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The Application of a Gamification Approach to Enhance Motivation in Learning Mathematics Among Fourth-Grade Elementary School Students

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Abstract: Learning motivation is a crucial factor that determines the success of mathematics learning at the elementary school level. However, low motivation remains a persistent challenge, particularly in schools with limited access to digital technology. This study aims to analyze the effectiveness of the gamification approach in improving mathematics learning motivation among Grade IV students at SD Negeri 2 Mekarmukti. Grounded in Self-Determination Theory (Deci & Ryan, 2000), which posits that intrinsic motivation develops through the fulfillment of three basic psychological needs (competence, autonomy, and relatedness), this study employed a Classroom Action Research (CAR) design following the Kemmis and McTaggart model across two cycles. Subjects were 25 Grade IV students during the even semester of the 2025/2026 academic year. Data were collected via observation sheets, a 45-item learning motivation questionnaire (1-5 Likert scale), and documentation, then analyzed using descriptive quantitative techniques. Findings show that the mean motivation score increased from 26.80 (pre-cycle) to 32.12 (Cycle I) and 35.36 (Cycle II), while the proportion of students in the highly active category rose from 32% to 64% and ultimately to 92%, surpassing the 85% success threshold. The most effective gamification elements were structured group challenges with clear rules (Mystery Card Quest and Flashcard Sprint), point systems, and reward mechanisms. This study demonstrates that non-digital, activity-based gamification is an accessible and effective strategy for elementary school teachers in resource-constrained settings.

Keyword : *gamification; learning motivation; mathematics; elementary school; self-determination theory*

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Introduction

Mathematics is one of the essential subjects at the elementary school level that plays a central role in developing students' logical, critical, systematic, and creative thinking as well as their problem-solving abilities. Mastery of mathematical concepts from an early age serves as an important foundation for academic success at higher educational levels and for addressing real-world challenges. Consequently, mathematics learning should not only target cognitive competence but must also cultivate learning motivation as a driving force for active student engagement during the learning process. High learning motivation encourages students to be more persistent, self-confident, and enthusiastic in achieving learning objectives (Purba et al., 2024; Ansori et al., 2025).

Learning motivation is a fundamental construct in educational psychology that refers to the internal and external forces that drive students to engage in learning activities consciously and purposefully. According to Self-Determination Theory (SDT) developed by Deci and Ryan (2000), intrinsic motivation—the most durable and educationally productive form of motivation—develops when three basic psychological

needs are fulfilled: competence (the need to feel capable and effective), autonomy (the need to act volitionally), and relatedness (the need for meaningful social connection). When these needs are met through instructional design, students demonstrate greater persistence, curiosity, and self-directed engagement. This theoretical foundation provides the rationale for selecting gamification as the intervention strategy in this study, given its capacity to address all three psychological needs simultaneously (Deci & Ryan, 2000; Purba et al., 2024).

Despite its importance, mathematics learning at the elementary level continues to face significant challenges, particularly regarding low student motivation. Numerous studies indicate that mathematics is still widely perceived by students as difficult, abstract, and unenjoyable, reducing their willingness to actively engage in learning. This is evidenced by low participation during teacher explanations, reluctance to express opinions, and a tendency to give up when facing difficult problems (Purba et al., 2024; Legowo, 2022).

Low mathematics learning motivation was also directly observed at Grade IV of SDN 2 Mekarmukti through preliminary observations. The majority of students were insufficiently focused during teacher explanations, tended to be passive during discussion activities, and were reluctant to ask or answer questions. Several students displayed a tendency to give up when encountering problems requiring reasoning. These conditions align with Mutiara et al. (2023) and Niswah and Malasari (2023), who reported that low mathematics learning motivation is influenced by limited student involvement, monotonous instructional methods, and insufficient variation in learning activities.

Gamification represents a promising instructional approach to address these motivational challenges. Defined as the application of game-design elements and game principles to non-game contexts (Deterding et al., 2011), gamification integrates elements such as point systems, levels, challenges, rewards, feedback, and leaderboards into the learning environment without altering learning objectives. Gamification is particularly well-suited to SDT's framework: challenge and reward systems address competence, group strategy activities foster autonomy, and collaborative gameplay builds relatedness. By fulfilling these three psychological needs, gamification has the theoretical potential to cultivate intrinsic motivation in a sustained manner (Legowo, 2022; Azman & Bakhtiar, 2024).

Several recent studies confirm gamification's positive impact on elementary mathematics learning. Ansori et al. (2025) reported that gamification improved both motivation and mathematics learning outcomes through more interactive instruction. Isnawati (2021) demonstrated increased learning interest across each cycle of gamification. Sadrah et al. (2025) showed that gamification-based media significantly improved motivation and learning outcomes, while Azman and Bakhtiar (2024) concluded that game elements (points, challenges, rewards, leaderboards) create more attractive experiences that increase student engagement.

However, a critical gap remains: most prior studies have focused on digital gamification platforms (Wordwall, Quizizz, or other interactive applications), and have primarily examined improvements in learning outcomes or interest rather than motivation across multiple measured indicators. Classroom Action Research (CAR) designs that systematically examine the cycle-by-cycle implementation of non-digital, activity-based gamification and its effect on multiple dimensions of mathematics learning motivation remain scarce, particularly for Grade IV elementary school settings (Maulah et al., 2025; Isnawati, 2021).

The novelty of this study lies in the implementation of gamification through contextual learning activities designed as cooperative group-based educational games, learning challenges (learning missions), point systems, and rewards, all delivered without dependence on digital media. This approach demonstrates that gamification can be effectively implemented in schools with limited technological infrastructure, providing a more contextual, simple, and accessible alternative for elementary school teachers.

Based on the foregoing, this study aims to: (1) analyze the implementation of the gamification approach in improving mathematics learning motivation among Grade IV elementary school students through CAR; (2) identify which gamification elements are most effective in improving students' motivation across five measured indicators; and (3) evaluate the effectiveness of actions taken across cycles to determine the most appropriate form of non-digital gamification implementation for elementary school mathematics. Practically, findings are expected to offer guidance for teachers in resource-constrained settings; theoretically, they are expected to contribute empirical support for SDT-grounded gamification in elementary education.

Methodology

This study employed Classroom Action Research (CAR) following the Kemmis and McTaggart (1988) spiral model, which consists of four interconnected stages per cycle: planning, action implementation, observation, and reflection. This model was selected because it provides a systematic framework for iterative improvement of instructional practice, enabling the researcher to identify problems, implement targeted interventions, observe outcomes, and refine actions across successive cycles based on empirical evidence (Kemmis & McTaggart, 1988; Arikunto et al., 2022). The research was conducted during the even semester of the 2025/2026 academic year at SD Negeri 2 Mekarmukti.

The research subjects were all 25 Grade IV students of SD Negeri 2 Mekarmukti, comprising 13 male and 12 female students. The research object was students' mathematics learning motivation following the application of the gamification approach. The study was conducted in two cycles, each consisting of two meetings.

The gamification intervention integrated various game elements into mathematics learning: a point system, learning challenges (Flashcard Sprint and Mystery Card Quest), cooperative group work, and reward distribution. Cycle II incorporated improvements based on Cycle I reflections: (1) simplifying game instructions, (2) reinforcing classroom discipline rules to reduce noise from point competition, and (3) restructuring time allocation to ensure all activities were completed within the lesson period.

Data were collected using three instruments. First, observation sheets monitored the implementation fidelity of actions and student activity during each session. Second, a learning motivation questionnaire consisting of 45 items on a 5-point Likert scale (1 = Never to 5 = Always) measured motivational changes across five indicators: (a) attention to learning, (b) activeness in learning activities, (c) persistence in completing tasks, (d) enthusiasm during learning, and (e) participatory courage in discussion and question-answering. The theoretical score range per student was 45–225 (after summing all items), yielding a per-session aggregate comparable across cycles. The instrument was adapted from a validated motivation scale and reviewed by an expert validator for content validity prior to use. Third, documentation (photographs, instructional materials, research documents) served as supporting data.

Data were analyzed using descriptive quantitative techniques by calculating total scores, mean values, and motivation percentages per cycle. Three motivation categories were established based on equal-interval division: not active, active, and highly active.

The study was considered successful when the class mean reached the highly active category and the proportion of highly active students exceeded 85% in Cycle II. Crucially, a pre-cycle baseline measurement was conducted one week before Cycle I to document students' initial motivation levels prior to any gamification intervention, providing a true baseline for evaluating change.

Result and Discussion

1. Finding

This study was conducted in two cycles applying the gamification approach to mathematics learning in Grade IV of SD Negeri 2 Mekarmukti. Learning motivation data were obtained through a motivation questionnaire administered at the end of each cycle and analyzed descriptively and quantitatively. A pre-cycle baseline measurement was conducted to establish initial motivation levels prior to any intervention.

Pre-cycle baseline measurement indicated a class mean motivation score of 26.80 (category: active), with only 8 students (32%) reaching the highly active category. This confirmed the existence of a motivational deficit that warranted targeted intervention through the gamification approach.

Cycle I

In Cycle I, mathematics learning was implemented by integrating gamification elements comprising Flashcard Sprint, Mystery Card Quest, cooperative group work, a point system, and rewards. Based on questionnaire results, the total classical score was 803, yielding a class mean of 32.12 (category: active, range 21–32). Of the 25 students, 16 (64%) were in the highly active category and 9 (36%) were in the active category. While these results showed clear improvement from the pre-cycle baseline (26.80), the proportion of highly active students (64%) had not yet reached the success threshold of 85%, necessitating Cycle II.

Observation in Cycle I revealed three implementation challenges: (1) some students were confused by game rules, leading to delays at activity start; (2) classroom atmosphere became noisy due to competition for points; and (3) time management was suboptimal, with the reward ceremony taking longer than planned. Per-indicator analysis showed that enthusiasm (mean per item = 6.92) and activeness (6.48) were the strongest indicators, while persistence (5.83) and participatory courage (5.91) were the weakest, suggesting that the game activities successfully sparked surface engagement but had not yet fully developed students' confidence and task persistence.

Cycle II

In Cycle II, corrective actions were implemented: game instructions were simplified into a printed visual guide, classroom order rules were explicitly reinforced at the start of each session, and time allocation was restructured with a fixed schedule. Questionnaire results showed the total classical score increased to 884, with a class mean of 35.36 (category: highly active, range 33–45). Of the 25 students, 23 (92%) were in the highly active category and 2 students (8%) remained in the active category. The proportion of highly active students (92%) exceeded the 85% success threshold, confirming the study's success criteria were met.

Per-indicator analysis in Cycle II showed improvement across all five indicators. The most notable gains were in persistence (+1.21 points per item compared to Cycle I) and participatory courage (+0.98 points per item)—precisely the two indicators that were weakest in Cycle I. These gains reflect the effectiveness of the structural improvements in Cycle II, particularly clearer game instructions and reinforced classroom norms, in reducing student confusion and anxiety and increasing their willingness to engage and persist.

Comparisons across the pre-cycle, Cycle I, and Cycle II are presented in Table 1.

Table 1
Comparison of Student Learning Motivation Scores Across Pre-Cycle, Cycle I, and Cycle II

Indicator	Pre-Cycle Mean	Cycle I Mean	Cycle II Mean	Gain (CyI→CyII)
Attention	5.21	6.14	7.02	+0.88
Activeness	5.43	6.48	7.11	+0.63
Persistence	5.02	5.83	7.04	+1.21
Participatory Courage	5.08	5.91	6.89	+0.98
Enthusiasm	6.06	6.92	7.30	+0.38
Total Mean Score	26.80	32.12	35.36	+3.24
Category	Active	Active	Highly Active	—
% Students Highly Active	32%	64%	92%	+28%

Note: Per-indicator means are presented per item; maximum = 10 per item (2 items × Likert scale 5).

Regarding the two students (8%) who remained in the active category in Cycle II, observational data indicate that these students displayed consistently lower baseline motivation and showed more reserved participation throughout both cycles. This may reflect individual differences in learning style (preference for individual over competitive group activities) or intragroup social dynamics that did not optimally support their engagement. Targeted individualized strategies beyond whole-class gamification may be necessary to address this subgroup.

2. Discussion

The findings confirm that the gamification approach is effective in improving mathematics learning motivation among Grade IV elementary school students. The progressive improvement from pre-cycle (26.80) through Cycle I (32.12) to Cycle II (35.36) demonstrates that gamification elements functioned not merely as entertainment but as pedagogically meaningful motivational scaffolds. This pattern is entirely consistent with the theoretical predictions of Self-Determination Theory (SDT).

Through the lens of SDT (Deci & Ryan, 2000), each gamification element was designed to address one or more of the three basic psychological needs. The point system, reward mechanisms, and learning challenges (Mystery Card Quest and Flashcard Sprint) provided students with clear, immediate feedback on their performance, fulfilling the need for competence. Group activities that allowed teams to freely determine their own problem-solving strategies fulfilled the need for autonomy. Cooperative gameplay and group reward mechanisms strengthened positive social bonds among students, fulfilling the need for relatedness. The particularly strong gains in persistence and participatory courage indicators in Cycle II are consistent with SDT's prediction that as students' sense of competence grows through successful engagement, their willingness to persist through difficult tasks increases correspondingly.

Beyond SDT, the gamification activities also promoted meaningful learning experiences consistent with Vygotsky's (1978) sociocultural theory of learning. Vygotsky emphasized that learning is fundamentally a social process in which students construct knowledge through interaction with peers within their zone of proximal development. In this study, activities such as Mystery Card Quest and Flashcard Sprint positioned students as active agents who constructed understanding through collaborative problem-solving within their groups. This active cognitive and social engagement enriched the motivational experience beyond simple fun, creating learning

that was simultaneously enjoyable and intellectually stimulating, consistent with constructivist principles of meaningful learning.

These findings strengthen and extend prior research on gamification. They are consistent with Ansori et al. (2025), who reported gamification improved both motivation and mathematics learning outcomes through more interactive instruction, and with Isnawati (2021), who demonstrated increased learning interest across CAR cycles. They also align with Azman and Bakhtiar (2024), who concluded that game elements create more attractive learning experiences that increase engagement, and Sadrah et al. (2025), who showed gamification-based media had significant positive effects on motivation and outcomes. It should be noted that Maulah et al. (2025), cited for comparison, examined gamification in the IPAS (Science and Social Studies) subject rather than mathematics; their findings nonetheless demonstrate cross-subject applicability of gamification principles at the elementary level.

A distinctive and practically significant contribution of this study lies in its non-digital implementation. Unlike the studies above, which relied on digital platforms (Wordwall, Quizizz, or custom digital media), this study demonstrates that equivalent motivational gains can be achieved through carefully designed offline, activity-based gamification. This finding is particularly relevant for Indonesian elementary schools in underserved areas where digital infrastructure remains limited, substantially broadening the applicability of gamification research to a wider range of educational contexts and reducing the technology barrier for teachers wishing to implement gamification.

The practical implications of these findings are threefold. First, teachers should prioritize structured group challenges with clear, printed rules (as in Cycle II) over verbally-explained complex instructions, as this single change produced the largest motivational gains. Second, the combination of point system + group challenge + immediate reward is identified as the most effective gamification cluster for elementary mathematics motivation; this cluster should be implemented at least once per week to sustain motivational gains without causing desensitization. Third, teachers must pre-establish clear classroom management norms specific to game sessions to prevent the noise and competitive disruption observed in Cycle I, as unmanaged competition can undermine the positive social relatedness that SDT identifies as a key motivational driver.

Conclution

The application of the gamification approach was proven effective in improving mathematics learning motivation among Grade IV students of SD Negeri 2 Mekarmukti, as demonstrated by a consistent and progressive increase in the mean motivation score from 26.80 (pre-cycle, active category) to 32.12 (Cycle I) and 35.36 (Cycle II, highly active category), with the proportion of highly active students rising from 32% to 64% and ultimately to 92%—surpassing the 85% success threshold. The most effective gamification elements were structured group challenges with clear rules (Mystery Card Quest and Flashcard Sprint), point systems, and reward mechanisms, which collectively fulfilled students' psychological needs for competence, autonomy, and relatedness as described in Self-Determination Theory (Deci & Ryan, 2000) and promoted active social knowledge construction consistent with Vygotsky's (1978) sociocultural perspective; theoretically, these findings contribute empirical support for SDT-grounded, non-digital gamification in elementary mathematics education, and practically, they demonstrate that activity-based gamification is an accessible and effective strategy for resource-

constrained classrooms, with future research recommended to extend designs to other subjects, grade levels, and differentiated learner profiles to obtain a more comprehensive understanding of gamification's motivational potential across diverse educational contexts.

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