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The Effect of Classcraft Gamification on Motivation and Academic Achievement In Primary Science Education

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ABSTRACT

Recent studies have highlighted persistent declines in primary students' science motivation and engagement in the post-pandemic and digital learning era, indicating a need for pedagogical approaches that are both motivating and cognitively meaningful. However, empirical evidence on structured gamification platforms that simultaneously enhance motivation and achievement in primary science remains limited. This study examined the influence of Classcraft gamification on learning motivation and academic achievement in primary science. A quasi-experimental non-equivalent pretest–posttest control group design was employed, involving 60 fifth-grade students from an Indonesian primary school, equally assigned to an experimental group using Classcraft and a control group receiving conventional instruction. Data were collected using a Science Achievement Test (KR-20 = 0.83) and a Motivation Questionnaire ($\alpha = 0.89$). Paired-sample t-tests, independent-sample t-tests, and ANCOVA were conducted to analyse group differences while controlling for pretest scores. The results demonstrated significant improvements in both achievement (from 60.13 to 85.20) and motivation (from 64.87 to 84.63) in the experimental group, with strong effect sizes (Cohen's $d > 1.70$) and robust ANCOVA results ($F = 60.35$, $p < 0.001$; $\eta^2 = 0.52$). These findings suggest that Classcraft gamification effectively enhances motivation, collaboration, and conceptual understanding in primary science. Practically, teachers can utilize Classcraft's role-playing and quest-based features to scaffold collaborative inquiry and sustain students' engagement in science learning.

Keywords: classcraft gamification, student motivation, academic achievement, digital learning

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INTRODUCTION

In the 21st century, educational methods have been influenced by the rapid development of technology including the most fundamental levels of teaching, primary education. Learning that was once teacher centered and focused on rote instruction has evolved and become more collaborative, student centered and educational technology is fully incorporated. The use of educational technologies enabled teachers to produce more engaging, inquiry-based, and multimodal education (Gillies & Baffour, 2017). There are various educational technologies in teaching science that help learners visualize and interact with complex natural phenomena that are otherwise difficult to observe (Fitri et al., 2025). These are particularly important in elementary schools as students have a natural curiosity, but need different, more hands on experiences to help them learn complex scientific concepts (Jirout, 2020). However, primary science students disengagement in technology-integrated classrooms has been documented broadly in multiple studies, including primary science education, and is a significant problem (Kamarudin et al., 2024). The roots of this problem lie in traditional practices that focus instruction on a memorization and rote learning that encourage passive learning and low enthusiasm for science.

One approach to these issues is gamification a teaching practice in which game-design components, such as points, badges, tiers, and rewards, are added to activities that are not games . The aim of gamification is to make activities games in order to increase participants' motivation, engagement, perseverance, and enjoyment of games (Oliveira et al., 2022). Gamification, as it is applied to education, is not solely to entertain, rather, it aims to make learning experience motivating in and of itself by focusing on the objectives in relation to goals, feedback, and achievement (Naaman et al., 2022). Motivation is said to rise as a result of

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gamification given the appropriate challenges, autonomy, and recognition. Motivation is especially important to younger students and primary counterparts as social engagement becomes available and as progress begins to be more readily observed through activities (Pujiastuti & Susilo, 2021). In the context of learning science, gamification allows student to play and meaningfully engage in scientific practices and helps to associate enjoyment with.

Among the various gamification platforms available, Classcraft has emerged as a comprehensive gamified learning and classroom management system specifically designed for educational contexts (Saputra, 2022). Unlike quiz-based platforms such as Kahoot! or Quizizz, which primarily emphasise short-term competition and rapid recall, Classcraft integrates role-playing game (RPG) mechanics into long-term instructional design. Developed by Young in 2011, Classcraft allows students to assume fantasy-based roles such as warriors, healers, or mages and progress through learning "quests" embedded within curricular objectives. Students earn experience points (XP), lose or gain health points (HP), and unlock powers based on academic performance, collaboration, and classroom behaviour (Lestari, 2025). These narrative and role-based elements are particularly well aligned with the developmental characteristics of elementary school students, who tend to be highly responsive to fantasy, storytelling, and imaginative play. By embedding learning tasks within a coherent narrative structure, Classcraft offers a more immersive and sustained form of engagement than point-based or quiz-oriented gamification alone (Sholihah & Buhanuddin, 2025).The needs of students are addressed within Classcraft. Students are given the opportunity to select their game roles and quests. They receive continuous feedback to help them master new skills and challenges. Students are brought together in teams for participation and success. The interconnectedness of gamification and SDT theorized Classcraft to derive internalized motivation. The phenomena of internalized motivation would help students achieved persistent engagement with the curriculum, to the point that their engagement would help them attain higher order learning outcomes. The theories of constructivism and social learning also advocated such learning environments with the participation of the students in the curriculum and social collaboration to construct knowledge, the very elements that Classcraft was designed for (Zajda, 2021).

The theoretical foundation underpinning the use of Classcraft in education is closely aligned with Self-Determination Theory (SDT), which posits that intrinsic motivation is driven by the fulfilment of three basic psychological needs: autonomy, competence, and relatedness. Classcraft addresses autonomy by allowing students to choose avatars, roles, and learning paths; competence through continuous feedback, level progression, and mastery-based challenges; and relatedness by organising students into collaborative teams that share goals and responsibilities. Through this design, Classcraft is theorised to promote internalised motivation, enabling students to sustain engagement and achieve deeper learning outcomes. In addition, constructivist and social learning theories further support such environments, as knowledge is actively constructed through participation, interaction, and collaboration elements that are central to Classcraft's design (Jayanti et al., 2024).

Empirical studies have reported positive effects of gamification on students' motivation, participation, and academic achievement (Alsadoon et al., 2022; Fitria et al., 2025). Specifically, research has shown that the integration of Classcraft with inquiry-oriented models, such as the 5E Learning Cycle, can enhance higher-order thinking skills and collaborative learning in science classrooms (Kaewmanee et al., 2024). Nevertheless, despite these promising findings, several important research gaps remain. First, much of the existing gamification research has focused on secondary or higher education contexts, while primary education remains underexplored. This gap is significant, as elementary students differ psychologically and developmentally from older learners; they require more immediate feedback, concrete rewards, and clearly structured goals to sustain motivation (Dean & Hubbell, 2012). Second, prior studies have tended to prioritise cognitive outcomes, such as achievement and problem-solving, while affective variables particularly motivation and engagement have received comparatively less systematic attention. Third, many gamification studies have been conducted in online or blended learning environments, leaving limited evidence regarding

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the effectiveness of gamified approaches in face-to-face primary science classrooms, where teacher guidance and peer collaboration play a central role.

Given these gaps, the present study seeks to examine the impact of Classcraft gamification on both learning motivation and academic achievement in primary science education. By focusing on a face-to-face elementary classroom context, this study aims to provide empirical evidence on how RPG-based gamification can support not only cognitive learning outcomes but also students' motivational and collaborative engagement in science. The findings are expected to contribute practical insights for teachers and curriculum designers, particularly regarding the use of narrative-driven gamification to create meaningful, motivating, and developmentally appropriate science learning experiences for elementary students.

METHOD

This study utilized a quantitative quasi-experimental approach to analyze the impact of Classcraft gamification on the motivation and academic performance of primary science learners. The justification for the quasi-experimental design of the study is because it favors causal inference in cases where there is no possibility for random assignment within classroom contexts (Cook et al., 2002). The study adopted a non-equivalent control group design with a pretest-posttest arrangement to enable analysis and comparison of an experimental group with a control group that had not been randomly assigned but whose demography and academic performance were comparable. The groups were subjected to the same pre-tests and post-tests to measure the extent of difference in responses with the introduction of the intervention. The independent variable was the Classcraft-based gamification while the dependent variables were the motivation and academic performance of the learners in science. The study was informed by Self Determination Theory (SDT) which postulates on the relevance of autonomy, competence, and relatedness as the principal variables for determining intrinsic motivation which in the case of Classcraft is engendered through quests, missions, and feedback (Oraif, 2018).

Alongside the analytical practices that have already been outlined, the current study also implemented a systematic operationalisation of the model that is consistent with the fundamentals of experimental educational research. This research was conducted at primary school located in West Sumatra, Indonesia. This particular research site was chosen because of convenience, administrative authorization, as well as the presence of two intact Grade 5 classes that exhibited similar academic traits. In order to achieve uniformity and consistency in the treatment fidelity, the steps taken in the preparation of the research were in order. In the preparation phase, the researcher worked closely with the science teacher to analyze the curriculum, establish essential outcomes regarding energy transformation, and create lesson guides for the gamified and traditional learning cohorts. For the experimental group, Classcraft was used as the primary instructional platform. All digital components, including quests, missions, reward systems, behavioural rules, and assessment checkpoints, were prepared in advance. The teacher received structured training on managing student avatars, monitoring experience points (XP) and health points (HP), tracking learning progress, and providing in-game feedback. For the control group, instructional materials such as textbooks, worksheets, and teacher-led explanations were prepared to ensure that the content coverage and learning objectives matched those of the experimental group.

Through purposive sampling, selected two fifth-grade classes with similar prior achievements, resulting in a total of 60 students, aged 10-11 years, split evenly into a control group and an experimental group. For 4 weeks, 8 sessions in 80 minutes each, the experimental group learned the lesson on "Energy Transformation and Its Applications in Daily Life" in Classcraft gamification, and the control group learned the same science topic through traditional, teacher-centered instruction. Conventional instruction in this study was characterized by teacher-led explanations, guided questioning, textbook reading, individual written exercises, and whole-class discussions without the use of digital gamification elements. The same science teacher taught both groups, biasing instruction. The same materials, learning objectives, and forms of assessment were used. For this research, that used three worksheets: a Science Achievement Test (SAT), a

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Motivation Questionnaire, and an Observation Checklist. The SAT contained 25 questions: a combination of multiple-choice and short answers focused on the understanding and application of energy transformations. Content validity was ensured by three experts in science education and a pilot test involving 20 students. Three research instruments were employed: a Science Achievement Test (SAT), a Motivation Questionnaire, and an Observation Checklist. The SAT consisted of 25 items combining multiple-choice and short-answer questions designed to assess conceptual understanding and application of energy transformation. Content validity was evaluated by three experts: two senior lecturers in science education with more than ten years of teaching and research experience, and one elementary science curriculum specialist involved in teacher training at the provincial level.

To clarify the distinction between the two instructional conditions, learning activities differed systematically across weeks. In the experimental group, each weekly session was organized as a narrative-based quest consisting of collaborative problem-solving tasks, science challenges, reflection checkpoints, and formative quizzes integrated within Classcraft. In contrast, the control group followed a linear instructional sequence involving explanation, example demonstration, individual practice, and review. While both groups engaged in discussions and exercises, only the experimental group experienced role-playing elements, team-based progression, immediate digital feedback, and reward-based motivation. These differences ensured that the treatment effect was attributable to the gamification design rather than content variation**.**

The Motivation Questionnaire included modifications made to Keller's ARCS (Attention, Relevance, Confidence, Satisfaction), and comprised 20 statements that were measured on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree) (Li & Moore, 2018). The Observation Checklist assessed behavioral engagement, including participation, collaboration, and curiosity, during class. The intervention occurred over three stages: preparation, implementation, and evaluation. For the preparation stage, lesson plans created by the researcher and teacher together were produced. The science curriculum was integrated with Classcraft gaming mechanics of quests, experience (XP), and health points (HP), powers, and rewards. The students in the experimental group received instructions, served as a tutorial in which they learned the functionalities of Classcraft, designed their avatar, and learned how they could gain experience points and level up in the game by participating, collaborating, and achieving. The control group also met the specified learning objectives but engaged in traditional activities of reading, note-taking, and teacher-centered explanation.

The implementation phase consisted of four weeks in which the experimental class participated in gamified lessons designed as ‘missions’ or ‘quests’. Each class session started with a narrative, which placed the science topic within a story as an introduction, followed by game-based learning activities, learning collaborative problem activities, quizzes, and challenges. For answering questions correctly, showing collaboration, and completing tasks, students received points. Health points were deducted for inactivity or disruptive behavior. Milestones were completed and level-ups were achieved through Classcraft rewards. Digital feedback was given immediately and health points were deducted for inactivity or disruptive behavior. Unlike the experimental group, the control group was engaged in traditional teaching characterized by the use of textbooks, exercises, and teacher-centered lectures, without any differentiation.

In the evaluation phase, all participants from both groups completed the posttest and the motivation questionnaire following the intervention. Summarized observation data were included to complement the qualitative aspects of the results. A combination of methods, both descriptive and inferential, was employed to analyze the data and to address the research hypotheses. Motivational and achievement improvements were summarized from the results gained in a particular educational context, and the mean, standard deviation of those results, and the scores of the normalized gain were used. The normalized gain was determined by using the following computation:

$$g = \frac{(X_{post} - X_{pre})}{(X_{max} - X_{pre})}$$

where $Xpost$ is the average posttest score, $Xpre$ is the average pretest score, and $Xmax$ is the

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maximum score (100). The N-Gain score can be described as either high ($g \geq 0.70$), moderate ($0.30 \leq g < 0.70$), or low ($g < 0.30$), and is considered to be an indicator of improvement (Hake, 1998). Inferential statistics for posttest scores between the experimental and control groups were examined using Analysis of Covariance (ANCOVA), which also takes into account the pretest scores. The ANCOVA model for this study is given as follows:

$$Y_{ij} = \mu + \tau_i + \beta(X_{ij} - \bar{X}) + \epsilon_{ij}$$

The variable Y_ij is a dependent variable corresponding to posttest score. In the above equation, μ is the overall mean score, τ_i is the treatment effect namely gamification, or traditional, X_ij is the covariate in this case a pretest score, β is the regression constant or coefficient, and ϵ_ij is the error term (Rutherford, 2011). This technique was selected to account for any pre-existing discrepancies with the groups and to ensure the disparity in posttest scores were a result of the gamification intervention. In order to review the changes that were experienced in each individual group, a paired-sample t-test was used to measure the differences in the pretest and posttest scores, and the formula was applied:

$$t = \frac{\bar{D}}{S_D/\sqrt{n}}$$

where $\bar{D}$is the mean of the score differences, $S_D$is the standard deviation of the differences, and $n$is the sample size. Between-group comparisons of mean gain scores were analyzed using independent-sample t-tests, calculated as:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

where $\bar{X}_1$and $\bar{X}_2$are the mean scores of the experimental and control groups, and $S_1^2$and $S_2^2$are their respective variances. Statistical significance was tested at the 0.05 level ($p < 0.05$).
The magnitude of the treatment effect was measured using Cohen's d formula:

$$d = \frac{\bar{X}_E - \bar{X}_C}{S_{pooled}}$$

$$S_{pooled} = \sqrt{\frac{(n_E - 1)S_E^2 + (n_C - 1)S_C^2}{n_E + n_C - 2}}$$

The values of Cohen's d were calculated as 0.2, 0.5, and 0.8 and described as small, medium, and large, respectively, to depict the magnitude of the impact of the intervention. For all parametric analyses carried out, the Shapiro-Wilk normality test was used to check the data normality and Levene's test was used to check the homogeneity of variance of the data (Larner, 2014). All analyses were carried out on SPSS v 26. The analysis of the data was implemented in accordance with a predetermined plan to enhance reliability and validity. First, data were screened in order to check completeness, to identify any outliers in the data, and to confirm that data were entered correctly. For any cases with less than 5% of their responses missing, a mean substitution was used to replace the missing responses. Second, internal consistency reliability of all of the questionnaires was recalculated using the actual data from the study in order to assess the stability of the measure. Third, descriptive statistics were calculated in order to outline the patterns of motivation and achievement. Fourth, paired-sample t-tests, ANCOVAs, and estimation of effect sizes were used in more advanced analyses to test the research questions regarding the differences between the groups. For the quantitative findings, particularly on the behavioral engagement, collaboration, and emotional responses during the lessons in the gamified environment, the qualitative data of the classroom observations and the teacher's reflective notes were also thematically analyzed as a form of cross validation.

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RESULTS AND DISCUSSION

Prior to hypothesis testing, descriptive analysis characterizing student performance and motivation in the experimental and control groups was conducted. Table 1 presents the average, standard deviation, and normalized gain (N-Gain) scores on the science achievement and the learning motivation scales at the pretest and posttest intervals. The pretest results show that there was no significant difference in the baseline ability of the groups, hence, it could be concluded that participants of the experimental and control classes started their learning with reasonably similar baseline conditions. Upon the conclusion of the four-week intervention, notable differences were observed in the two attributes as a consequence of the gamified learning experience facilitated with Classcraft.

Table 1. Descriptive Statistics of Science Achievement and Motivation

Variable	Group	N	retest Mean (SD)	osttest Mean (SD)	-Gain (g)	Category
ence Achievement	Experimental	30	60.13 (7.82)	85.20 (6.91)	0.63	oderate–High
ence Achievement	Control	30	62.07 (8.15)	70.47 (7.62)	0.22	Low
arning Motivation	Experimental	30	64.87 (7.13)	84.63 (6.55)	0.56	oderate–High
arning Motivation	Control	30	65.27 (6.94)	72.47 (7.21)	0.20	Low

As detailed in Table 1, there was positive development in science achievement and learning motivation among the experimental participants in Classcraft gamification. The experimental group achievement averages shifted significantly from 60.13 to 85.20 alongside an N-Gain of 0.63, indicating high improvement. The motivation scores were similar, moving from 64.87 to 84.63, which fulfills an N-Gain of 0.56. The control group receiving traditional instruction was, however, minimally effective, indicated by achievement and motivation N-Gain values of 0.22 and 0.20, respectively, confirming low improvement. The data demonstrate that the gamified learning environment significantly shifted students engagement and learning comprehension, while traditional instruction achieved minimal success.

A paired-sample t-test was conducted for both the experimental and control groups to identify any statistically significant improvements in students' science achievement. Motivation for learning was also considered in the research. In this analysis, the researcher employed the dependent samples t-test to assess the differences between the pre and post test scores for each group to investigate if the differences were statistically significant. The analysis sought to determine whether the learning intervention, Classcraft gamification, had an impact on student learning outcomes, and if so, to what degree, over the four-week implementation period. The results of the t-test involving both variables are presented in Table 2.

Table 2. Paired-Sample t-Test Results

Variable	Group	Mean Difference	t	df	Sig. (p)	Category
Science Achievement	Experimental	25.07	12.41	29	0.000**	Highly significant
Science Achievement	Control	8.40	4.68	29	0.001**	Highly significant
Motivation	Experimental	19.76	10.26	29	0.000**	Highly significant
Motivation	Control	7.20	3.94	29	0.001**	Highly significant

According to the findings of the study presented in Table 2, it can be stated that both experimental and control groups demonstrated statistically significant improvements in the area of science achievement and motivation to learn ($p < 0.01$). However, in the case of the experimental group, that difference was more pronounced. In terms of science achievement, experimental group members scored 25.07 points more than the

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control group members who scored 8.40 points. In terms of learning motivation as well, experimental group members scored 19.76 points more than 7.20 points achieved by the control group members. Thus, it can be concluded that despite traditional instruction leading to an increase of learning gains to some extent, the adoption of Classcraft gamification brought about an even greater increase of learning gains. The increase in the t-values was good ($t = 12.41$, $t = 10.26$ with respect to the experimental group). This shows that the increase was not only statistically significant, but it was also meaningful in terms of education. Through the use of gaming elements in the lessons, students received rewards within a more effective and improved educational setting which improved performance as well.

The findings also corroborate the findings that gamification achieved the void created by the absence of extrinsic incentivisation and the presence of intrinsic engagement in self-determination theory (Larner, 2014). During implementation, the experimental class exhibited greater persistence, enjoyment, and cooperation, and this was noted all through the lesson. Conversely, the control group's progress was more attributable to the fact that they were exposed to the same instructional content and did not have the motivational enhancement provided by the gamified environment. In an attempt to better understand if the noted improvement was any better in the experimental group than the control group, an independent-sample t-test was conducted on the posttest scores of science achievement and learning motivation. This test determines the mean scores of the two groups to determine if classclast gamification resulted in a statistically significant effect compared to other conventional methods of teaching. The assumption of normality and homogeneity of variance were evaluated in order to run the analysis by the Shapiro an Wilk and Levene tests which were sufficiently and collaboratively determined to have met the assumptions for the parameters of this test ($p > 0.05$). These results have been clearly outlined in table 3.

Table 3. Independent t-Test Results on Posttest Scores

Variable	Group 1 Mean	Group 2 Mean	t	df	Sig. (p)	Cohen's d
Science Achievement	85.20	70.47	7.02	58	0.000	1.81
Motivation	84.63	72.47	6.74	58	0.000	1.73

The experimental group had post-test means that were higher than the control group's means in both science achievement and learning motivation show at Table 3. The differences between the experimental and control groups were 14.73 and 12.16 points for achievement and motivation respectively, which were shown to be statistically significant ($p < 0.001$). The degrees of differences between the experimental and control means were also illustrated by the t-values of 7.02 and 6.74 which showed that students in the Classcraft gamified cohort were more successful than students in the more traditional instructional class. The differences were also educationally significant, which can be illustrated by the Cohen's d measure of effect which was 1.81 for achievement and 1.73 for motivation.

In educational research, effect sizes exceeding 1.70 are relatively uncommon and may partially reflect a novelty effect, whereby students' heightened enthusiasm and engagement are influenced by the introduction of a new and engaging digital platform rather than by instructional quality alone. The Classcraft environment, with its role-playing elements, avatars, and immediate feedback mechanisms, was a novel experience for students who had previously been accustomed to conventional instruction. This novelty may have temporarily intensified motivation and effort, thereby inflating short-term gains. Accordingly, while the magnitude of the effects is compelling, these results should be interpreted as evidence of strong short-term impact rather than definitive proof of sustained long-term effectiveness. The significant differences between groups also align with findings from previous studies (Khan & Ahmad, 2017) as digital gamification tools elevate learners' participation, engagement, and attainment in science domains. In the current investigation, students in the gamified setting were seen to be able to work together more efficiently, take the lead in solving challenges,

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and showed more spirited attitudes towards the activities related to science. In contrast, the control group, who also studied the same curriculum content, showed more passivity and lesser engagement.

Although the descriptive and t-test analyses indicated considerable differences in the performance of the experimental and control groups, it was crucial to also be sure that such observations were not the result of small differences in the participants' entry level abilities. To this end, an Analysis of Covariance (ANCOVA) was conducted to account for differences in the pre-test scores statistically, as well as to ascertain whether the differences in the post-test scores were still significant after considering the differences in baseline scores. The findings of the ANCOVA are consolidated in Table 4.

Table 4. ANCOVA Summary

Source	SS	df	MS	F	Sig. (p)	Partial η^2
Pretest	184.92	1	184.92	8.04	0.006**	0.12
Treatment	1388.37	1	1388.37	60.35	0.000**	0.52
Error	1312.08	57	23.02	—	—	—
Total	4886.45	60	—	—	—	—

As shown in Table 4, ANCOVA results indicate that the treatment effect was still significant and that after adjusting for pretest differences, effects remained, F=(60.35, $p < 0.001$). This means that the enhancement in posttests was due to the Classcraft gamification and not pre-existing differences in the student's abilities. The covariate pretest scores also had a significant impact on the scores, F=(8.04, p=0.006), meaning that prior knowledge had a moderate effect. The treatment effect, however, was significantly stronger with a partial $\eta 2$ of 0.52 meaning that about 52% of the variance in adjusted posttest scores was due to the gamification. Using Cohen's effect size criteria, this is a large effect size and great proof of the impact of the intervention.

The data support the conclusion that Classcraft has resulted in significant educational benefits that would otherwise not be possible given the students' level of pre-existing knowledge. Digital gaming features such as instant feedback, experience points, and group challenges seem to have provided an educational environment in which students' motivation, engagement, and understanding of concepts were all enhanced. This is consistent with constructivist learning theory in that it focuses on the importance of both active engagement and social interactions to assure that learning is achieved. Also, the significant impact of the Classcraft platform on students is consistent with Self-Determination Theory (Huang & Wang, 2025) in that it effectively stimulates students' autonomy, competence, and relatedness. Gamification of learning, which is the embodiment of Classcraft, provided students with the ability to self-direct their learning, experience goal achievement and level advancement, and work with other students toward shared objectives each of which is a significant contributor to motivation, learning, and engagement.

The relatively low improvement observed in the control group (N-Gain = 0.22) deserves closer examination. One plausible explanation lies in the nature of the science topic itself energy transformation which involves abstract processes that are often difficult for elementary students to grasp through traditional, teacher-centered instruction alone. Without visual, interactive, or experiential supports, students may struggle to meaningfully connect theoretical explanations to real-life phenomena. Consequently, while conventional instruction led to some learning gains, these improvements remained limited, suggesting that traditional approaches may be less effective for conceptually demanding topics at the primary level.

In addition to instructional factors, the potential influence of the Hawthorne Effect must also be acknowledged. Students in the experimental group may have exhibited heightened motivation and effort partly because they perceived themselves as receiving special treatment through the use of a novel digital platform. This sense of novelty and attention could temporarily elevate engagement and performance. Relatedly, the possibility of a Novelty Effect cannot be dismissed. It remains an open question whether the elevated motivation observed in this four-week intervention would be sustained if Classcraft were implemented over a

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longer period, such as an entire semester. Prior research suggests that motivational gains from educational technology may diminish once the novelty wears off, underscoring the importance of longitudinal investigations.

Reflecting on the earlier findings, utilising ANCOVA, the conclusion states ANCOVA results show that the Classcraft gamification program motivated and taught fifth grade learners more than traditional approaches. Given the results, additional gaps from pre-test to post-test indicated the gamification did make a difference in the students learning outcomes. The degree of change suggests that in gamification resides the potential of positively changing the educational landscape and approach of teaching in modern science education. Gamification can educate learners, motivate learners and sustain their interest in continued learning.

Gamification in education is a growing field of research, and this study documents some new contributions (applications) from this research. First, based on studies, the implementation of Classcraft gamification in 5th-grade elementary science education shows a strengthening of learning motivation and achievement, both in terms of affective (motivation) and cognitive (learning outcomes). This finding suggests that gamification is not just a tool to "entertain" students, but can be a strategy to achieve academic achievement goals. This finding illustrates that, for educational purposes, gamification can be an effective intervention tool for students aged 5-12, not just for upper-middle-class students, which is widely discussed in many pieces of literature. Second, this research shows that the effects of gamification are not only on motivation, but also on education. Most previous studies have only shown increased motivation (gamification-based), increased engagement, but not increased academic achievement. This research provides new empirical contributions demonstrating that gamification can simultaneously connect the affective and cognitive dimensions in Science education.

Behavioral indicators such as student collaboration, active participation, curiosity, and persistence were synthesized and reported to complement the quantitative motivation results. These observational findings were used as triangulation evidence to support the statistical outcomes, particularly the observed increases in learning motivation and engagement in the experimental group. The integration of qualitative observations enhances the robustness of the results and provides a more comprehensive interpretation of students' learning experiences

The current research showed similar results to previous studies indicating the balancing act that exists between gamification and motivation/academic performance. Other research, such as that by (Zourmpakis et al., 2024) ("The Effects of Adaptive Gamification in Science Learning: A Comparison Between Traditional Inquiry-Based Learning and Gender Differences"), found that elementary students performed better in science learning within adaptive gamification settings compared to traditional inquiry-based settings. Thus, supporting the current research that the addition of simple game mechanics (earning points, progressing to higher levels, collaborating with fellow students) to learning can result in students learning to a much higher degree.

Reflecting on the earlier findings, utilising ANCOVA, the conclusion states ANCOVA results show that the Classcraft gamification program motivated and taught fifth grade learners more than traditional approaches. Given the results, additional gaps from pre-test to post-test indicated the gamification did make a difference in the students learning outcomes. The degree of change suggests that in gamification resides the potential of positively changing the educational landscape and approach of teaching in modern science education. Gamification can educate learners, motivate learners and sustain their interest in continued learning.

In primary and secondary school, research has been conducted on motivation levels, school participation, school enjoyment, and school success. (Krath et al., 2021)performed a systematic review to provide evidence that gamification has supportive evidence to improve all these interrelated aspects of school and school success. Research has confirmed that gamification achieves positive school participation and positive impacts in the school environment. These results also corroborate the experimental group's N-Gain in motivation of 0.56 and achievement of 0.63, both falling within the parameters of moderate to high improvement, while the control group showed only minimally positive gains. It can thus be concluded that gamification in the educational sphere likely satisfies fundamental psychological needs espoused in Self-

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Determination Theory (SDT), namely autonomy, competence, and relatedness, which are all crucial in raising intrinsic motivation. These results may also have a positive impact on educational achievement.

Nonetheless, the results of some studies are not as positive. (Ikhsan & Chen, 2025) are critical of the positive effects of gamification methodology in primary education. They found that increased gaming engagement in primary education even led to worsened cooperation. These studies serve as a necessary counterbalance to Romero-Rodriguez et al. This suggests that certain parameters weakly justify the outcomes of the present study. In addition to protecting the variable elements of the positive gaming implementation, other contextual elements related to the professional educator's active role, and the strategic integration of positive gaming components with the curriculum's instructional outcomes, the identified positive education engagement outcomes could not, in fact, be attributed to the integration of positive educational gaming methodologies. The result could even include negative outcomes in the students' identified educational gains.

The existing literature on gamification also reveals the importance of design. Effective gamification, according to (Triantafyllou et al., 2025) in their entry on "Gamification in Education and Training: A Literature Review," is achieved through the application of sound instructional design, whereby gamification is integrated in a pedagogical fashion, as opposed to being a mere overlay to traditional teaching. Their expert opinion justifies the methodological sophistication of the current study whereby game elements were purposefully aligned to the science learning outcomes, thus the high effect sizes (Cohen's d = 1.81 for achievement and 1.73 for motivation) may be a function of a well-thought-out design and not just of the elements' novelty. Caution, however, is also warranted as restated in the systematic review by (Triantafyllou et al., 2025) titled "Gamification in School Education: A Systematic Review of Its Effects on Student Motivation and Learning Outcomes Across Educational Levels." Concern that a number of the studies on gamification suffer a range of methodological issues, e.g., short duration of the study, and no longitudinal follow-up. Journal STAI Hubbulwathan Over the four-week period within which this study achieved considerable short-term outcomes, we cannot comment on the possible long-term retention, transfer of learning, or whether motivation sustained over time, thus, the need for further study to address the issues of primary science education.

As discussed with the balance of the findings presented in the current study, it is also possible to view the results of the study through the prism of the constructivist learning theory: through the active engagement of students in reflection, problem-solving, social interaction, and the feedback mechanisms implemented, the levels of cognitive processing are heightened, whereas the enhanced levels of engagement were resulted in the increased degrees of gamification. But it also highlights a crucial practical warning: the triumph of gamification is contextual and highly correlational to the teacher's ability to manage the tools, scaffold, and synthesize the components of the platform. The high levels of achievement of the participants in this study are the result of a synthesis of highly favorable conditions: elements of robust instructional design and active learner engagement mediated by the instructor.

In conclusion, the current findings add to the body of evidence supporting the use of gamification in primary science education, especially the Classcraft platform, that is likely to result in enhanced motivation and achievement. The literature, however, points out that these outcomes are not guaranteed and emphasizes the need for careful planning and enduring pedagogy accompanied by tracking these activities over time to assess learner outcomes and the sustainability of those outcomes. Future studies need to address the longitudinal impact of these gamification systems, the variability of outcomes, and the impact of teacher professional development on the effective and sustained use of gamification systems.

CONCLUSIONS AND RECOMMENDATION

Compared to conventional instructional approaches, this study demonstrates that Classcraft gamification significantly enhances students' motivation and academic achievement in primary science learning. Students in the experimental group showed substantial gains, with motivation scores increasing from 64.87 to 84.63 and science achievement rising from 60.13 to 85.20, while the control group experienced only

marginal improvement. These differences were statistically significant ($p < 0.001$) and accompanied by large effect sizes (Cohen's $d > 1.70$), indicating strong educational impact.

The findings confirm that Classcraft effectively activates both cognitive and affective learning domains through narrative-based missions, collaborative challenges, and real-time feedback. Consistent with Self-Determination Theory, the gamified learning environment supported students' autonomy, competence, and relatedness, thereby strengthening intrinsic motivation. The cooperative design of Classcraft also reduced competitive pressure and promoted inclusive participation, enabling students with varying ability levels to engage actively in science learning.These results highlight gamification as a pedagogically meaningful strategy rather than a purely entertainment-driven approach. When purposefully designed and aligned with learning objectives, gamification can enhance science literacy, engagement, and inquiry skills in elementary education. Consequently, Classcraft represents a viable instructional alternative for addressing persistent motivational challenges in primary science classrooms.At the institutional level, successful implementation of gamified learning requires adequate digital infrastructure and systematic teacher professional development. School leaders and policymakers should support access to devices, stable connectivity, and training programs that emphasize pedagogical integration rather than technical use alone. Despite its positive outcomes, this study was limited by its short intervention period. Future research should examine the long-term effects of gamification on knowledge retention, transfer of learning, and sustained motivation. Longitudinal and multi-site studies, as well as investigations integrating gamification with other digital tools such as virtual laboratories or e-modules, are recommended to strengthen evidence on the sustainability and scalability of gamified science instruction

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could
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