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Cloud-Based Gamification in Adult Open and Distance Learning: Evidence from Academic Achievement Outcomes

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ABSTRACT

Gamification has been widely adopted in higher education; however, evidence regarding its effects on objective academic achievement remains inconclusive, particularly among adult learners in open and distance learning (ODL) environments. This study examined whether integrating a cloud-based gamified Learning Management System (LMS) was associated with changes in academic performance among adult learners enrolled in a fully online university course. Grounded in Self-Determination Theory (SDT) and principles of andragogy, the intervention incorporated progress dashboards, milestone roadmaps, automated feedback, leaderboards, and digital badges aligned with course learning outcomes. A quantitative pre-experimental one-group pre-test and post-test design was employed. Sixteen adult learners who completed both assessments were included in the matched analysis. Academic achievement was measured using equivalent knowledge tests administered before and after the intervention. Results indicated a modest increase in mean performance; however, the difference was not statistically significant, and the observed effect size was small. A strong positive correlation between pre-test and post-test scores suggested substantial stability in learners' relative standing over time. These findings indicate that cloud-based gamification may serve as a competence-supportive mechanism that reinforces existing achievement trajectories rather than producing substantial changes in academic performance among adult ODL learners. While these findings should be interpreted with caution due to the small sample size, the absence of a control group, and the pre-experimental design, the study contributes to a more context-sensitive understanding of gamification in digitally mediated higher education. It also highlights the need for further investigation using more rigorous research designs.

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1. INTRODUCTION

The rapid digitalisation of higher education has deepened scholarly debate regarding whether technological innovation translates into meaningful learning outcomes. Learning Management Systems (LMS) now function as the central instructional infrastructure in open and distance learning (ODL) contexts, mediating content delivery, assessment, interaction, and analytics (Martin et al., 2020; Kasabova et al., 2023). Although LMS adoption has expanded accessibility for adult learners, enabling them to balance professional and familial responsibilities (Park & Choi, 2009; Mansoor et al., 2024), issues related to student motivation, persistence, and academic performance in online environments remain significant.

Research consistently indicates that online learners experience higher attrition rates than their face-to-face counterparts (Lee & Choi, 2011; Rovai, 2003; Hart, 2012). Meta-analytic and longitudinal studies suggest that dropout in online higher education is influenced more strongly by motivational, self-regulatory, and contextual variables than by technological access alone (Broadbent & Poon, 2015; Kizilcec et al., 2013). Learners frequently report diminished social presence, reduced immediacy, and fluctuating engagement in asynchronous settings (Xie et al., 2006; Richardson et al., 2016). These findings suggest that the effectiveness of digital learning environments depends not only on access but also on the motivational architecture embedded within instructional systems.

Gamification has emerged as one such design strategy. Defined as the application of game design elements in non-game contexts (Deterding et al., 2011), gamification commonly incorporates elements such as points, badges, leaderboards, and progress indicators (Kapp, 2012; Werbach & Hunter, 2012). These mechanisms are intended to enhance motivational salience and reinforce goal progression. However, empirical evidence regarding gamification effects in higher education remains heterogeneous. Meta-analyses report small-to-moderate average effects on learning and motivation, accompanied by substantial variability across contexts and implementation quality (Huang et al., 2020; Sailer & Homner, 2020). In some cases, competitive elements have been associated with neutral or even negative motivational consequences (Hanus & Fox, 2015).

This variability underscores the importance of examining gamification effects within specific learner populations and technological configurations rather than assuming a uniform impact.

Adult learners represent a theoretically distinct population. Andragogical theory characterises adults as self-directed, mastery-oriented, and motivated by relevance and experiential integration (Knowles, 1984; Merriam & Bierema, 2014). Empirical work further indicates that perceived autonomy and competence predict persistence and academic success in adult online contexts (Broadbent, 2017). Gamification mechanisms may therefore operate differently for adults than for traditional undergraduate cohorts, particularly when reward structures risk misalignment with intrinsic goal orientations.

The theoretical foundation of gamification is frequently grounded in Self-Determination Theory (Deci & Ryan, 2000; Ryan & Deci, 2020), which posits that intrinsic motivation is supported when autonomy, competence, and relatedness are satisfied. Informational feedback and transparent mastery progression may enhance competence perceptions (Hattie & Timperley, 2007; Niemiec & Ryan, 2009), while autonomy-supportive structures promote volitional engagement (Reeve, 2012). However, extrinsic reward contingencies may undermine intrinsic motivation when perceived as controlling (Deci et al., 1999). Accordingly, gamification may function either as a competence-supportive scaffold or as a superficial incentive system, depending on design orientation and learner interpretation.

Recent advances in cloud computing have enabled the seamless integration of gamification features directly within LMS architectures. Cloud-based systems facilitate real-time analytics, automated feedback, adaptive progression pathways, and scalable deployment (Alamri, 2019; Bouchrika et al., 2021). Although such affordances hold promise for enhancing competence visibility and self-regulated learning (Panadero, 2017; Viberg et al., 2020), empirical evidence examining the magnitude of academic achievement change associated with cloud-based gamification in adult ODL contexts remains limited.

Importantly, much of the gamification literature emphasises engagement-related indicators, while comparatively fewer studies examine objective academic achievement outcomes using controlled pre–post measurement designs (Bond et al., 2020; Kahu, 2013). Establishing whether competence-oriented gamification embedded within cloud-based LMS

environments produces measurable knowledge gains and determining the magnitude of such gains, therefore, represent a necessary empirical step.

The present study addresses this gap by evaluating changes in adult learners' academic achievement following exposure to a cloud-based gamified LMS intervention implemented within an authentic university course. Drawing upon Self-Determination Theory (SDT) and principles of andragogy, the intervention is conceptualised as a motivational scaffold designed to enhance competence, transparency, and mastery progression.

Specifically, this study examines whether participation in a cloud-based gamified LMS is associated with statistically significant differences in pre-test and post-test academic performance among adult learners. By focusing on the magnitude and statistical significance of achievement change within a real-world instructional context, the study contributes empirical evidence to ongoing debates regarding the pedagogical value and contextual boundaries of gamification in higher education.

Although experimental and quasi-experimental designs provide stronger evidence for causal inference, exploratory pre-experimental investigations remain valuable when evaluating emerging instructional innovations implemented within authentic educational settings. In adult ODL environments, practical constraints often limit the feasibility of random assignment and control groups. Consequently, examining patterns of achievement change within naturally occurring course contexts can provide important preliminary evidence to inform subsequent large-scale studies.

2. LITERATURE REVIEW

2.1 Adult Learners in Digitally Mediated Higher Education

The expansion of online higher education has significantly increased adult participation in ODL environments. LMS serve as the primary instructional infrastructure in such contexts, structuring content access, assessment processes, and interaction patterns (Martin et al., 2020; Kasabova et al., 2023). While LMS platforms enhance accessibility and flexibility for adults balancing professional and personal commitments (Park & Choi, 2009), persistent concerns remain regarding sustained academic performance and retention.

Attrition research consistently demonstrates that dropout rates in online higher education are influenced more strongly by motivational and self-regulatory variables than by technological access alone (Lee & Choi, 2011; Hart, 2012; Broadbent & Poon, 2015). For adult learners, competing responsibilities and time constraints intensify the need for instructional environments that support efficient mastery progression and competence development.

Andragogical theory characterises adults as self-directed, mastery-oriented, and motivated by relevance and experiential integration (Knowles, 1984; Merriam & Bierema, 2014). Empirical research indicates that autonomy support and structured feedback are associated with persistence and academic achievement in adult online contexts (Broadbent, 2017). Consequently, instructional design interventions in adult LMS environments must be evaluated not only for their motivational appeal but also for their measurable learning outcomes.

2.2 Gamification in Higher Education: Variability and Context

Gamification, defined as the application of game design elements in non-game contexts (Deterding et al., 2011), has been widely adopted in educational settings. Common elements include badges, leaderboards, progress indicators, and structured feedback mechanisms (Kapp, 2012; Werbach & Hunter, 2012).

Meta-analytic findings suggest that gamification can produce small to moderate positive effects on learning outcomes; however, effect sizes vary substantially across contexts (Huang et al., 2020; Sailer & Homner, 2020). Systematic reviews emphasise that implementation quality, learner characteristics, and contextual alignment strongly moderate these outcomes (Seaborn & Fels, 2015; Toda et al., 2018). In some cases, competitive reward structures have been associated with neutral or negative effects on intrinsic motivation (Hanus & Fox, 2015; Mekler et al., 2017).

These heterogeneous findings indicate that gamification does not operate as a uniformly effective pedagogical strategy. Instead, its impact appears contingent upon design orientation and learner interpretation.

Importantly, most empirical investigations focus on traditional undergraduate populations, leaving adult learners in ODL higher education comparatively underexamined (Zainuddin et al., 2020; Por et al., 2025). Given adults' intrinsic goal orientation and emphasis on mastery relevance, gamified systems that prioritise superficial rewards may produce limited measurable change in academic achievement.

2.3 Self-Determination Theory (SDT) and Motivational Design

Self-Determination Theory (SDT) provides a framework for understanding how instructional design influences learning behaviour (Deci & Ryan, 2000; Ryan & Deci, 2020). Autonomy-supportive and competence-supportive environments have been shown to enhance intrinsic motivation and persistence (Reeve, 2012; Niemiec & Ryan, 2009).

Within digital environments, timely informational feedback and transparent progress tracking are associated with improved self-regulated learning processes (Hattie & Timperley, 2007; Panadero, 2017). Conversely, extrinsic reward contingencies may undermine intrinsic motivation when they are perceived as controlling (Deci et al., 1999).

Accordingly, gamification may function either as a competence-enhancing scaffold or as an externally imposed incentive system. The magnitude of its impact on academic achievement likely depends on the degree to which specific design features align with learners' motivational orientations.

2.4 Cloud-Based Gamification and Academic Achievement

Recent advances in cloud computing enable seamless integration of gamification features within LMS architectures. Cloud-based systems support automated feedback, adaptive progression, and analytics-driven performance tracking (Alamri, 2019; Bouchrika et al., 2021). Such affordances may enhance competence visibility and support structured mastery progression.

Nevertheless, empirical research examining objective academic achievement outcomes in adult cloud-based LMS environments remains limited. While engagement-related indicators are frequently reported (Bond et al., 2020), fewer studies examine measurable knowledge gains using controlled pre–post designs.

Given the documented heterogeneity of gamification effects and the underrepresentation of adult ODL populations, it remains unclear whether cloud-based gamification produces statistically meaningful achievement changes in authentic adult higher education settings.

2.5 Research Gap

The literature reveals three interrelated empirical gaps.

a) First, adult learners in ODL higher education remain underrepresented in gamification research.
b) Second, existing studies demonstrate substantial variability in effect sizes, suggesting the need for context-specific evaluation rather than generalised claims of effectiveness.
c) Third, comparatively few investigations examine objective academic achievement using controlled pre–post measurement in cloud-based LMS environments.

Addressing these limitations is necessary to determine the magnitude and statistical significance of academic achievement change associated with cloud-based gamification in adult learning contexts.

3. METHODOLOGY

3.1 Research Design

This study employed a quantitative pre-experimental one-group pre-test and post-test design to examine changes in academic achievement following the implementation of a cloud-based gamified LMS intervention. The design enabled a within-subject comparison across two measurement occasions and was considered appropriate for evaluating an instructional innovation implemented within an authentic higher education setting where random assignment was not feasible (Shadish et al., 2002; Creswell & Creswell, 2018).

A pre-experimental design was selected because the intervention was embedded within an existing fully online university course and formed part of routine instructional delivery. In this context, assigning a subset of learners to a non-gamified control group was not operationally appropriate, as all enrolled learners were required to receive the same course resources, learning opportunities, and instructional support. Therefore, the purpose of the study was not to establish definitive causal effects, but to generate preliminary evidence on the direction and magnitude of academic achievement changes associated with the activation of gamified LMS features.

The intervention was integrated without modification to course content, assessment standards, or learning outcomes. Consequently, the primary instructional change during the study period was the introduction of cloud-based gamification features. Given the absence of a comparison group, the findings are interpreted cautiously as evidence of performance changes over time rather than as conclusive evidence of causal impact.

3.2 Participants and Context

The study was conducted in a fully online university course delivered within an ODL learning environment. At the beginning of the semester, 34 students were enrolled in the course. Participation in the analysis required the completion of both the pre-test and post-test assessments. A sample of 16 adult learners completed both measures and were included in the matched analysis, yielding a completion rate of 47.1%.

The final sample size reflects participation patterns commonly observed in adult ODL learning contexts, where learners often balance academic study with employment, family responsibilities, and other personal commitments. Although the sample was modest, it represented the complete set of learners who provided matched pre-test and post-test data required for the within-subject comparison.

To examine whether attrition may have affected the validity of the results, the baseline pre-test scores of completers and non-completers were compared using independent-samples analysis. No statistically significant difference was observed, suggesting that attrition was not strongly associated with initial academic performance. Nevertheless, the final analytic sample remains self-selected, and the findings should be interpreted as exploratory and context-specific rather than generalisable to all adult ODL learners.

3.3 Intervention

The intervention involved integrating a cloud-based gamification system into the LMS. The system was implemented throughout a single instructional cycle and embedded within regular coursework activities. Rather than replacing the existing course structure, the gamification system functioned as an additional motivational and competence-supportive layer within the LMS environment.

The core gamification features included the following:
a) personalised progress dashboards;
b) structured milestone roadmaps;
c) interactive question sequences with automated feedback;
d) avatar representation;
e) leaderboard visibility; and
f) digital badges aligned with course learning outcomes.

Figure 1 presents the gamification dashboard used in Module 1 of the Kursus Integriti dan Anti-Rasuah (Integrity and Anti-Corruption Course), a compulsory course for all higher education students. The dashboard illustrates how these gamification elements were integrated into the LMS to support student engagement, monitor learning progress, and reinforce achievement throughout the course.

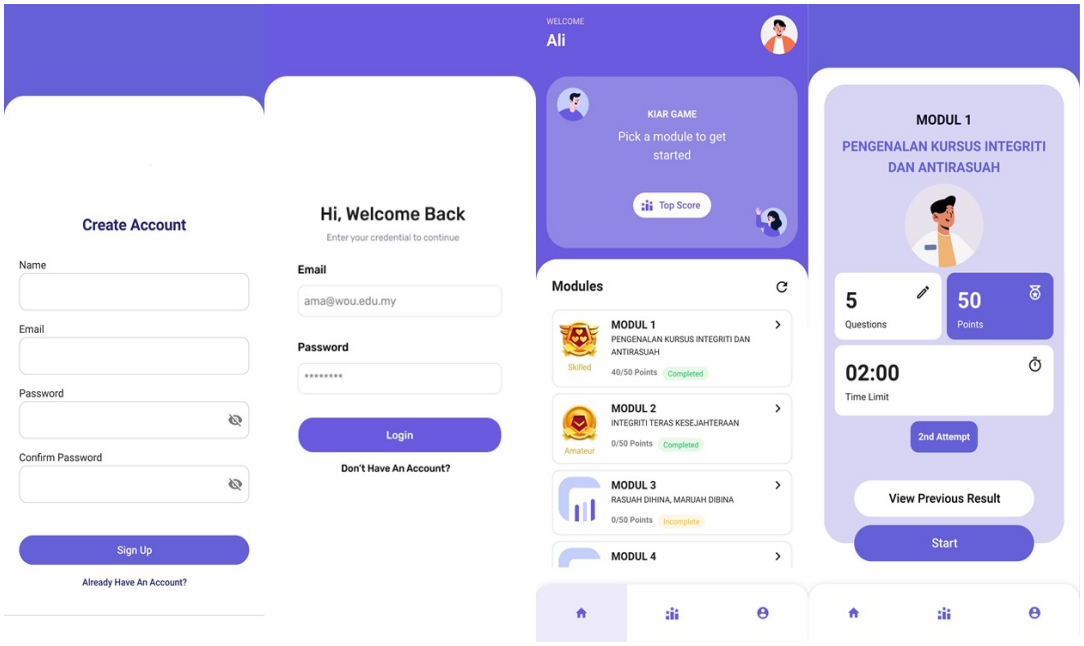

Fig. 1 *Gamification Dashboard for Module 1 of the Kursus Integriti dan Anti-Rasuah Course*

The design of the intervention was informed by Self-Determination Theory (Deci & Ryan, 2000; Ryan & Deci, 2020) and adult learning principles (Knowles, 1984; Merriam & Bierema, 2014). Progress dashboards, automated feedback, and milestone roadmaps were intended to enhance learners' visibility of competence and mastery progression. Structured pacing supported learner autonomy, while digital badges and leaderboards provided recognition of progress without being linked to punitive or high-stakes academic consequences.

These gamified elements were aligned with course learning outcomes and embedded within academic tasks. They were not designed as superficial rewards detached from core learning activities. LMS logs indicated consistent engagement with the gamified features during the intervention period.

3.4 Instrumentation and Measurement

Academic achievement was assessed using a structured knowledge test aligned directly with the course learning outcomes. Equivalent forms of the test were administered at pre-test and post-test to reduce potential testing effects while allowing comparison of performance across the two measurement points (Shadish et al., 2002).

The test items assessed conceptual understanding and applied knowledge relevant to the course. Content validity was established through expert review to ensure alignment between the test items, course outcomes, and instructional content. Internal consistency reliability was evaluated using Cronbach's alpha and met acceptable standards for educational measurement (DeVellis, 2017). Pre-test score distributions were also examined to determine whether ceiling effects were present. The distribution did not indicate clustering at the upper bound, suggesting that participants had sufficient latitude for measurable improvement following the intervention.

3.5 Procedure

Participants completed the pre-test at the beginning of the instructional period before the activation of the gamified LMS features. The cloud-based gamification system was then activated and remained available throughout the course, allowing learners to access the gamified features as part of routine course participation.

At the end of the instructional period, participants completed the post-test under comparable conditions. Both assessments were administered within the same course environment, and all data were anonymised before analysis to protect participant confidentiality.

3.6 Data Analysis

Data were analysed using statistical software following established quantitative procedures (Field, 2018). Initial screening involved the inspection for missing data, outliers, and the normality of difference scores. Normality was assessed using the Shapiro-Wilk test and visual examination.

Descriptive statistics were computed for pre-test and post-test scores, including means and standard deviations. A Pearson product-moment correlation analysis was used to examine the stability of learners' relative performance across the two measurement occasions. A paired-samples t-test was then conducted to determine whether the difference between pre-test and post-test scores was statistically significant. Statistical significance was set at .05 using two-tailed testing, and 95% confidence intervals were calculated.

Effect size was computed using Cohen's d for dependent samples to assess the practical magnitude of change independent of statistical significance (Cohen, 1988). In addition, a sensitivity power analysis was conducted to determine the minimum effect size that the available sample could reliably detect. With N = 16 and alpha = .05, the design had approximately 80% power to detect a large effect. Therefore, the study was adequately powered to detect substantial achievement gains but underpowered to detect small-to-moderate effects.

3.7 Validity Considerations

Several threats to internal validity are inherent in pre-experimental one-group pre-test and post-test designs, including maturation, history, testing effects, regression to the mean, and participant attrition (Cook & Campbell, 1979; Shadish et al., 2002). These limitations were addressed where possible within the constraints of an authentic educational setting.

Equivalent test forms were used to reduce testing effects. Furthermore, course content, assessment standards, and learning outcomes remained consistent throughout the intervention period. Baseline comparisons between completers and non-completers were conducted to examine potential attrition bias, and no statistically significant difference in pre-test performance was observed. These steps helped to strengthen the credibility of the findings, although they do not eliminate all threats to validity.

The absence of a control group prevents the definitive attribution of observed performance changes solely to the gamified LMS intervention. Similarly, the modest sample size limits statistical precision and generalisability. These limitations are acknowledged as characteristic of exploratory educational research conducted in real-world instructional contexts. Accordingly, the findings should be interpreted as preliminary evidence of achievement patterns associated with cloud-based gamification rather than conclusive evidence of causal effectiveness.

3.8 Ethical Considerations

Ethical approval was obtained in accordance with institutional procedures. Participation was voluntary, and informed consent was secured from all participants. The intervention formed part of routine course delivery and did not introduce additional academic risk. Data were anonymised before analysis, and findings were reported in aggregate form to protect participant confidentiality.

4. RESULTS AND FINDINGS

All sixteen participants completed both measurement occasions and were included in the matched analysis. Data were screened for outliers and normality before inferential testing. Visual inspection of boxplots and standardised residuals did not indicate extreme values. Shapiro–Wilk tests conducted on the difference scores did not reveal significant departures from normality, supporting the use of parametric procedures.

Pre-test scores (M = 8.13, SD = 1.63) were not clustered at the upper bound of the scale, reducing the likelihood of ceiling effects constraining potential post-intervention gains. Variability remained comparable at post-test (M = 8.50, SD = 1.59), indicating stable dispersion across time.

Table 1
Descriptive Statistics for Pre-Test and Post-Test Scores

N=16	Pre-Test	Post-Test
Mean	8.13	8.50
Std. Deviation	1.628	1.592

4.1 Descriptive Patterns of Academic Achievement Change

Mean performance increased from 8.13 at pre-test to 8.50 at post-test, yielding an average gain of 0.38 points. The standard error of the mean difference was 0.32, reflecting moderate sampling variability relative to the magnitude of change.

Inspection of individual change scores indicated that the majority of participants demonstrated either no change or small positive gains, while a smaller subset showed minor decreases. No extreme shifts were observed, suggesting that the aggregate results were not driven by isolated outliers.

Collectively, the descriptive statistics indicate a modest upward movement in overall performance following exposure to the cloud-based gamified LMS.

4.2 Stability of Individual Performance

To examine whether performance changes reflected a redistribution of achievement levels or the reinforcement of existing trajectories, a Pearson product–moment correlation was conducted between pre-test and post-test scores.

Results revealed a strong positive association, $r = .70$, $p = .003$, indicating substantial rank-order stability across measurement occasions. Approximately 49% of the variance in post-test scores was explained by baseline performance ($r^2 = .49$), suggesting that students' relative standing within the cohort remained largely consistent over time.

Table 2
Frequency Analysis Pre-Test

Scores	Frequency	Percent	Cumulative Percent
3	1	6.3	6.3
6	1	6.3	12.5
7	1	6.3	18.8
8	3	18.8	37.5
9	10	62.5	100.0
Total	16	100.0	

This pattern indicates that while mean performance shifted slightly upward, the intervention did not substantially alter the relative distribution of achievement within the group.

4.3 Inferential Comparison of Pre- and Post-Test Scores

A paired-samples t-test was conducted to evaluate whether the observed increase in mean scores reached statistical significance. The difference between pre-test (M = 8.13, SD = 1.63) and post-test (M = 8.50, SD = 1.59) scores was not statistically significant, t (15) = –1.19, p = .252 (two-tailed), 95% CI [–1.05, 0.30].

Table 3
Frequency Analysis Post-Test

Scores	Frequency	Percent	Cumulative Percent
3	1	6.3	6.3
7	1	6.3	12.5
8	1	6.3	18.8
9	12	75.0	93.8
10	1	6.3	100.0
Total	16	100.0	

The confidence interval spans zero and includes both small negative and small positive values, indicating imprecision in the estimation of the true population difference. Although the direction of change was positive, the evidence does not support a statistically reliable improvement at the conventional alpha level.

To assess robustness, a non-parametric Wilcoxon signed-rank test was conducted. Results similarly indicated no statistically significant median difference, thereby confirming consistency across analytic approaches.

4.4 Effect Size and Detection Sensitivity

To evaluate practical significance independent of sample size, Cohen's d for dependent samples was calculated. The observed effect size was d = 0.30, corresponding to a small magnitude of change according to conventional benchmarks.

A sensitivity power analysis indicated that, with N = 16 and alpha = .05 (two-tailed), the study achieved approximately 80% power to detect a large effect (d ≈ 0.75). The design was therefore sufficiently powered to detect substantial achievement gains but underpowered to reliably detect small-to-moderate effects.

Given that the observed effect size falls below the minimum detectable threshold under these conditions, the absence of statistical significance should not be interpreted as definitive evidence of no effect. Given the modest sample size and limited statistical power, small effects may not have been detectable under the present study conditions.

In summary, the results indicate a modest upward shift in academic performance following the implementation of the cloud-based gamified LMS. However, the magnitude of change was small and did not reach statistical significance within this sample. Performance rankings remained relatively stable across time, suggesting the reinforcement of existing achievement trajectories rather than a large-scale redistribution of outcomes.

5. DISCUSSION

The present study examined whether the integration of a cloud-based gamified LMS was associated with measurable changes in academic achievement among adult learners in an ODL context. Although mean performance increased modestly following the intervention, the observed gain did not reach statistical significance and was accompanied by a small effect size. In addition, a strong positive correlation between pre-test and post-test scores indicated substantial stability in learners' relative performance over time. Rather than suggesting pedagogical ineffectiveness, this pattern provides theoretically meaningful insight into how competence-oriented gamification may function within mature adult learning populations by reinforcing existing achievement trajectories rather than substantially altering them.

The findings should be interpreted in light of the study's pre-experimental design, modest sample size, and the absence of a comparison group, all of which limit the strength of causal inferences that can be drawn. Nevertheless, the results provide valuable preliminary evidence regarding the role of cloud-based gamification in authentic adult ODL environments and contribute to a more nuanced understanding of how gamified learning systems may support competence development among adult learners.

5.1 Interpreting Effect Magnitude in Context

The small positive effect observed in this study aligns with meta-analytic evidence indicating that gamification in educational contexts typically yields small to moderate effects on learning outcomes, with considerable heterogeneity across studies (Huang et al., 2020; Sailer & Homner, 2020). Effect sizes in gamification research are influenced by implementation fidelity, duration of exposure, pedagogical integration, and learner characteristics (Seaborn & Fels, 2015; Toda et al., 2018). In ecologically valid higher education settings where curricular content, instructional design, and assessment standards remain constant, gamification operates as a structural augmentation rather than a transformative intervention. Under such conditions, incremental gains are theoretically plausible and consistent with broader instructional design literature.

Importantly, the absence of statistical significance should not be equated with an absence of pedagogical value. The study was powered to detect large effects, whereas the observed magnitude fell within the small range commonly reported in authentic educational environments. Large-scale syntheses of educational interventions demonstrate that effect sizes in naturalistic settings are frequently modest, particularly when innovations are layered onto established instructional systems rather than replacing them (Hattie, 2009). The present findings, therefore, align with realistic expectations of instructional enhancement rather than laboratory-style contrast effects.

5.2 Reinforcement Dynamics in Adult Learner Populations

A particularly salient finding concerns the strong positive correlation between pre-test and post-test scores, indicating substantial stability in learners' relative standing. This suggests that the gamified LMS did not meaningfully redistribute achievement patterns within the cohort. Instead, it appears to have reinforced existing mastery trajectories.

This reinforcement dynamic can be interpreted through the lens of Self-Determination Theory (Deci & Ryan, 2000; Ryan & Deci, 2020). The intervention emphasised the visibility of competence, structured milestone progression, and informational feedback, while deliberately avoiding controlling or high-stakes reward contingencies. Within SDT, informational feedback enhances perceived competence and supports autonomous regulation, yet it does not necessarily override established motivational orientations. Adult learners, particularly in ODL environments, are often characterised by relatively stable goal orientation, self-direction, and internalised mastery values (Knowles, 1984; Merriam & Bierema, 2014). In such contexts, competence-supportive scaffolding may consolidate effective learning strategies rather than fundamentally alter performance hierarchies.

This interpretation contributes to the boundary-condition discourse in gamification research. Much of the literature implicitly assumes that gamification should elevate lower-performing learners or disrupt achievement disparities. However, empirical evidence increasingly indicates that gamification effects are moderated by learner characteristics, including intrinsic motivation and personality traits (Hanus & Fox, 2015; Mekler et al., 2017; Smiderle et al., 2020). In adult ODL populations where intrinsic motivation and self-regulation may already be relatively established, the marginal utility of gamified enhancements may be attenuated. Under these conditions, gamification may operate primarily as a competence-reinforcing architecture rather than a redistributive mechanism.

5.3 Implications for Cloud-Based LMS Design

These findings carry important implications for instructional design within adult ODL environments.

First, expectations of transformative academic improvement attributable solely to gamified features should be moderated. Adult learners frequently balance professional, familial, and academic responsibilities, and their engagement patterns are shaped by contextual constraints as much as by motivational architecture (Broadbent, 2017). Within such

constraints, structured supports that enhance transparency, pacing, and progress feedback may yield incremental rather than dramatic achievement shifts.

Second, the pedagogical value of cloud-based gamification may extend beyond short-term achievement metrics. Real-time analytics, progress dashboards, and milestone mapping strengthen self-monitoring processes central to self-regulated learning (Panadero, 2017; Viberg et al., 2020). While the present study assessed immediate knowledge gains, longer-term outcomes such as persistence, course completion, or sustained competence development may reveal broader impact. Engagement architecture embedded within cloud-based LMS environments may therefore function cumulatively rather than instantaneously.

Third, the absence of negative performance consequences is itself noteworthy. Prior research has demonstrated that competitive or externally controlling gamification designs can undermine intrinsic motivation in certain contexts (Deci et al., 1999; Hanus & Fox, 2015). The competence-oriented design employed in this study did not produce detrimental academic effects, suggesting that alignment with autonomy-supportive principles is essential when implementing gamification in adult education settings.

5.4 Theoretical Contribution

This study advances the educational technology literature in three substantive ways.

a) First, it provides empirical evidence from adult learners in ODL higher education, a population comparatively underrepresented in gamification research (Zainuddin et al., 2020). Extending inquiry beyond traditional undergraduate samples enhances the ecological and theoretical relevance of motivational design frameworks.
b) Second, the study emphasises objective academic achievement rather than engagement proxies. Although engagement is frequently examined in gamification research (Bond et al., 2020), achievement outcomes provide a more direct test of instructional impact and alignment with learning objectives (Kahu, 2013). By foregrounding performance change and effect magnitude, the study contributes to methodological rigor in educational technology evaluation.
c) Third, the findings refine theoretical expectations regarding magnitude and distribution. Rather than reinforcing a narrative of uniform effectiveness, the results support a differentiated model in which gamification functions as a competence-supportive scaffold whose impact depends on learner maturity, baseline motivational orientation, and instructional embedding. In adult ODL contexts, effects may manifest as reinforcement and stabilisation rather than redistribution. Clarifying such contextual boundaries strengthens the conceptual precision of gamification research and moves the field beyond simplistic effectiveness claims.

5.5 Limitations and Future Research

Several limitations should be considered when interpreting the findings of this study. First, the pre-experimental one-group pre-test and post-test design limits causal inference, as alternative explanations such as maturation, testing effects, and concurrent instructional influences cannot be fully ruled out (Shadish et al., 2002). In particular, the absence of a control group makes it difficult to isolate the effects of the gamified LMS intervention from other contextual or instructional factors that may have influenced learner performance during the study period. Second, although baseline comparisons did not indicate systematic attrition bias, the modest matched sample size reduced statistical power and limited the generalisability of the findings beyond the study context.

Future research should employ quasi-experimental or randomised controlled designs, where feasible, to provide stronger evidence regarding the causal effects of cloud-based gamification on academic achievement. Studies involving larger and more diverse adult learner populations would improve statistical precision and external validity. Further investigation of moderating factors, such as intrinsic motivation, self-regulated learning capacity, digital literacy, and workload constraints, may help explain variations in learner responses to gamified environments. Longitudinal research is also needed to determine whether competence-supportive gamification produces cumulative effects over extended instructional periods. Finally, mixed-methods approaches combining quantitative and qualitative data could provide deeper insights into how adult learners perceive, engage with, and integrate gamified features into their self-regulated learning processes.

6. CONCLUSION

Within this adult ODL context, cloud-based gamification was associated with a modest upward shift in academic performance but did not produce a statistically significant change within this sample. Achievement trajectories remained largely stable, indicating the reinforcement of existing competence structures rather than a large-scale redistribution.

These findings contribute to a more nuanced and context-sensitive understanding of gamification in higher education. In adult ODL environments, competence-oriented gamification embedded within cloud-based LMS systems may function primarily as a stabilising and supportive architecture. Articulating these boundary conditions refines theoretical expectations and supports more realistic implementation strategies for motivational design in digitally mediated higher education.

7. ACKNOWLEDGEMENTS

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8. FUNDING

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9. AUTHORS' CONTRIBUTION

Arathai and Asnina designed and organised the pre- and post-tests. Jayaeswari and Rabikha contributed to the analysis of the results. Arathai led the writing of the manuscript. All authors provided valuable feedback and contributed to shaping the research, analysis, and final manuscript.

10. CONFLICT OF INTEREST DECLARATION

We certify that the article is the authors' and co-authors' original work. The article has not received prior publication and is not under consideration for publication elsewhere. This research/manuscript has not been submitted for publication, nor has it been published in whole or in part elsewhere. We testify to the fact that all authors have contributed significantly to the work, validity and legitimacy of the data and its interpretation for submission to IJELHE.

11. DECLARATION OF GENERATIVE AI IN THE WRITING PROCESS

The authors wrote this manuscript. ChatGPT was used only for language polishing to improve clarity and readability. The authors reviewed and finalised the text and take full responsibility for the content of the publication.

12. DATA AVAILABILITY/SUPPLEMENTARY MATERIALS

The data that support the findings of this study are available from the corresponding author upon request.

13. REFERENCES

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