integrating gamification and multimodal tools within a Project-Based Learning (PBL) framework significantly enhances both technical writing skills and Higher-Order Thinking Skills (HOTs), including critical thinking, creativity, and problem-solving. The results show substantial improvements in engagement, motivation, and writing performance, highlighting the effectiveness of tools like Quizizz and Canva in fostering active participation and deeper cognitive engagement. These findings suggest that combining innovative technologies with PBL provides a practical and inclusive approach to writing instruction. Future research should explore the long-term impact of these strategies across diverse educational contexts and investigate how such interventions can be personalized to address individual learning needs.

Author Contributions

Conceptualization, R.R. and E.F.P.; methodology, R.R.; software, M.M.; validation, R.R., E.F.P., and M.M.; formal analysis, R.R.; investigation, R.R.; resources, F.N.H.; data curation, D.A.K.; writing—original draft preparation, R.R.; writing—review and editing, E.F.P. and S.S.; visualization, F.N.H.; supervision, R.R.; project administration, R.R.; funding acquisition, E.F.P. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of Nusantara PGRI Kediri University and approved on July, 2024.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study. Participants were provided with detailed

information about the research objectives, procedures, and their rights, including the option to withdraw at any stage without penalty.

Data Availability Statement

The data presented in this study are available on request from the corresponding author. The data are not publicly available due to confidentiality and privacy restrictions.

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Conflicts of Interest

The authors declare no conflict of interest.

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