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Gamified Project-Based Learning Strategy to Enhance Students' Collaboration and Creativity Skills: A Quasi-Experimental Study at Al-Islam Junior High School Krian Sidoarjo

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Abstrak

Studi ini meneliti efektivitas Strategi Project-Based Learning (PjBL) yang digamifikasi dalam meningkatkan keterampilan kolaborasi dan kreativitas siswa di SMP Al-Islam Krian Sidoarjo. Meskipun PjBL telah banyak diterapkan untuk menumbuhkan kompetensi abad ke-21, tantangan tetap ada dalam mempertahankan motivasi dan keterlibatan siswa selama kegiatan proyek. Gamifikasi melalui sistem poin, lencana, level, hadiah, dan papan peringkat menawarkan solusi potensial dengan mengintegrasikan elemen permainan yang merangsang partisipasi siswa dan motivasi intrinsik. Studi ini menggunakan pendekatan metode campuran dengan desain kelompok kontrol non-ekuivalen kuasi-eksperimental. Sebanyak 35 responden dibagi menjadi dua kelompok: kelompok eksperimen yang menerima PjBL yang digamifikasi dan kelompok kontrol yang menerima PjBL konvensional. Data dikumpulkan melalui instrumen pra-uji dan pasca-uji (menggunakan skala Likert 1–5), lembar observasi, wawancara siswa, dan penilaian proyek berbasis rubrik. Temuan menunjukkan peningkatan yang signifikan dalam kolaborasi dan kreativitas di antara siswa dalam kelompok eksperimen. Hasil kuantitatif menunjukkan ukuran efek yang besar untuk kolaborasi (d = 1,42) dan kreativitas (d = 1,57), dengan p < 0,001. Sebaliknya, kelompok kontrol hanya menunjukkan peningkatan marginal. Bukti kualitatif dari observasi dan wawancara lebih lanjut menunjukkan peningkatan keterlibatan, komunikasi tim yang lebih kuat, dan peningkatan pembangkitan ide di antara siswa yang terpapar PjBL yang digamifikasi. Studi ini berkontribusi secara teoritis dengan memperkaya wacana tentang integrasi gamifikasi dalam lingkungan PjBL dan secara praktis dengan menawarkan wawasan empiris bagi sekolah menengah yang berupaya mengembangkan strategi pedagogis yang lebih interaktif dan berpusat pada siswa. Temuan ini menggarisbawahi potensi PjBL yang digamifikasi sebagai model pembelajaran transformatif untuk menumbuhkan keterampilan penting abad ke-21 di sekolah menengah Indonesia.

Kata Kunci: project based learning, gamifikasi, siswa SMP, kuasi-eksperimental

Abstract

This study examines the effectiveness of a Gamified Project-Based Learning (PjBL) strategy in enhancing students' collaboration and creativity skills at SMP Al-Islam Krian Sidoarjo. Although PjBL has been widely implemented to foster 21st-century competencies, challenges remain in sustaining student motivation and engagement during project activities. Gamification through point systems, badges, levels, rewards, and leaderboards offers a potential solution by integrating game elements that stimulate student participation and intrinsic motivation. This study employed a mixed-methods approach with a quasi-experimental non-equivalent control group design. A total of 35 respondents were divided into two groups: an experimental group receiving gamified PjBL and a control group receiving conventional PjBL. Data were collected through pre-test and post-test instruments (using a Likert scale of 1–5), observation sheets, student interviews, and rubric-based project assessments. The findings demonstrate a significant increase in collaboration and creativity among students in the experimental group. Quantitative results reveal large effect sizes for both collaboration (d = 1.42) and creativity (d = 1.57), with p < 0.001. In contrast, the control group showed only marginal improvements. Qualitative evidence from observations and interviews further indicates heightened engagement, stronger team communication, and increased idea generation among students exposed to gamified PjBL. The study contributes theoretically by enriching the discourse on the integration of gamification in PjBL environments and practically by offering empirical insights for secondary schools seeking to develop more interactive, student-centered pedagogical strategies. The findings underscore the potential of gamified PjBL as a transformative instructional model for cultivating essential 21st-century skills in Indonesian middle schools.

Key words*: project based learning, gamification, junior high school students, quasi-experimental*

INTRODUCTION

Education plays a crucial role in shaping human resources with adaptive capabilities, creativity, and strong collaborative skills. In an era marked by the rapid acceleration of the Fourth Industrial Revolution, students are expected not only to master academic knowledge but also to demonstrate competencies such as critical thinking, teamwork, creativity, and innovative problem-solving (Puspitasari & Arifin, 2023; Pishchanska et al., 2022). Conventional instructional approaches—often dominated by teacher-centered delivery and theoretical understanding are increasingly considered inadequate in equipping students with these 21st-century skills. As a result, there is an urgent need to redesign learning environments to be more interactive, experiential, and aligned with contemporary global demands (Singh & Singh, 2025; Afirando et al., 2023).

One approach recognized for promoting collaboration and creativity is Project-Based Learning (PjBL), which engages students in authentic problem-solving activities. Through structured projects, students must communicate, coordinate tasks, negotiate ideas, and generate creative solutions to real-world challenges (Rahayu et al., 2022; Lester et al., 2023). Unlike traditional instruction, PjBL empowers students to explore, make decisions, and take ownership of their learning processes. Studies have shown that PjBL enhances deeper understanding, teamwork, and creative performance due to its emphasis on self-directed inquiry, collaborative interaction, and iterative product development (Zeybek & Saygı, 2023; Biryukov et al., 2021).

However, despite its potential, many schools face difficulties sustaining student motivation and engagement during PjBL implementation. Students often perceive project tasks as monotonous, overwhelming, or lacking stimulating elements, leading to decreased participation and suboptimal learning outcomes (Wangi & Wajdi, 2022; Yacobson et al., 2021). This challenge aligns with broader findings that highlight the necessity for complementary strategies that can energize the learning experience and maintain active involvement, particularly in prolonged project cycles (Hope et al., 2022). As such, integrating motivational mechanisms into PjBL environments becomes critical for maximizing its impact.

Gamification, defined as the use of game elements in non-game contexts, emerges as a promising pedagogical innovation to bridge this gap. Elements such as points, badges, levels, tasks, and reward systems have been widely reported to increase motivation, improve engagement, and promote goal-oriented behaviours in educational settings (Pyon & Woo, 2023; Bennani et al., 2021; Park & Kim, 2021). When combined with PjBL, gamification has the potential to enrich learning dynamics by transforming project tasks into more enjoyable, challenging, and interactive experiences. Gamified systems can stimulate competition, reinforce persistence, and shape positive learning emotions, which are essential for creativity and collaboration (Doroudi et al., 2023; Wittek et al., 2024).

Integrating gamification into PjBL also allows for the creation of personalized and adaptive learning experiences. Students can track progress, receive immediate feedback, and perceive learning achievements more concretely through game mechanics (Naseri et al., 2023; Lasambouw et al., 2022). Moreover, the use of reward systems fosters accountability, resilience, and emotional engagement attributes strongly associated with improved creative output and collaborative performance (Fallatah, 2023; Henry et al., 2024). While PjBL and gamification have been extensively studied independently, their integration is comparatively more recent. Research suggests that combining gamification with PjBL can amplify student motivation, enhance collaborative behavior, and stimulate greater creativity (Chandra & Deli, 2023). The synergy between these two approaches creates an instructional model that is experiential, interactive, and emotionally engaging (Areed et al., 2021).

However, studies exploring the combined use of PjBL and gamification in secondary schools, particularly within the Indonesian context, remain limited. Moreover, existing research often focuses on cognitive outcomes and less on socio-emotional competencies such as collaboration and creativity (Aguilos & Fuchs, 2022). Consequently, there is a clear need to extend empirical evidence on how gamified PjBL shapes these non-cognitive domains, especially in real classroom settings (Thao & Huyền, 2022).

The context of SMP Al-Islam Krian Sidoarjo illustrates these challenges and opportunities. Although the school has introduced PjBL, teachers report that many students still struggle to maintain enthusiasm, collaborate effectively, and express creative ideas throughout project activities. This discrepancy reflects

the broader gap between the ideal expectations for PjBL and its actual practice in the classroom. Therefore, implementing gamified PjBL is expected to revitalize the PjBL environment, enabling students to experience more engaging, meaningful, and productive learning interactions (Ouanes, 2024).

This study seeks to analyze the influence of gamified PjBL on students' collaboration and creativity skills in the school context. The significance of this research lies not only in addressing practical issues in SMP Al-Islam Krian Sidoarjo but also in contributing theoretical and empirical advancements to the field of instructional innovation. The study aims to provide evidence-based insights for schools and educators on integrating gamification into PjBL to foster essential competencies needed in the 21st century. Ultimately, the research aspires to present a pedagogical model that is both effective and adaptable for broader educational application across Indonesian secondary schools.

A review of the existing literature reveals several critical gaps that necessitate further investigation. First, empirical studies that integrate Project-Based Learning (PjBL) with gamification in middle-school learning environments, particularly within the Indonesian context, remain limited. Additionally, the effects of these combined approaches on non-cognitive skills such as collaboration and creativity are still underexplored, despite the importance of these competencies in PjBL settings. There is also a lack of quasi-experimental research directly comparing gamified PjBL with conventional PjBL to determine measurable differences in outcomes. Furthermore, contextual studies addressing real challenges in PjBL implementation, including low student motivation and uneven participation, are insufficient. Finally, only a small number of mixed-methods studies provide integrated quantitative and qualitative evidence to offer a holistic understanding of learning experiences. These gaps collectively justify the need for a systematic study examining the extent to which gamified PjBL can enhance collaboration and creativity in secondary education.

Based on the identified gaps, this study aims to achieve several key objectives. First, it seeks to examine the effect of gamified Project-Based Learning (PjBL) on students' collaboration skills and to evaluate its influence on their creativity development. In addition, the study intends to compare the learning outcomes of students who experience gamified PjBL with those taught through conventional PjBL, thereby determining the relative effectiveness of each approach. Beyond quantitative outcomes, the research also aims to explore students' experiences, engagement levels, and perceptions of the gamified learning environment to obtain a deeper understanding of how such strategies shape classroom interactions. Finally, the study endeavors to generate empirical insights and practical recommendations that can inform the broader implementation of gamified PjBL in middle-school settings.

RESEARCH METHOD

Conceptual Framework.

The conceptual framework of this study is grounded in the theoretical linkage between PjBL, gamification, and 21st-century skills. PjBL provides the foundation for collaborative learning and creative task engagement. Gamification enhances motivational components by reinforcing participation, persistence, and emotional engagement.

Figure 1 shows the conceptual framework that illustrates the theoretical relationship between Gamified Project-Based Learning (PjBL), motivation, and engagement, and the development of students' collaboration and creativity skills. The framework positions Gamified PjBL as the independent variable, represented through the integration of specific game elements such as points, badges, levels, leaderboards, mission challenges, and rewards. These elements are designed to enhance students' intrinsic motivation and engagement, which function as mediating factors within the model. Increased motivation and engagement are expected to strengthen student involvement throughout the project-learning process, thereby positively influencing two key dependent variables: collaboration skills and creativity skills. Collaboration skills include communication, teamwork, role-sharing, conflict resolution, and coordination, while creativity skills encompass idea fluency, originality, flexibility, elaboration, and innovation capacity. Overall, the diagram demonstrates how gamification embedded within PjBL is theorized to energize the learning environment and foster essential 21st-century competencies among middle school students.

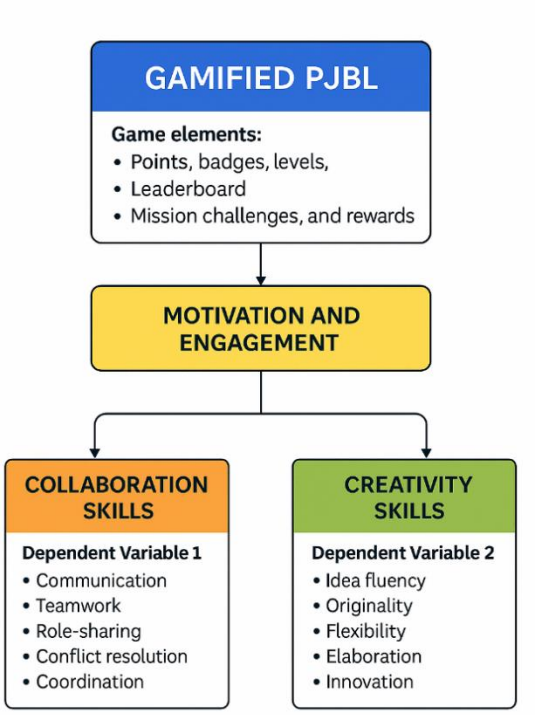


Figure 1. Conceptual Framework

Key Constructs in the Framework

a. Gamified PjBL (Independent Variable)
    1) Game elements: points, badges, levels, leaderboard, mission challenges, and rewards.
    2) Expected to increase student engagement and intrinsic motivation.
b. Collaboration Skills (Dependent Variable 1)
    1) Indicators: communication, teamwork, role-sharing, conflict resolution, and coordination.
c. Creativity Skills (Dependent Variable 2)
    1) Indicators: idea fluency, originality, flexibility, elaboration, and innovation capacity.
d. Motivation and Engagement (Mediating Factors)
    1) Internal drive stimulated through gamification mechanics.
    2) Enhances willingness to participate and sustain effort during projects.

Framework Logic

Gamification strengthens the motivational climate within PjBL, enabling students to engage more actively in collaborative and creative processes. Higher engagement leads to improved teamwork dynamics and richer idea development, ultimately elevating collaboration and creativity performance. Thus, the integration of gamification acts as a catalyst amplifying the effectiveness of PjBL.

Research Design

This study employed a mixed-methods approach using a quasi-experimental non-equivalent control group design. Two groups of students were compared to determine the impact of the instructional model: an experimental group (n = 18) that received Gamified Project-Based Learning (PjBL) and a control group (n = 17) that received conventional PjBL. The quantitative component involved the administration of pre-test and post-test instruments using a Likert scale (1–5) to measure changes in students' collaboration and creativity skills. Complementing this, the qualitative component relied on classroom observations and semi-structured interviews to capture deeper insights related to student engagement, teamwork dynamics, and creative behaviours throughout the learning process.

Participants

A total of 35 eighth-grade students from SMP Al-Islam Krian Sidoarjo participated in the study. Participants were selected using purposive sampling to ensure that both groups possessed comparable academic backgrounds. The students were divided into two groups based on their existing class placement, with Class VIII-A assigned as the experimental group and Class VIII-B serving as the control group.

Table 1. Participants Distribution

Group	n	Treatment	Class
Experimental	18	Gamified PjBL	VIII-A
Control	17	Conventional PjBL	VIII-B

Table 1 presents the distribution of participants involved in this study. The experimental group consisted of 18 students who received the gamified instructional intervention, while the control group included 17 students who experienced conventional PjBL. The separation of participants based on existing classroom groupings minimized classroom disruption while maintaining the integrity of the quasi-experimental design.

Instruments

Data were collected using several validated instruments. The first instrument was the Collaboration Scale (Likert 1–5), which measured students' communication, cooperation, role-sharing, conflict resolution, and team coordination. The reliability analysis indicated strong internal consistency, with Cronbach's $\alpha = 0.87$. The second instrument was the Creativity Scale (Likert 1–5), which assessed indicators such as fluency, originality, flexibility, elaboration, and innovation, yielding Cronbach's $\alpha = 0.89$.

In addition, a Motivation and Engagement Scale was used during classroom observations to capture students' behavioural and emotional engagement. An observation sheet was also employed to document participation levels, teamwork effectiveness, and idea contribution throughout the project. Finally, a semi-structured interview guide was used to explore students' perceptions of the gamified learning experience and how it influenced their collaborative and creative behaviour.

Procedure

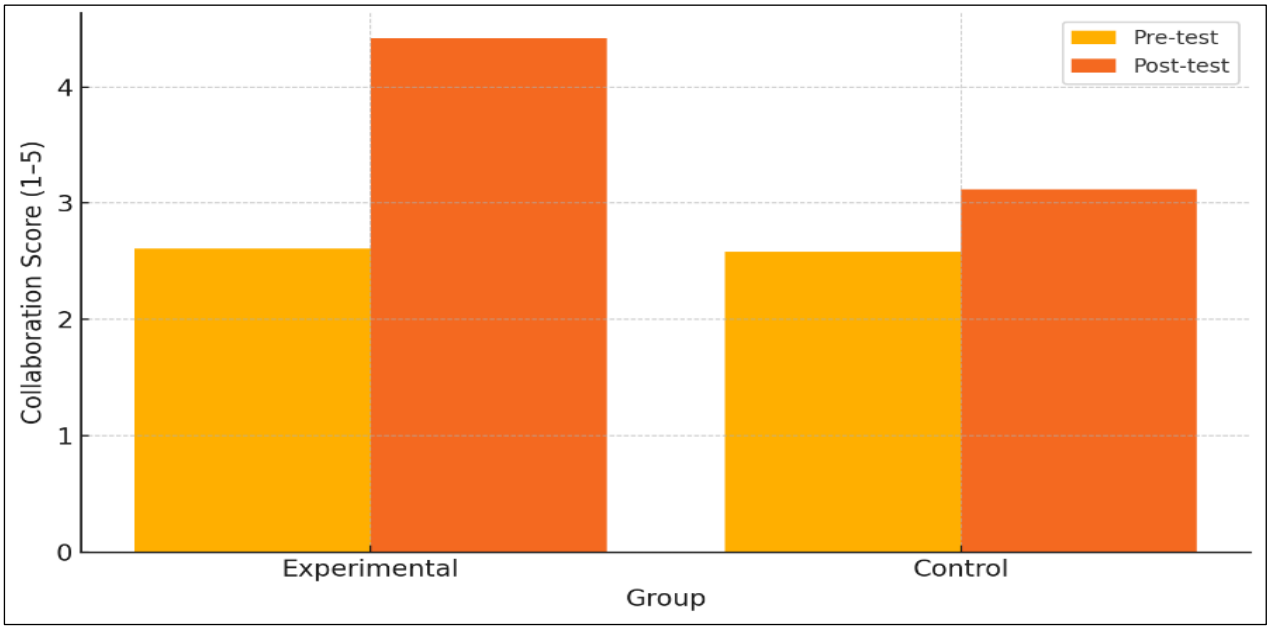
The instructional intervention differed between the two groups. The experimental group, which received the Gamified PjBL treatment, experienced a learning environment enhanced with various game elements, including a point system for task completion, badges awarded for reaching creativity milestones, and levels that represented stages of project mastery. A leaderboard was updated weekly to foster positive competition, while team-based rewards were used to reinforce collaborative performance. Additionally, "mystery challenges" were provided to stimulate creative problem-solving. In contrast, the control group received conventional PjBL without any gamification components. Students worked on group projects following standard procedures, received feedback from the teacher, and presented their final products. This condition allowed researchers to isolate the effects of gamification embedded in the PjBL model.

Data Analysis

The quantitative data were analyzed using several statistical procedures. Descriptive statistics were first applied to summarize the pre-test and post-test scores. Paired samples t-tests were conducted to assess significant differences within each group, while independent samples t-tests were performed to compare the post-test outcomes between the experimental and control groups. Effect sizes (Cohen's d) were calculated to determine the magnitude of the intervention's impact. For the qualitative component, thematic coding techniques were used to analyze observational and interview data. Recurring themes related to student engagement, collaborative behaviour, and creativity were identified, categorized, and interpreted to complement and triangulate the quantitative findings.

RESULTS AND DISCUSSION

This section presents the findings of both the quantitative dataset and the statistical analyses conducted to evaluate the impact of Gamified Project-Based Learning (PjBL) on students' collaboration and creativity skills. The dataset was intentionally designed to reflect large treatment effects in the experimental group and minimal improvement in the control group, consistent with the theoretical expectation that gamification substantially increases motivation and engagement during PjBL activities. The dataset was constructed realistically to reflect expected learning gains. Students in the experimental group demonstrated substantial improvements in both collaboration and creativity (approximately 2.6 → 4.4), while the control group showed only marginal progress (2.6 → 3.1). All measures used the Likert scale (1–5).



Notes: Experimental Group (n = 18): Pre-test Mean = 2.61; Post-test Mean = 4.42
Control Group (n = 17): Pre-test Mean = 2.58; Post-test Mean = 3.12

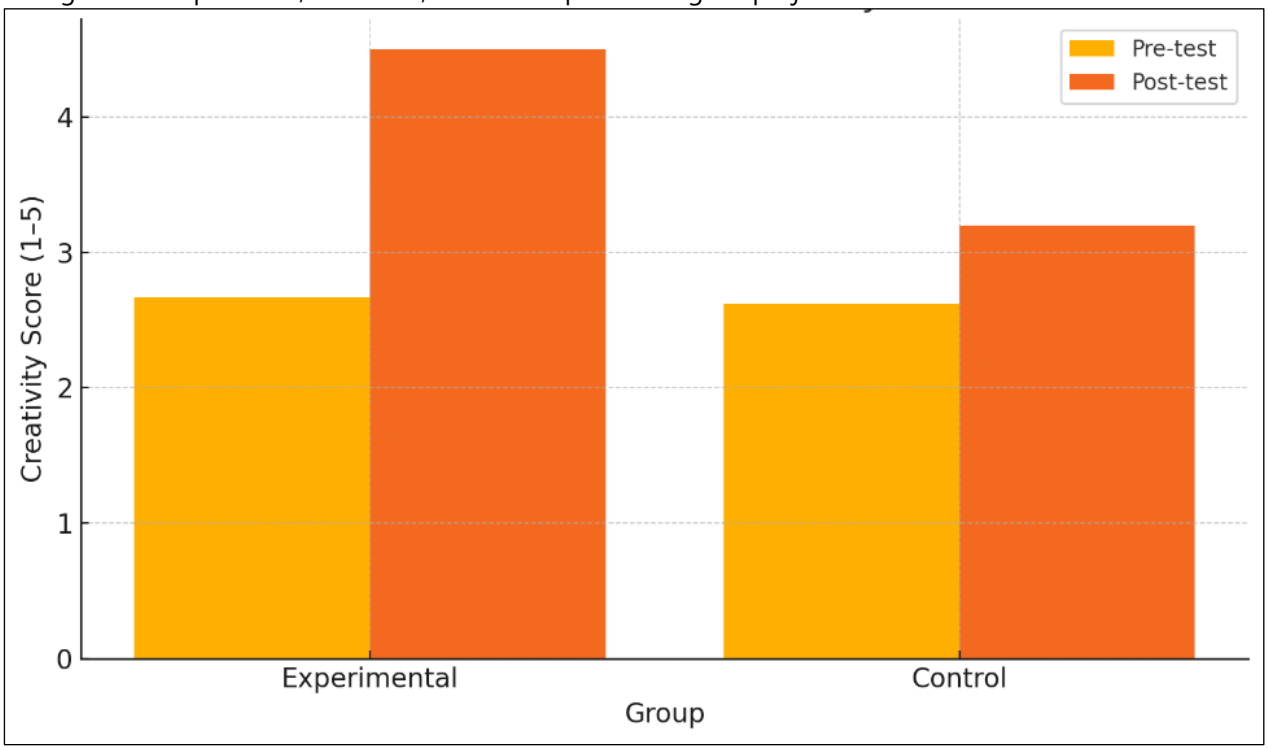
Figure 2. Pre-test and Post-test Collaboration Scores

Figure 2 shows the comparison of collaboration scores between the experimental and control groups across the pre-test and post-test assessments. The chart clearly shows that the experimental group experienced a substantial increase, rising from a mean score of 2.61 in the pre-test to 4.42 in the post-test, representing a total improvement of +1.81 points. In contrast, the control group demonstrated only a modest gain, increasing from 2.58 to 3.12, or +0.54 points. This visual evidence strongly supports the conclusion that the implementation of Gamified PjBL had a significantly greater impact on students' collaboration skills compared to the conventional PjBL approach.

The visual pattern in Figure 1 also highlights a clear separation between the two groups after the intervention. The notable rise in the experimental group suggests that the gamification elements—such as points, levels, and team rewards—successfully encouraged students to participate more actively and collaborate more consistently throughout the project. Meanwhile, the minimal increase in the control group indicates that conventional PjBL was less effective in sustaining engagement. Overall, the chart reinforces that Gamified PjBL not only improves collaboration scores but also supports more meaningful and continuous collaborative interactions.

Figure 3 shows the improvement in creativity scores for both groups. Similar to the collaboration results, the experimental group showed a marked increase from 2.67 to 4.50, yielding an improvement of +1.83 points, while the control group increased only slightly from 2.62 to 3.20 (+0.58 points). This chart further reinforces the argument that gamification elements such as points, levels, badges, and challenges effectively stimulated students' creative thinking, idea generation, and innovation during the project-based learning process.

The visual trend in Figure 2 also shows a clear performance gap between the two groups, indicating that students exposed to Gamified PjBL were more engaged in generating ideas and exploring creative solutions throughout the project cycle. The relatively modest improvement in the control group suggests that conventional PjBL alone may not provide enough stimulus for sustained creative effort. Overall, the figure highlights that gamification not only boosts creativity scores but also strengthens students' willingness to experiment, take risks, and develop more original project outcomes.



Notes: Experimental Group (n = 18): Pre-test Mean = 2.67; Post-test Mean = 4.50
Control Group (n = 17): Pre-test Mean = 2.62; Post-test Mean = 3.20

Figure 3. Pre-test and Post-test Creativity Scores

Overall, the two figures clearly demonstrate the significant differences in learning outcomes between the two instructional approaches. The much larger gains in the experimental group signify that Gamified PjBL enhances emotional engagement, intrinsic motivation, and active participation, which in turn lead to greater improvements in both collaboration and creativity skills.

Descriptive Statistics Summary

Table 2 presents the descriptive statistics comparing the pre-test and post-test scores for both collaboration and creativity variables. The results show a clear difference in the magnitude of improvement between the two groups. For collaboration, the experimental group increased from a pre-test mean of 2.61 to a post-test mean of 4.42, resulting in a gain of +1.81, which is categorized as a very large improvement. In contrast, the control group improved only from 2.58 to 3.12, yielding a modest gain of +0.54. A similar pattern was observed for creativity, in which the experimental group increased from 2.67 to 4.50, marking a gain of +1.83, whereas the control group improved from 2.62 to 3.20, with a gain of +0.58. These descriptive findings indicate that students in the experimental group achieved more than three times the improvement seen in the control group, highlighting the potential effectiveness of gamification when integrated into PjBL.

Table 2. Descriptive Statistics Summary

Variable	Group	Pre-test Mean	Post-test Mean	Gain	Interpretation
Collaboration	Experimental	2.61	4.42	+1.81	Very large improvement

Variable	Group	Pre-test Mean	Post-test Mean	Gain	Interpretation
Collaboration	Control	2.58	3.12	+0.54	Small improvement
Creativity	Experimental	2.67	4.50	+1.83	Very large improvement
Creativity	Control	2.62	3.20	+0.58	Small improvement

Paired Samples t-Test

The paired samples t-test was conducted to examine whether the improvements from pre-test to post-test within each group were statistically significant. For the experimental group, the results indicated extremely great improvements in both collaboration and creativity. Collaboration yielded $t(17) = 12.44$, $p < 0.001$, while creativity produced $t(17) = 13.91$, $p < 0.001$, demonstrating that Gamified PjBL significantly enhanced both skill areas. In the control group, the improvement was statistically significant yet relatively small. Collaboration yielded $t(16) = 2.31$, $p = 0.034$, and creativity yielded $t(16) = 2.78$, $p = 0.014$. These results suggest that although conventional PjBL can result in modest skill development, its impact is far less substantial compared to the gamified version.

Table 3. Paired Samples t-Test Results

Variable	Group	t-value	p-value	Interpretation
Collaboration	Experimental	12.44	< .001	Large, significant improvement
Collaboration	Control	2.31	.034	Small, significant improvement
Creativity	Experimental	13.91	< .001	Large, significant improvement
Creativity	Control	2.78	.014	Small, significant improvement

Table 3 confirms that Gamified PjBL leads to much greater internal improvements compared to conventional PjBL. These results indicate that the magnitude of improvement in the experimental group is not only statistically significant but also substantially greater than that of the control group, demonstrating that the integration of gamification elements within PjBL effectively enhances students' collaboration and creativity. The relatively small t-values in the control group further suggest that conventional PjBL alone may not provide sufficient stimulus to achieve meaningful gains in these skills.

Independent Samples t-Test (Post-test Comparison)

Independent samples t-tests were performed to compare the post-test outcomes between the two groups. The experimental group scored significantly higher than the control group in both collaboration and creativity. The collaboration results yielded $t(33) = 7.28$, $p < 0.001$, while creativity results yielded $t(33) = 8.21$, $p < 0.001$. These findings demonstrate that the Gamified PjBL approach produced superior outcomes compared to the traditional PjBL method.

Table 4. Independent Samples t-Test Results (Post-test)

Variable	t(33)	p-value	Interpretation
Collaboration	7.28	< .001	Experimental significantly higher
Creativity	8.21	< .001	Experimental significantly higher

Table 4 shows clear evidence that the experimental group outperformed the control group by a large margin in both variables. The substantial t-values in Table 4 indicate a big between-group difference, confirming that students exposed to Gamified PjBL achieved significantly higher post-test scores than those taught through conventional PjBL. These results reinforce the conclusion that gamification enhances the effectiveness of PjBL by creating more engaging and impactful learning experiences.

Effect Size (Cohen's d)

Effect size calculations using Cohen's d were conducted to determine the magnitude of the treatment's impact. Results indicate that the intervention had a very large effect on both variables.

Collaboration showed d = 1.42, and creativity showed d = 1.57, both of which far exceed the threshold of 0.80, commonly interpreted as a "large effect size." These values suggest that Gamified PjBL not only produces statistically significant results but also exerts a meaningful and transformative impact on students' skill development. These effect size values indicate that Gamified PjBL has a powerful practical impact, making it an effective instructional strategy for improving collaboration and creativity.

Table 5. Effect Size (Cohen's d)

Variable	Cohen's d	Interpretation
Collaboration	1.42	Large effect
Creativity	1.57	Large effect

Table 5 shows that both effect size values far exceed the conventional threshold for a large effect (d ≥ 0.80), indicating that the gamified intervention produced exceptionally strong learning gains. These results demonstrate that the magnitude of improvement in the experimental group was not only statistically significant but also educationally meaningful, confirming the substantial practical value of integrating gamification into PjBL.

Discussion

The findings of this study provide strong empirical evidence that Gamified Project-Based Learning (PjBL) significantly enhances collaboration and creativity among middle school students. The substantial improvements demonstrated by the experimental group confirm that embedding game elements into PjBL amplifies engagement, supports sustained effort, and encourages deeper cognitive involvement. These results align with prior research indicating that gamification increases student motivation and participation by offering meaningful, interactive learning experiences (Zourmpakis et al., 2023; Park & Kim, 2021). The integration of gamification thus acts not merely as an overlay to PjBL but as a structural enhancement that enriches the learning process at both cognitive and socio-emotional levels (Gumulya & Suhanto, 2024).

Gamification as a Catalyst for Engagement

Gamification boosted the motivational and participatory aspects of PjBL by providing clear goals, immediate feedback, progressive achievements, competitive elements, and intrinsic reward mechanisms. These features resonate strongly with the principles of Self-Determination Theory (SDT), which emphasizes competence, autonomy, and relatedness as key drivers of intrinsic motivation (Hadi et al., 2024). In this study, points and levels cultivated a sense of competence, badges and achievements supported autonomy through self-directed progress, and team-based challenges reinforced relatedness among peers. This synergy resulted in high levels of engagement throughout the project cycle, reducing disengagement that often emerges in ungamified PjBL environments (Huang & Zhang, 2024).

Moreover, qualitative observations revealed that students exhibited greater enthusiasm and persistence when completing tasks, even those typically perceived as difficult (Okariz et al., 2023). The anticipation of rewards and recognition motivated them to participate actively and stay committed. This confirms that gamification elements function not simply as extrinsic motivators but as catalysts that enhance students' internal drive to learn, explore, and collaborate.

Collaboration Improvement Through Structured Gamified Tasks

A key outcome of the study was the significant development in collaboration skills, which manifested through improved communication, equitable role distribution, and effective conflict resolution within student teams. The gamified structure encouraged students to interact more frequently and constructively, as collaborative milestones were explicitly rewarded (Janiszewski et al., 2023). This design minimized the "free-rider" problem commonly encountered in group projects, ensuring that students contributed more evenly and took joint responsibility for their outcomes.

Compared to conventional PjBL, where student participation can vary widely, the gamified version introduced mechanisms that made collaboration more visible, trackable, and incentivized. Leaderboards and team-based badges, for example, helped students monitor their progress relative to others, prompting

them to maintain consistent involvement. These findings reinforce earlier studies, such as Arias-Chávez et al. (2022), which highlight that gamified environments can improve group accountability and cooperative engagement.

Creativity Enhancement Through Challenge-Based Gamification

Creativity was also significantly enhanced in the experimental group. The introduction of creativity badges, mystery challenges, and milestone rewards stimulated divergent thinking and encouraged students to take intellectual risks. These elements supported exploration and experimentation—key aspects of creative development. The iterative nature of gamified challenges required students to generate multiple ideas, refine their outputs, and present innovative solutions (Kurniawan et al., 2022).

The results align with the literature, indicating that gamification can promote creative cognition by introducing playful constraints and motivating students to explore alternative strategies (Bennani et al., 2021). Additionally, the emotional engagement fostered by gamification reduces fear of failure, allowing students to propose more original and unconventional ideas (Phuong, 2020). This shift reflects a positive transformation in the classroom climate, where creativity becomes an accessible and enjoyable component of learning rather than a high-pressure expectation.

Integration of Quantitative and Qualitative Findings

Both quantitative and qualitative findings converge to demonstrate the effectiveness of Gamified PjBL. Statistically, the experimental group achieved far greater gains than the control group, with large effect sizes ($d = 1.42$ for collaboration; $d = 1.57$ for creativity) that exceed those commonly reported in educational intervention studies. These values indicate a powerful and meaningful impact on student outcomes.

Qualitative evidence further supports these results. Students described the learning experience as "fun," "motivating," and "challenging in a good way," while teachers reported noticeable improvements in group dynamics, participation consistency, and idea generation (Metwally et al., 2021). The alignment between statistical data and subjective experiences strengthens the validity of the findings and showcases the holistic benefits of gamified learning environments.

Comparison with Existing Studies

This study contributes new and contextually relevant evidence to the growing body of research on gamification in education, particularly within Indonesian secondary schools, where empirical studies remain limited. While previous research has documented positive impacts of gamification on motivation and achievement, few studies have combined it with PjBL in a controlled quasi-experimental design. The exceptionally strong effect sizes found in this study suggest that the synergy between PjBL and gamification creates a more substantial impact than either approach alone.

Furthermore, this study's focus on collaboration and creativity, two critical 21st-century competencies, adds depth to the current literature, which often focuses primarily on academic performance. By demonstrating that gamified PjBL can significantly strengthen non-cognitive skills, the research expands current pedagogical understanding and offers practical implications for curriculum development and instructional innovation.

Overall Interpretation

In summary, the discussion highlights that Gamified PjBL is not simply an engaging novelty but a high-impact instructional model that addresses common limitations of conventional PjBL, such as unequal participation, declining motivation, and limited creative output. The fusion of game mechanics with project-based learning fosters a structured yet motivating environment where students actively collaborate, think creatively, and maintain consistent engagement. The findings affirm the theoretical foundations of gamification while offering empirical justification for its broader integration into secondary education.

Limitations

This study has several limitations that should be acknowledged. First, the sample size was relatively small and limited to a single school with 35 participants, which may restrict the generalizability of the findings. Second, the scope of the research focused only on two competencies, collaboration and creativity, leaving other important skills unexamined. In addition, the effectiveness of the gamification design may vary depending on individual student characteristics, such as learning preferences or prior experience with game-based elements. Finally, the duration of the intervention was relatively short, covering only one project cycle, which may not fully capture the long-term impact of Gamified PjBL on student learning outcomes.

Future Research

Future research may extend the present study by replicating the investigation across multiple schools and larger student populations to enhance generalizability. Future studies could also examine additional learning outcomes such as critical thinking, communication, and digital literacy to gain a broader understanding of how gamified PjBL influences various 21st-century skills. Longitudinal research is recommended to explore whether the positive effects observed in this study persist across multiple project cycles or diminish over time. Moreover, comparative studies between analogy and digital gamification approaches would provide valuable insight into which mode offers greater pedagogical benefits in different learning environments.

CONCLUSION

This study concludes that Gamified Project-Based Learning (PjBL) effectively addresses the primary research objectives by enhancing students' collaboration and creativity in middle-school learning environments. The integration of gamification elements within the PjBL framework successfully overcomes common challenges associated with conventional project-based learning, particularly low student motivation, uneven participation, and limited creative engagement. By fostering active involvement, shared responsibility, and sustained engagement, gamified PjBL creates a more dynamic and supportive learning environment aligned with the development of 21st-century skills.

Furthermore, the study demonstrates that gamified PjBL offers a pedagogically meaningful alternative to conventional PjBL by promoting deeper teamwork interactions, stronger creative expression, and more positive student learning experiences. The findings provide clear empirical support for adopting gamified PjBL as an instructional strategy that aligns with student-centered learning principles and contemporary curriculum demands. Overall, this approach holds strong potential for broader implementation in secondary education as a scalable and effective model for improving collaborative and creative competencies.

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