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The Gamified Classroom: Boosting Student Engagement in the Modern Classroom

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Abstract
Gamification, which involves incorporating game design features into educational contexts, is frequently advocated as a means to rekindle student interest, the studies show evidence is varied and often overlooks the intricate dynamics present in actual classroom environments. This research investigated whether a 12-week gamified instructional approach utilizing elements such as points, badges, levels, collaborative quests, and a narrative framework enhanced academic performance, multidimensional engagement, and intrinsic motivation compared to traditional teaching methods of the same curriculum. Eight classes were evaluated, including two dedicated science classes (N = 312 enrolled; 304 analyzed), which were alternately assigned to either a gamified group (k = 4, n = 150) or a control group (k = 4, n = 154). The results were assessed using covariate-adjusted models with cluster-robust inference alongside class-level permutation tests and mediation analyses. After adjusting for pre-test scores, the gamified approach yielded better post-test results than the control condition (B = 4.58 points, 95% CI; Hedges' g = .59) and showed greater intrinsic motivation (g = .50). The difference in engagement levels was less pronounced (g = .26) and while statistically significant under conventional analysis, it did not hold up under cluster-robust scrutiny (p = .373). Engagement served as a partial mediator of the effect on academic achievement (indirect effect = .56, 95% bootstrap CI [.12, 1.15]), contributing approximately 12% to the overall impact. Although the advantages tended to be greater for students with lower prior achievements, this interaction lacked statistical significance. The findings suggest a prudent focus on mechanisms: gamification can enhance motivation and learning when designed with principles of autonomy, competence, and relatedness in mind; however, claims regarding engagement should be substantiated by larger class samples than those typically found in current research literature.
Keywords: Gamification, student engagement, intrinsic motivation, self-determination theory

1. Introduction

Few problems occupy teachers as persistently as the problem of attention. Across college systems, surveys and observational studies describe the same drift: students who begin a term

curious gradually settle into compliance, and compliance, in turn, into disengagement. Engagement is among the most consistent proximal predictors of achievement, persistence and college completion [1], and its decline through adolescence is one of the better-documented regularities in educational psychology. Against this backdrop, gamification has become one of the most visible instructional responses of the past decade [2]. Gamification is commonly defined as the use of game design elements in non-game contexts. In classrooms it typically means points, badges, levels, leaderboards, quests and narrative framing layered onto otherwise ordinary content [3]. The appeal is intuitive. Games sustain effortful, voluntary and often difficult activity for hours, and educators would like to borrow some of that sustaining power. Enthusiasm has outrun evidence, however. Early reviews concluded that gamification "works" in most studies but that the studies themselves were short, small, methodologically uneven and often confounded with novelty [4]. More recent meta-analyses find positive average effects on cognitive, motivational and behavioral outcomes, but with large heterogeneity and with effects that shrink under stronger research designs [5]. Three weaknesses in the existing literature motivate the present study. First, most primary studies treat the individual student as the unit of analysis even though the intervention is delivered to whole classes. When students within a class share a teacher, a timetable and a peer climate, their outcomes are correlated, conventional standard errors are too small, and apparent effects are overstated [6]. Second, the dependent variable is often a single global score of "engagement" or "motivation", obscuring whether gamification changes what students do, how they feel or how they think. Third, the field is long on theory and short on tests of mechanism: gamification is said to work because it satisfies basic psychological needs, yet few studies ask whether engagement actually carries the effect on learning [7]. The present study addresses these gaps with a quasi-experimental field design in intact secondary-college science classes. It examines achievement, three facets of engagement like behavioural, emotional and cognitive and intrinsic motivation; it analyses the data with cluster-aware methods and reports effect sizes with interval estimates; and it tests a simple mediation model and a compensatory-benefit hypothesis. The contribution is therefore both substantive and methodological [8]. Substantively, it estimates how large the gamification effect is for a carefully designed, need-supportive implementation. Methodologically, it shows how much of the apparent effect on engagement survives when the clustered structure of the classroom is respected.

2. Theoretical background and literature review

Gamification distinguished from serious games from full games built for a non-entertainment purpose and from playful design more generally: gamification borrows elements, not the whole game. This distinction matters for education because it clarifies what is being tested [9]. A gamified classroom is not a classroom that plays games; it is a classroom in which the reward structure, feedback loops, goal architecture and social comparison familiar from games have been laid over the curriculum [10]. The study organise these ingredients into dynamics like constraints, progression, relationships, mechanics as challenges, rewards, feedback, cooperation and competition and components as points, badges, leaderboards, levels, quests cautions that the components are the least important layer. Reward-focused implementations, which he terms "pointsification", can be experienced as controlling, whereas meaningful gamification connects activity to the learner's own goals and interests [11]. Student engagement is generally treated as a multidimensional meta-construct, distinguish behavioural engagement as participation, effort, persistence, emotional engagement as interest, enjoyment, belonging and cognitive engagement like investment in learning, strategy use, willingness to exert effort to master difficult ideas [12]. The three facets are empirically correlated but not interchangeable, and they plausibly respond differently to an intervention. Points and badges might readily raise visible participation yet

leave deep processing untouched; narrative and choice might do the opposite [13]. Treating engagement as a single score therefore risks missing exactly the information that would let designers improve their systems. Engagement is also conceptually distinct from motivation: motivation is the energy and direction of behaviour, whereas engagement is its observable and experiential expression in a particular task context [14]. We therefore model intrinsic motivation, the inherent interest and enjoyment in an activity, as a separate outcome.

2.1. Conceptualizing gamification and student engagement

Gamification is serious games, which are full games designed for purposes other than entertainment, as well as from playful design in a broader sense: gamification utilizes certain elements rather than entire game systems. This differentiation is significant in educational contexts because it defines what aspects are being evaluated [15]. A gamified classroom does not equate to a classroom filled with games; instead, it incorporates game-like features such as reward systems, feedback mechanisms, goal structures, and social comparisons into the existing curriculum. The categorize these features into three areas, dynamics like constraints, progression, relationships, mechanics as challenges, rewards, feedback, cooperation, and competition, and components as points, badges, leaderboards, levels, quests [16], warns that components are the least critical aspect of gamification. He describes implementations focused solely on rewards—termed "pointsification" as potentially controlling; conversely, effective gamification should align activities with the learner's personal goals and interests [17]. Student engagement is typically viewed as a complex meta-construct comprising multiple dimensions. The study of [18] identify three types of engagement, behavioral engagement as involvement, effort, persistence), emotional engagement like interest, enjoyment, sense of belonging, and cognitive engagement like commitment to learning tasks and strategy application. Although these dimensions are related empirically, they are not interchangeable and likely respond differently to various interventions [19]. For instance, points and badges might enhance visible participation while failing to promote deeper cognitive processing; narratives and choices may have the reverse effect. Therefore, evaluating engagement through a single metric could overlook crucial insights necessary for designers aiming to refine their systems. Furthermore, engagement is conceptually separate from motivation: while motivation refers to the driving force behind behavior in terms of energy and direction, engagement represents its observable manifestation within a specific task context [20]. Thus, we conceptualize intrinsic motivation the natural interest and enjoyment derived from an activity as an independent outcome.

2.2. Theoretical Review

Several theories suggest that gamified designs can enhance learning, though they vary in their explanations of how this occurs. One of the most significant theories in educational research is Self-Determination Theory (SDT). This theory posits that intrinsic motivation and overall well-being thrive when the social environment meets three fundamental psychological needs: autonomy, which encompasses volition and choice; competence, relating to effectance and mastery; and relatedness, which involves connections with others [21]. Well-crafted game elements are believed to fulfill each of these needs: choices among quests promote autonomy; levels, progress bars, and immediate feedback convey a sense of competence; while team challenges nurture relatedness. Experimental studies provide partial support for these claims, indicating that various elements satisfy different needs badges, leaderboards, and performance graphs enhance perceived competence, whereas meaningful narratives and avatars contribute

to experienced meaning and relatedness [22]. However, SDT also warns against potential pitfalls. Rewards may be interpreted as either informational indicating competence or controlling implying manipulation of behavior. A meta-analysis encompassing 128 experiments revealed that tangible rewards that are expected or contingent on performance tend to undermine intrinsic motivation. In contrast, verbal rewards that are unexpected or informational do not have this negative effect [23]. If points and badges are perceived as controlling mechanisms, gamification might achieve short-term compliance at the expense of fostering genuine interest a concern known as the "overjustification" problem highlighted by critics of gamification. This underscores the importance of implementation quality over merely including game elements [24].Flow Theory provides an additional perspective on this issue. It suggests that engagement occurs when there is a balance between challenge and skill, clear goals exist, and feedback is immediate; games facilitate these conditions through thoughtful level design and adaptive difficulty [25]. This mediated structure where instructional content leads to learning while game elements modify mediating processes is the basis for the mediation hypothesis explored in this analysis.

2.3. Empirical evidence on gamification in education

Early systematic reviews indicated that while many empirical studies on gamification yielded positive outcomes, they also highlighted weaknesses in design. The comprehensive review of these studies noted improvements in engagement, motivation, and learning; however, it emphasized that results were influenced by the context and the alignment of game elements with educational objectives [26]. It was observed that the effects of gamification depend on contextual factors and user traits, with novelty effects and individual competition preferences complicating the analysis. In a meta-analysis of both experimental and quasi-experimental research, a medium overall effect on academic achievement was estimated, though variations were noted based on the duration and context of interventions [27]. This raises questions about a potential novelty effect that may diminish over time. Similar findings were reported in another pooled analysis, which suggested that the impact varied according to discipline, duration, and types of game mechanics employed. Related literature supports this observation: meta-analyses focusing on digital games report modest benefits for learning [28]. Further insights from primary studies revealed nuances; for instance, one study found that a gamified e-learning course led to improved performance on practical tasks but not on written assignments. Students who were less favorable toward competitive aspects tended to engage less. In a full-semester investigation, it was found that students in a gamified course experienced reduced intrinsic motivation, satisfaction, empowerment, and final exam performance compared to those in a non-gamified environment. Additionally, research indicated that while points, levels, and leaderboards increased task completion rates, they did not enhance quality or intrinsic motivation. Another study showed varying influences of badges on learner activity based on their pre-existing motivations [29]. Furthermore, it was demonstrated that game mechanics fostered engagement in certain tasks but not others underscoring the significance of aligning mechanics with task requirements.

2.4. Boundary conditions and methodological concern

Three primary factors account for the varying results of gamification across different studies. The effectiveness of gamification is significantly influenced by its design. Activities that integrate elements such as competition, collaboration, choice, and narrative tend to yield better outcomes compared to those that rely solely on points or rankings [30]. The length of the intervention plays a crucial role in its effectiveness. Initially, students may exhibit heightened interest due to the novelty of the learning method; consequently, short-term studies might struggle to differentiate between the actual effects of gamification and the initial excitement associated with

a new approach. While some research indicates that the duration can impact outcomes, long-term studies are still scarce [31]. Individual student traits can also influence results. Learners with lower academic performance or motivation might find clear objectives and visible progress more beneficial than their higher-performing peers, who may view these features as less advantageous or even constraining. However, evidence supporting this notion is limited and shows inconsistent findings. Another consideration involves statistical analysis methods. Gamification is frequently applied at the class level, yet some studies treat each student as an independent case [32]. This approach can lead to distorted conclusions since students within the same class often share similar educational experiences and outcomes. Overlooking this similarity may result in an inflated perception of gamification's effectiveness, particularly in large classes or when only a few classes are studied. Given that academic performance and engagement typically exhibit patterns among students in a shared class environment, failure to account for these nuances could result in erroneous interpretations [33]. Consequently, it is vital for research on gamification to align statistical methodologies with how interventions are executed.

2.5 The present study and hypotheses

Drawing these strands together, the study evaluates a need-supportive gamified design, one that combines points and levels with team-based cooperation, choice among quests and a coherent narrative, in an extended (12-week) implementation and with an analysis that respects the clustered design. Based on the SDT account and the meta-analytic evidence, the following hypotheses were specified before analysis:

H1. Students in the gamified condition will achieve higher post-test scores than students in the comparison condition, controlling for pre-test achievement.

H2. Students in the gamified condition will report higher engagement in behavioural, emotional and cognitive facets than students in the comparison condition.

H3. Students in the gamified condition will report higher intrinsic motivation than students in the comparison condition.

H4. Engagement will partially mediate the effect of gamification on achievement

H5. The effect of gamification on achievement will be moderated by prior achievement, with larger benefits for students with lower pre-test scores

3. Research Methodology

The research utilized a quasi-experimental design featuring a non-equivalent comparison group, encompassing pre-test and post-test assessments. It involved 312 Plus Two students drawn from eight science classes in Bengaluru, India, over the course of 12 weeks. The classes were divided into gamified (GC) and comparison (CC) groups, with four classes assigned to each category, ultimately resulting in a sample size of 304 students. The gamified approach included elements such as narrative-driven quests, collaborative challenges, rewards based on mastery, options for learners, progress monitoring, and formative feedback, while reducing competitive rankings and decoupling rewards from grades. In contrast, the comparison group received traditional instruction that adhered to the same curriculum, learning goals, and assessment timelines. Data collection methods included a 40-item achievement test aligned with the curriculum administered both prior to and following the intervention; a 15-item scale measuring student engagement; and a seven-item scale assessing intrinsic motivation. Analysis of the data was conducted using Python software through methods such as descriptive statistics, reliability analysis, ANCOVA with cluster-robust standard errors, effect size calculations, and robustness checks. Mediation effects were explored through a bootstrap technique involving 5,000

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resamples; moderation effects were evaluated via interactions between conditions and pre-test results. Statistical significance was determined at the 5% threshold.

4. Results

4.1. Preliminary analyses and baseline equivalence

Table 1 presents a summary indicating that the groups did not vary in terms of pre-test performance, with Welch's t = -1.42, p = .157, showing that the GC had an average starting score approximately 1.9 points lower. Additionally, there was no significant difference in gender distribution, $\chi^2(1) = .24$, p = .624. The slight baseline advantage for the comparison group is considered conservative for testing H1 and supports the choice to account for pre-test scores in all models.

Table 1 : Participant Characteristics

Characteristic	Gamified (GC)	Comparison (CC)	Test	p
Classes (k)	4	4	—	—
Students analysed (n)	150	154	—	—
Female, %	57.3	54.5	$\chi^2(1) = .24$	.624
Pre-test, M (SD)	54.12 (12.36)	56.01 (10.85)	t = -1.42	.157

Descriptive statistics and reliability measures are detailed in Table 2. The skewness and kurtosis values for all variables ranged between ±1, with intrinsic motivation in the GC exhibiting a moderate negative skew of -0.80, which is common for positively phrased attitude scales. Consequently, the data were deemed appropriate for parametric analysis. Class membership explained 3.8% of the variance in post-test scores (ICC = 0.038; adjusted ICC = 0.030 after accounting for covariates) and 12.8% of the variance in engagement (ICC = 0.128). Given that there were approximately 38 students per class, the design effect for post-test scores was calculated to be 2.41, leading to a reduction in effective sample size from 304 to around 126 students. These figures fall within the typical range observed for educational outcomes, underscoring the importance of considering clustering effects.

Table 2: Descriptive Statistics and Reliability

Variable	GC M (SD)	CC M (SD)	Skew	Kurtosis	α
Pre-test	54.12 (12.36)	56.01 (10.85)	-0.10	0.11	—
Post-test	61.75 (11.53)	58.52 (11.22)	-0.06	-0.31	—
Engagement	3.88 (0.72)	3.71 (0.72)	-0.36	-0.63	.96
Behavioural	3.85 (0.72)	3.72 (0.73)	-0.35	-0.47	.87
Emotional	3.87 (0.76)	3.71 (0.76)	-0.29	-0.68	.88
Cognitive	3.92 (0.77)	3.71 (0.78)	-0.36	-0.68	.89
Intrinsic motivation	3.87 (0.62)	3.61 (0.63)	-0.50	0.08	.84

Table 3: Zero-Order Correlations among study variables

Variable	1	2	3	4
1. Pre-test	—			
2. Engagement	.18	—		
3. Intrinsic motivation	.30	.32	—	
4. Post-test	.71	.33	.26	—

Correlations were in the expected directions. Post-test achievement was strongly related

to the pre-test (r = .71), and moderately related to engagement (r = .33) and intrinsic motivation (r = .26). Engagement and intrinsic motivation correlated at r = .32, indicating related but distinct constructs, with less than 11% shared variance.

4.2 Unadjusted Condition Differences

Table 4: Unadjusted differences between the gamified and comparison conditions

Outcome	M diff.	t (df)	p	g	95% CI for g
Post-test	3.23	2.47 (301)	.014	.28	[.06, .51]
Engagement	.17	2.01 (302)	.045	.23	[.00, .46]
Behavioural	.13	1.53 (302)	.127	.18	[-.05, .40]
Emotional	.17	1.90 (302)	.059	.22	[-.01, .44]
Cognitive	.21	2.32 (302)	.021	.27	[.04, .49]
Intrinsic motivation	.26	3.66 (302)	< .001	.42	[.19, .65]

Without any adjustments (refer to Table 4), the GC exhibited an increase of 3.23 points on the post-test (g = .28) and indicated greater levels of engagement (g = .23) as well as intrinsic motivation (g = .42). The variations observed in the various aspects of individual engagement were relatively consistent in magnitude, with the cognitive aspect being the most substantial (g = .27) and the behavioral aspect being the least significant (g = .18). These unrefined estimates serve primarily as a reference point: they overlook both pre-test results and clustering effects, making them unsuitable for confirmatory inference.

4.3. Primary Analysis: Covariate-Adjusted Effects (H1, H2, H3)

The ANCOVA assumptions were satisfied. The residuals of the achievement model did not depart from normality (Shapiro–Wilk W = .994, p = .289), variances were homogeneous across conditions (Levene's F = .45, p = .504), and the regression slopes of post-test on pre-test were parallel (condition × pre-test B = -.091, p = .244).

Table 5: Covariate-adjusted effects of gamification (ANCOVA, pre-test as covariate)

Outcome	Adj. M GC	Adj. M CC	B (SE)	t	p	p Holm	ηp^2	g	B [95% CI]	p
Post-test	62.43	57.85	4.58 (.90)	5.10	< .001	< .001	.080	.59	4.58 [1.45, 7.70]	.012
Engagement	3.89	3.70	.19 (.08)	2.30	.022	.022	.017	.26	.19 [-.29, .67]	.373
Intrinsic motivation	3.89	3.59	.30 (.07)	4.34	< .001	< .001		.50	.30 [.06, .53]	.021

H1: Achievement

Following the adjustment for prior achievement, the GC surpassed the CC by 4.58 points on the post-test (adjusted means of 62.4 compared to 57.9). This difference was statistically significant, evidenced by both model-based inference, t(301) = 5.10, p < .001, and the more conservative cluster-robust inference, with a 95% confidence interval of [1.45, 7.70], p = .012. The standardized effect size was g = .59, indicating a medium effect according to Cohen's (1988) criteria and

aligning closely with pooled estimates from relevant meta-analyses (Bai et al., 2020; Sailer & Homner, 2020). The pre-test proved to be a strong covariate (B = .71), and the model accounted for 54% of the variance in post-test scores. Thus, H1 received support.

H2: Engagement

Engagement also showed higher levels in the GC (adjusted means of 3.89 versus 3.70; g = .26). However, this result is sensitive to the method of statistical inference employed. The model-based test yielded significance, t(301) = 2.30, p = .022 (Holm p = .022), yet the cluster-robust confidence interval [-0.29, 0.67] included zero (p = .373). This variability stems from clustering effects: engagement appeared more dependent on class factors (ICC = .128) than achievement did; thus, much of the raw difference may be attributed to classroom dynamics and teacher influence rather than solely to the intervention itself. Consequently, we interpret H2 as being tentatively supported: while the point estimate is positive and comparable in magnitude to previous studies, a design encompassing four classes per condition cannot definitively rule out explanations at the class level.

H3: Intrinsic Motivation

The GC exhibited higher levels of intrinsic motivation by .30 scale points (adjusted means of 3.89 against 3.59; g = .50). This difference remained robust under cluster-robust inference with a confidence interval of [0.06, 0.53], p = .021, as well as through Holm correction (< .001). In light of Self-Determination Theory's critique regarding reward-based systems, this finding stands out as pivotal: a design integrating points within a narrative framework that encourages teamwork and offers choices enhanced students' interest and enjoyment instead of diminishing them. Therefore, H3 was supported.

4.4. Engagement facets

Table 6: Covariate-Adjusted Effects on Engagement Facets

Facet	B	t(301)	p	g	p
Behavioural	.15	1.81	.072	.21	.477
Emotional	.19	2.16	.031	.25	.357
Cognitive	.23	2.61	.009	.30	.307

The pattern observed at the facet level aligns with the theoretical expectation that narrative and quest structures influence cognitive and emotional engagement as much as they do visible participation. Among the facets, the cognitive aspect exhibited the most substantial adjusted effect (g = .30, model-based p = .009), followed by the emotional facet (g = .25) and the behavioral facet (g = .21, p = .072). However, none of **this facet effects-maintained** significance when assessed using cluster-robust inference (all p > .30). The differences between the facets are minor compared to their uncertainty, suggesting that they should be regarded as hypotheses for future research rather than definitive conclusions.

4.5 Mediation by engagement (H4)

Table 7: Mediation of the gamification

Path	Estimate	SE	t	p
Condition → Engagement	.19	.08	2.30	.022
Engagement → Post-test (controlling for condition, pre-test)	3.00	.61	4.90	< .001
Total effect	4.58	—	—	—
Direct effect	4.01	—	—	—
a × b: Indirect effect	.56	—	—	[.12, 1.15]

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Table 7 indicates that gamification was associated with increased engagement (a = .19), which subsequently led to higher post-test achievement, controlling for both condition and pre-test scores (b = 3.00 points per scale point, p < .001). The indirect effect measured .56 points, with a bootstrap 95% confidence interval of [.12, 1.15] that did not include zero, making up approximately 12% of the total effect (c = 4.58); the direct effect also remained significant (c′ = 4.01). In line with H4, engagement functioned as a partial mediator. However, two important caveats should be noted. First, both the mediator and outcome were assessed simultaneously, preventing the establishment of temporal precedence. Second, path a exhibits clustering sensitivity similar to the engagement findings discussed in Section 4.3. Therefore, these mediation results should be interpreted as supporting evidence for a pattern of associations consistent with the theoretical model rather than definitive proof of a causal sequence. Additionally, since the majority of the effect (88%) does not pass through engagement, it implies that alternative mechanisms such as feedback, clarity of goals, or time spent on tasks may also play a role.

4.6. Moderation by prior achievement and gender (H5)

Table 8: Moderation of the gamification effect on post-test achievement by pre-test score

Effect	B	SE	t	p
Condition × Pre-test interaction	-.091	.078	-1.17	.244
Simple effect at –1 SD pre-test	5.64	1.28	4.41	< .001
Simple effect at mean pre-test	4.59	.90	5.11	< .001
Simple effect at +1 SD pre-test	3.53	1.27	2.78	.006
Condition × Gender interaction	-1.07	1.81	-.59	.554

The interaction between the condition and pre-test was found to be negative, aligning with the predictions of the compensatory hypothesis; however, this effect was small and not statistically significant, B = -.091, p = .244 (cluster-robust p = .181). Consequently, H5 was not upheld in a strict sense. Nonetheless, the descriptive analysis of simple effects, is noteworthy: gamification provided an advantage of 5.64 points for students who scored one standard deviation below the pre-test average, 4.59 points at the average, and 3.53 points for those scoring one standard deviation above it. All three differences were statistically significant from zero. Therefore, gamification was beneficial across various performance levels; while there appears to be a slightly greater benefit for lower-achieving students, the data does not allow for a definitive distinction between this trend and a consistent effect across all groups. Additionally, gender did not influence this effect (p = .554).

4.7 Robustness and Sensitivity Analyses

Table 9: Robustness of the effect on post-test achievement

Analysis	Estimate	Inference
Primary ANCOVA, cluster-robust	B = 4.58	95% CI [1.45, 7.70] p = .012
Class-level regression	B = 5.93	t(5) = 3.34 p = .021
Permutation test, all 70 class assignments	B = 5.93	p = .029
Adding gender as covariate	B = 4.60	p < .001
Leave-one-class-out (8 re-estimations)	B range = 3.56 to 5.37	all positive
Mann–Whitney U (unadjusted, student level)	U = 13,537	p = .010

The stability of the achievement effect was consistent across various analyses. A regression analysis focusing on the means of eight classes, which considers each class as the unit of analysis and is thus regarded as a conservative method, yielded an adjusted difference of 5.93 points ($p = .021$). Additionally, a precise permutation test where the treatment label was reassigned in all 70 possible configurations resulted in $p = .029$, representing the minimum value achievable by this design. The estimate varied between 3.56 and 5.37 points when any one class was excluded, but its sign remained unchanged. Including gender as a covariate had little to no impact on the estimate. Furthermore, a rank-based test applied to unadjusted post-test scores indicated a significant difference as well. The minimum detectable effect, based on an effective sample size around 126 with an 80% power threshold, was approximately $d = .50$. This context clarifies why the engagement results ($g \approx .26$) cannot be conclusively affirmed or dismissed: the study was designed to identify medium effects, yet both facet and moderator analyses fell significantly short of that threshold.

5. Discussion

5.1. Summary and Interpretation of Findings

The study investigated whether a well-structured gamified classroom enhances student achievement, engagement, and intrinsic motivation. The results reveal beneficial impacts on achievement and intrinsic motivation, although the evidence for engagement is less definitive. Students participating in gamified classrooms achieved scores approximately 4.6 points higher on the post-test ($g = .59$) and exhibited increased intrinsic motivation ($g = .50$). These findings remained robust even when analyzed using cluster-robust methods and at the class level. Conversely, the effect on engagement was modest ($g = .26$) and statistically unstable when classrooms were treated as the analytical unit. The more pronounced influence on intrinsic motivation implies that gamification is particularly effective when it fosters autonomy, competence, and collaboration instead of merely focusing on points and rankings. Factors such as decoupling game rewards from grades, acknowledging mastery, and allowing choices may have contributed to these positive outcomes; however, isolating the specific impact of each design element remains unfeasible. Mediation analysis revealed that engagement accounted for only about 12% of the overall effect on achievement. Other factors such as formative feedback, clearly defined learning objectives, and collaborative exercises might also play a role in enhancing learning. Future research should integrate self-reported data with behavioral observations in classroom settings. The compensatory hypothesis did not receive support; nonetheless, it appeared that lower-achieving students benefited slightly more from the intervention. Notably, high-achieving students also gained advantages, indicating that a mastery-focused approach can assist learners across various achievement levels without disproportionately disadvantaging those who find academic work challenging.

5.2. Theoretical Implications

These findings endorse a nuanced view of gamification's effectiveness depending on how game elements are constructed and executed. They emphasize that engagement alone does not suffice to clarify the connection between gamification and achievement, underscoring the necessity to explore other mediating factors. Additionally, the stronger reaction observed in intrinsic motivation relative to engagement suggests that these two constructs warrant separate examination rather than being viewed as interchangeable outcomes.

5.3. Practical Implications

Educators should design gamified activities emphasizing autonomy, competence, and collaboration instead of solely relying on point systems. Rewards ought to acknowledge mastery, progress in learning, and improvement rather than merely speed or compliance; furthermore, achievements derived from gaming should be distinct from academic grades. Competition

should be minimized with greater focus placed on individual growth rather than public standings. Effective application also necessitates teacher training along with suitable instructional support and monitoring to ensure that gamification facilitates meaningful learning experiences instead of simply incorporating gaming elements into traditional classroom practices.

5.4 Limitations

The study presents two principal limitations: first is the non-random assignment of classes coupled with a small sample size which hinders causal interpretations and statistical accuracy; second is the limited generalizability stemming from a 12-week intervention within a specific educational context regarding long-term academic outcomes. Moreover, combining multiple game elements restricts the capacity to evaluate each component's individual effects.

5.5 Directions for Future Research

Subsequent studies ought to employ cluster-randomized designs encompassing larger numbers of classrooms to enhance estimate reliability particularly concerning engagement metrics. Research should also aim to isolate distinct gamification components like narrative elements, cooperation dynamics, or competition features to ascertain their unique impacts. Longitudinal investigations integrating repeated surveys alongside behavioral data and classroom observations could help assess ongoing engagement while differentiating enduring benefits from temporary novelty effects. Researchers are encouraged to report variations at the classroom level while utilizing appropriate multilevel analyses; preregistration of hypotheses along with sharing data sets and materials would further enrich this evidence base.

6. Conclusion

This 12-week quasi-experimental research demonstrated that gamification, which supports students' needs, significantly enhanced both achievement and intrinsic motivation among Plus Two science students. The study observed an increase in achievement by roughly 4.6 points (g = .59) and a notable improvement in intrinsic motivation (g = .50). However, the impact on engagement was not statistically significant, with engagement accounting for only a minor portion of the achievement improvement. The results indicate that gamification is most effective when it fosters autonomy, competence, and collaboration, distinguishes rewards from grades, and reduces excessive competition. Instead of questioning the effectiveness of gamification, future studies should focus on identifying which design features are successful, for whom they are beneficial, and the mechanisms behind their effectiveness. There is a need for larger classroom-based investigations and more rigorous research designs to validate the long-term educational benefits of gamification.

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