Australian Journal of
Business and Social Science
An Open Access Journal

Gamification Fatigue and Continuance Intention in Technology-Enhanced Learning Platforms: A Post-Adoption Extension of TAM

K. H. Tso
Faculty of Technology, Torrens University, Australia
ejoe.tso@torrens.edu.au

Abstract

Technology-Enhanced Learning (TEL) platforms have become infrastructure in higher education, yet many implementations fail to sustain students' voluntary engagement over time. Gamification is widely adopted to increase participation through game design elements such as points, badges, leaderboards, and progress feedback. However, a growing body of work suggests that gamification's benefits are temporally dynamic: early engagement gains may attenuate after an initial "novelty window," and some designs may introduce psychological strain that contributes to disengagement and fatigue. Despite these practical concerns, most gamification-acceptance studies remain cross-sectional and focus on initial adoption rather than continuance. This paper reframes gamified TEL acceptance as a post-adoption phenomenon and proposes a continuance-oriented model that extends the Technology Acceptance Model (TAM) with two constructs that are theoretically central to sustained use: satisfaction and gamification fatigue. Gamification fatigue is conceptualised as a progressive decline in motivational value due to habituation, mechanic–goal misalignment, perceived unfairness, competitive pressure, or interaction overload. To ground the post-adoption framing, we report pilot evidence from a university student survey (N=71) containing TAM beliefs, perceived gamification features, and continuance-oriented intention items. The pilot results indicate strong positive associations among constructs; perceived gamification shows the strongest correlation with intention (r=.795), followed by perceived ease of use (r=.696) and perceived usefulness (r=.679). In multiple regression, perceived gamification (β=.521, p<.001) and perceived ease of use (β=.247, p=.013) significantly predict continuance-oriented intention, while perceived usefulness is not significant when controlling for the other predictors (β=.159, p=.116). Building on these findings and recent longitudinal evidence on novelty and fatigue dynamics, the paper contributes: (i) a post-adoption conceptual model that distinguishes adoption drivers from continuation drivers; (ii) an operational definition of gamification fatigue aligned to observable design affordances; and (iii) a publication-ready longitudinal protocol and measurement instrument for semester-scale evaluation. The resulting agenda supports both theory development—by explaining why initial gamification gains may not persist—and practice—by guiding the design of durable, equity-sensitive gamified learning experiences.

Keywords: gamification; technology-enhanced learning; post-adoption; continuance intention; satisfaction; gamification fatigue; Technology Acceptance Model

1. Introduction

TEL platforms—learning management systems, interactive quizzes, virtual labs, practice portals, and assessment environments—now mediate a substantial share of learning activity in higher education. For many courses, TEL is no longer an optional supplement but a dominant channel for content access, submission, feedback, and progress monitoring. Yet the presence of a platform does not guarantee sustained engagement. Students' technology use frequently concentrates around assessment deadlines, with limited voluntary practice during the rest of the semester. This pattern creates an educational paradox: institutions invest heavily in TEL ecosystems while learners often under-utilise the very tools designed to support mastery and self-regulated learning.

Gamification has become one of the most widely adopted design strategies to address engagement volatility. By embedding game elements—points, badges, leaderboards, leveling, progress bars, narratives, challenges, and social interaction—gamification aims to make learning tasks more compelling and to increase persistence. Instructors often observe immediate benefits after introducing gamified features: heightened participation, improved activity completion, and increased classroom energy. These visible effects help explain the popularity of gamification across disciplines and platform types.

However, gamification's benefits are not guaranteed to persist. Longitudinal evidence indicates that gamification can suffer from a novelty effect where impact decreases after several weeks and then may partially recover through a familiarization process as learners adjust to the mechanics and incorporate them into their study routines. Rodrigues et al. report a U-shaped pattern of gamification impact over time, with declines beginning after approximately four weeks and recovery emerging between six and ten weeks, implying that studies shorter than a semester may misrepresent long-term effectiveness. In parallel, research on the 'dark side' of gamification argues that competitive and socially comparative mechanics may create psychological stressors, contributing to fatigue, disengagement, and withdrawal.

These observations imply that acceptance in gamified TEL should not be conceptualised only as initial adoption. In education, the outcomes of interest—practice, skill acquisition, and mastery—depend on sustained participation over an extended period. Thus, a post-adoption lens becomes essential. Post-adoption acceptance refers to students' continued intention to use and repeatedly engage with a platform after initial exposure. This is particularly important for TEL systems that are not strictly mandatory or where meaningful learning benefits depend on voluntary practice beyond minimum requirements.

This paper responds to the post-adoption gap by repositioning gamified TEL acceptance as a continuance problem and developing a research model that extends TAM with satisfaction and gamification fatigue. TAM explains technology usage through perceived usefulness (PU) and perceived ease of use (PEOU). While PU and PEOU remain relevant, continuance in gamified contexts is shaped by experience: satisfaction summarises learners' evaluative judgement of the platform, and gamification fatigue captures motivational degradation under repeated exposure. We define gamification fatigue as a progressive decline in the motivational value of gamified features due to reward habituation, repetitive mechanics, mechanic–goal misalignment, competitive pressure, and interaction overload.

The paper makes three contributions. First, it proposes a post-adoption conceptual model for gamified TEL continuance that integrates TAM beliefs with satisfaction and gamification fatigue. Second, it reports pilot evidence from a university student survey (N=71) showing that perceived gamification and PEOU are strong predictors of continuance-oriented intention, while PU is not significant once these predictors are considered jointly. Third, it provides a publication-ready longitudinal protocol and complete survey instrument (Appendix A) to enable semester-scale testing of novelty decay, fatigue formation, and continuance intention. The resulting guidance supports both theoretical refinement and practical design decision-making for durable gamified learning experiences.

2. Literature Review and Hypothesis Development

2.1 Adoption versus continuance in gamified TEL

Technology acceptance research has traditionally treated intention to use as a proxy for future usage. In educational technology, this approach is often useful for early-stage adoption studies, when the central problem is whether students are willing to try a new tool. In operational TEL environments, however, the more consequential question is whether students will keep returning after initial exposure. Continuance intention emphasises repeated use, habit formation, and persistence over time. From a learning perspective, continuance is central because practice effects and skill development accrue through repeated engagement rather than one-time use.

Several mechanisms distinguish adoption from continuance. First, once students have experienced a system, their subsequent intention is shaped more by experienced quality than by expectation. Second, engagement costs become salient: time, cognitive effort, and emotional responses (e.g., frustration, pressure, or enjoyment) influence willingness to continue. Third, the motivational effect of gamification elements can change over time due to habituation and shifting social context (e.g., cohorts competing on leaderboards).

These considerations suggest that continuing intention in gamified TEL requires a post-adoption model that explicitly includes experience-based constructs and that accommodates time-varying effects.

2.2 TAM beliefs in voluntary learning contexts

TAM explains technology usage through two central beliefs: PU and PEOU. In TEL contexts, PU can be interpreted as perceived contribution to learning outcomes (e.g., deeper understanding, better retention, higher grades, or time-efficient practice). PEOU captures usability, including learnability, interface clarity, and the perceived effort required to complete tasks.

In voluntary learning contexts—where students choose whether to engage beyond minimum requirements—PEOU is especially consequential. Even a useful tool may not be used if navigation is cumbersome, tasks are confusing, or the platform creates unnecessary friction. PU also matters but may become less discriminating when TEL platforms share similar baseline utility; in such conditions, experiential and motivational features become differentiators. Thus, TAM beliefs remain relevant but incomplete for explaining sustained engagement in gamified contexts.

2.3 Novelty, familiarization, and time-varying gamification effects

A persistent methodological challenge in gamification research is the novelty effect: the initial positive response to an intervention that fades as the novelty wears off. Longitudinal evidence indicates that the timing of novelty decay matters. Rodrigues et al. observed that gamification's impact in an ecological educational setting did not begin to decrease until after approximately four weeks, with the downtrend lasting multiple weeks; importantly, they also observed a familiarization effect, where impact began to recover between six and ten weeks without redesigning the gamification system. This implies that studies shorter than a semester may misinterpret the sustainability of gamification and may wrongly conclude that a design "fails" when effects are temporarily suppressed.

For post-adoption modelling, these findings motivate two design and measurement implications. First, continuance intention should be measured at multiple points in time to capture changing trajectories. Second, mechanisms explaining decline and recovery should be modelled explicitly. In this paper, we treat satisfaction and gamification fatigue as key mechanisms: satisfaction captures evaluative response at a timepoint, while fatigue captures cumulative negative adaptation across time.

2.4 Gamification fatigue: definition, antecedents, and consequences

Gamification fatigue is defined here as a progressive reduction in motivational value and willingness to engage that results from repeated exposure to gamification mechanics. Fatigue is conceptually distinct from low initial engagement: a learner may be highly engaged early on but become fatigued later if the design becomes repetitive, pressuring, or misaligned with meaningful learning.

We conceptualise five antecedent pathways. (1) Reward habituation: points and badges lose salience when they become predictable or disconnected from meaningful progress. (2) Competitive pressure: leaderboards and ranking systems can create stress, discourage lower-ranked students, or encourage strategic behaviour that is unrelated to learning. (3) Mechanic–goal misalignment: game elements are perceived as superficial overlays rather than scaffolds, reducing authenticity and undermining intrinsic motivation. (4) Interaction overload: excessive prompts, notifications, and micro-tasks increase cognitive load and produce avoidance. (5) Perceived unfairness: students perceive that the system advantages certain users (e.g., fast typists, prior knowledge) or that the rules are unclear.

Recent empirical work in social gamification contexts demonstrates that competitive and interactive designs can generate stressors (e.g., fear of missing out and reputation maintenance concerns) that are associated with user fatigue. Although the learning domain differs, the underlying mechanism is relevant: social comparison and interaction dynamics can contribute to fatigue and subsequent disengagement. Thus, modelling fatigue provides a theoretical pathway to explain why gamified TEL can simultaneously increase engagement for some learners while discouraging others.

In a post-adoption model, fatigue should reduce satisfaction and weaken continuance intention directly by increasing perceived psychological and time costs. This motivates the inclusion of fatigue as a negative determinant in the proposed model.

2.5 Satisfaction as an experiential driver of continuance

Satisfaction represents a global evaluation of experience after using the platform. In post-adoption research, satisfaction is frequently a proximal determinant of continuance intention because it aggregates multiple experiential dimensions—usability, perceived learning value, enjoyment, fairness, and emotional response—into a single judgement.

In gamified TEL, satisfaction is expected to be shaped by TAM beliefs and by gamification perceptions. If students perceive the platform as easy to use, useful for learning, and supported by meaningful mechanics, satisfaction should increase. Conversely, fatigue is expected to reduce satisfaction. Therefore, satisfaction is posited to mediate the effects of TAM beliefs and gamification perceptions on continuance intention.

2.6 Research Model and Hypotheses

Figure 1 presents the proposed post-adoption model. The full model extends TAM by introducing satisfaction (SAT) as an experiential mediator and gamification fatigue (GF) as a negative determinant of SAT and continuance intention (CI). For the present paper, the available pilot dataset includes PU, PEOU, perceived gamification quality (GAMQ), and continuance-oriented intention items. Thus, we report pilot tests of the baseline relationships and articulate a protocol for the full longitudinal evaluation.

H1: Perceived usefulness (PU) positively predicts satisfaction (SAT).
H2: Perceived ease of use (PEOU) positively predicts satisfaction (SAT).
H3: Perceived gamification quality (GAMQ) positively predicts satisfaction (SAT).
H4: Satisfaction (SAT) positively predicts continuance intention (CI).
H5: Gamification fatigue (GF) negatively predicts satisfaction (SAT).
H6: Gamification fatigue (GF) negatively predicts continuance intention (CI).
H7: Perceived ease of use (PEOU) positively predicts perceived usefulness (PU).

Pilot hypotheses (tested with available data):
P1: PU positively predicts continuance-oriented intention.
P2: PEOU positively predicts continuance-oriented intention.
P3: GAMQ positively predicts continuance-oriented intention.

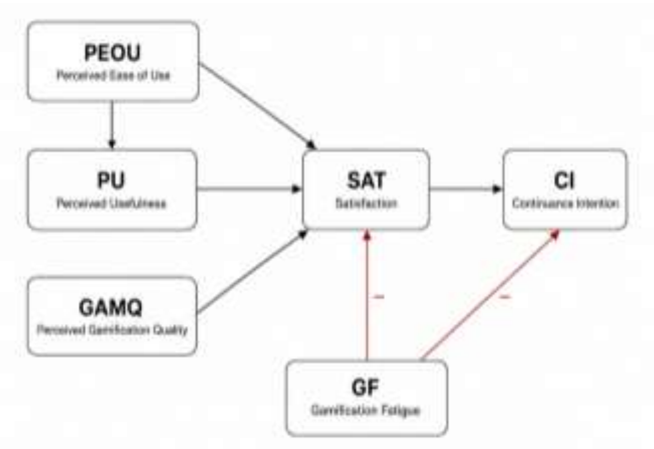

Figure 1. Proposed Post-Adoption Model for Gamified TEL Continuance

3. Methodology

3.1 Research design

This paper uses a two-part design. First, we conduct a pilot analysis of an existing cross-sectional student survey dataset (N=71) to estimate baseline relationships between TAM beliefs, perceived gamification, and continuance-oriented intention items. Second, we propose a publication-ready longitudinal protocol to test the full post-adoption model (Figure 1), including satisfaction and gamification fatigue.

3.2 Pilot participants and context

Participants were university students who reported prior exposure to gamified TEL tools. The dataset includes responses to TAM items (PU, PEOU), gamification items capturing common mechanics, and intention items framed around enjoyment, commitment, and return to use. The pilot data are suitable for examining associations among constructs but do not permit causal inference due to the cross-sectional design.

3.3 Measures

Perceived usefulness (PU) was measured using five items reflecting perceived learning value and productivity. Perceived ease of use (PEOU) was measured using five items reflecting usability and interaction effort. Perceived gamification quality (GAMQ) was measured using six items reflecting perceived motivational value of common mechanics (points, leaderboards, badges, storylines/themes, unlocking content, and timed challenges). Continuance-oriented intention (BIU) was measured using four items reflecting enjoyment, time investment, commitment, and likelihood of return. In the longitudinal extension, satisfaction (SAT) and gamification fatigue (GF) are measured using additional items in Appendix A.

3.4 Data analysis (pilot)

We computed construct composites as item means. Internal consistency was assessed using Cronbach's alpha. Bivariate relationships were evaluated using Pearson correlations. Multiple linear regression was used to estimate the relative contribution of PU, PEOU, and GAMQ to continuance-oriented intention. While SEM/PLS-SEM is common in acceptance studies, regression is appropriate for the pilot given the available construct composites and provides an interpretable baseline.

3.5 Longitudinal protocol for testing novelty and fatigue

To test post-adoption dynamics, a two-wave design is recommended across a teaching period (e.g., 12-week semester). Wave 1 should be administered shortly after onboarding (Week 2–3) to capture initial perceptions of PU, PEOU, GAMQ, and early satisfaction. Wave 2 should be administered after sustained exposure (Week 8–10) to capture fatigue and continuance intention. To capture novelty and recovery patterns, a three-wave design is ideal (e.g., Week 2, Week 6, Week 10), enabling the identification of mid-semester decline and later familiarization effects. Researchers should consider measurement invariance across waves, control for mandatory usage (assessment requirements), and collect platform telemetry (logins, voluntary practice attempts, completion rates) to triangulate self-reports and mitigate common-method bias.

3.6 Ethical considerations

Data should be collected with informed consent, anonymity, and clear disclosure that participation does not affect grades. Because competitive and social mechanics may create pressure for some learners, the longitudinal study should include a debrief statement and provide opt-out or privacy options where possible (e.g., hiding leaderboards).

4. Results (Pilot Study)

4.1 Descriptive Statistics

Table 1 reports construct-level descriptive statistics for the pilot dataset (N=71).

Table 1. Construct-level Descriptive Statistics (Pilot Dataset).

Construct	N	Mean	Std. Deviation
Perceived Usefulness (PU_Avg)	71	2.31	0.48
Perceived Ease of Use (PEOU_Avg)	71	3.27	0.57
Gamification (Gam_Avg)	71	3.13	0.64
Behavioral Intention to utilise (BIU_Avg)	71	3.15	0.67

4.2 Reliability

All constructs demonstrated acceptable internal consistency: PU (α=.858), PEOU (α=.745), GAMQ (α=.823), and BIU (α=.783).

4.3 Correlation Analysis

Table 2 presents Pearson correlations among the pilot constructs. All correlations were positive and significant at the 0.01 level.

Table 2. Pearson Correlation Matrix (** p<.01).

Construct	1. PU_Avg	2. PEOU_Avg	3. Gam_Avg	4. BIU_Avg
1. PU_Avg	1			
2. PEOU_Avg	.650**	1		
3. Gam_Avg	.691**	.665**	1	
4. BIU_Avg	.679**	.696**	.795**	1

4.4 Multiple Regression Predicting Continuance-Oriented Intention

A multiple regression model predicting continuance-oriented intention from PU, PEOU, and GAMQ was statistically significant ($R=.833$, $R^2=.693$, Adjusted $R^2=.680$, $F=50.525$, $p<.001$). GAMQ ($\beta=.521$, $p<.001$) and PEOU ($\beta=.247$, $p=.013$) were significant predictors, while PU was not significant when controlling for the other predictors ($\beta=.159$, $p=.116$). Table 3 presents the regression coefficients.

Table 3. Regression Coefficients Predicting Continuance-Oriented Intention (Pilot Dataset).

Model	Unstandardized B	Std. Beta (β)	t	Sig. (p-value)
(Constant)	-.050		-.179	.859
PU_Avg	.223	.159	1.590	.116
PEOU_Avg	.294	.247	2.547	.013
Gam_Avg	.550	.521	5.119	.000

4.5 Interpretation of pilot findings in a post-adoption frame

Two implications follow from the pilot evidence. First, the strong role of GAMQ indicates that perceived motivational value of mechanics is central to whether students intend to continue using gamified TEL. Second, PEOU remains critical, supporting the view that usability is a prerequisite for voluntary practice. The non-significance of PU in the multivariate model suggests that perceived learning utility may be less discriminating once motivational and usability factors are accounted for, particularly in contexts where baseline TEL utility is assumed or where students evaluate engagement primarily through experience.

5. Discussion

The post-adoption perspective clarifies why many gamification interventions show early success yet struggle to sustain momentum. The pilot model suggests that students' intention to return is strongly tied to perceived gamification value and ease of use—variables that directly shape the immediate experience. If mechanics are engaging and the interface is frictionless, students are more likely to continue. However, the literature on novelty and fatigue indicates that these perceptions may change across time.

In particular, the novelty–familiarization pattern reported in longitudinal research implies that engagement trajectories can be non-linear. A mid-semester decline does not necessarily mean the intervention has failed; it may represent the transition from novelty to stable integration into study routines. Nevertheless, fatigue remains a risk, especially when mechanics are repetitive or when social comparison features generate pressure. The recent evidence that competition and interactivity can produce stressors associated with user fatigue suggests that some gamification designs carry hidden costs, and those costs are likely to be unevenly distributed across learners.

The proposed model integrates these insights by positioning satisfaction as the proximal driver of continuance and fatigue as a cumulative negative influence. Satisfaction is expected to mediate the influence of PU, PEOU, and GAMQ, while fatigue explains why motivational value may erode over time. This approach also resolves a common ambiguity in TAM-style studies: if PU becomes non-significant when other variables are included, the issue may not be that utility is irrelevant, but that post-adoption behaviour is dominated by experiential evaluations and motivational dynamics rather than abstract performance beliefs.

From a methodological standpoint, the paper argues that cross-sectional studies may over-estimate the benefit of gamification if conducted in the novelty window, or under-estimate it if conducted during the decline phase. A semester-scale longitudinal design is therefore not a luxury but a requirement for valid conclusions about sustainability. Researchers should also consider combining self-report measures with behavioural telemetry to distinguish intention from actual usage patterns and to mitigate common-method bias.

6. Practical and Theoretical Implications

6.1 Practical implications for TEL and learning design

Designing for continuance requires attention to the temporal life cycle of engagement. First, mechanics should evolve across the semester. Instead of repeating identical point-earning tasks, systems can introduce staged goals, mastery-aligned badges, and varied challenge formats that map to curriculum progression. Second, competitive features should be carefully governed. Leaderboards can motivate some learners but may create discouragement and fatigue for others; providing opt-out, anonymised rankings, or cooperative goals can reduce social pressure while preserving motivation. Third, designers should minimise interaction overhead. Excessive notifications, micro-tasks, and complex navigation increase cognitive load and can accelerate fatigue. Clear task flows, consistent interface patterns, and minimal clicks are essential.

6.2 Equity and student wellbeing

A continuance lens highlights equity concerns that are often invisible in adoption studies. Gamification that rewards speed, constant participation, or public ranking may systematically disadvantage students with work commitments, caregiving responsibilities, disability accommodations, or anxiety about public comparison. Thus, sustainable gamified TEL should support autonomy and privacy while providing multiple pathways to progress (e.g., completing fewer high-quality tasks rather than many low-value clicks). Where social mechanics are used, instructors should establish norms that emphasise learning progress rather than competition.

6.3 Theoretical implications

The paper advances gamification-acceptance research by shifting the dependent variable toward continuance and by introducing gamification fatigue as an explanatory construct. This complements TAM's instrumental beliefs by adding a mechanism for motivational degradation over time. It also aligns acceptance research with how learning outcomes accumulate: sustained engagement is more predictive of mastery than initial intention. Finally, the model invites future work on moderation (e.g., player type, digital literacy, assessment regime) and mediation (e.g., satisfaction as a mediator of TAM beliefs) using SEM/PLS-SEM in a longitudinal setting.

7. Limitations and Future Research

The pilot analysis relies on a cross-sectional dataset (N=71) and uses self-reported measures. Therefore, the statistical results should be interpreted as associative evidence rather than causal effects. The dataset does not include direct measures of satisfaction and gamification fatigue; thus, the full post-adoption model is proposed and operationalised but not fully tested in the pilot.

Future research should implement the longitudinal protocol outlined in Section 3.5. In addition to multi-wave surveying, researchers should capture system telemetry (logins, voluntary practice, completion) and record contextual variables such as assessment deadlines, mandatory usage requirements, and instructor prompts. For analysis, PLS-SEM or covariance-based SEM can test mediation (e.g., SAT mediating PU/PEOU/GAMQ effects) and estimate fatigue pathways. Measurement invariance should be assessed across waves to ensure construct comparability.

A further priority is to examine boundary conditions and sub-group differences. Fatigue may form more rapidly in systems dominated by competitive ranking and social comparison, and it may vary by learner profile. Multi-group analysis can test whether the model differs across age cohorts, digital literacy levels, course type (compulsory vs elective), and player-type preferences. Finally, experimental studies can compare fatigue trajectories between alternative gamification designs (competitive vs cooperative; static vs adaptive mechanics) to establish causal design guidance.

8. Conclusion

This paper advances gamified TEL research by reframing acceptance as a post-adoption continuance phenomenon. Pilot evidence indicates that perceived gamification quality and ease of use are strong predictors of continuance-oriented intention, whereas perceived usefulness may contribute less once motivational and usability factors are considered jointly. To explain sustainability, the paper proposes a post-adoption model that integrates satisfaction and gamification fatigue, supported by recent longitudinal and fatigue-focused evidence indicating that gamification effects change over time and that some social designs can contribute to user fatigue.

By providing a longitudinal protocol and full measurement instrument, the study offers a practical pathway for future semester-scale evaluation and supports more credible conclusions about durable impact. For practice, the key message is that sustainable gamified TEL requires evolving mechanics, careful governance of social comparison, and low-friction usability—designed with equity and wellbeing in mind.

References

Aydınlıyurt, E. T., Taşkın, N., Scahill, S., & Toker, A. (2021). Continuance intention in gamified mobile applications: A study of behavioral inhibition and activation systems. International Journal of Information Management, 61, 102414. https://doi.org/10.1016/j.ijinfomgt.2021.102414

Kalana, M. H. A., & Junaini, S. N. (2025). Gamification and technology acceptance model: A systematic review and future research directions. Journal of Education and Learning (EduLearn), 19(3), 1606–1614. https://doi.org/10.11591/edulearn.v19i3.22154

Klock, A. C. T., Gasparini, I., Pimenta, M. S., & Hamari, J. (2020). Tailored gamification: A review of literature. International Journal of Human-Computer Studies, 144, 102495. https://doi.org/10.1016/j.ijhcs.2020.102495

Queiro-Ameijeiras, C. M., Seguí-Mas, E., & Martí-Parreño, J. (2025). Determinants of gamification acceptance in Higher Education: An empirical model. RIED-Revista Iberoamericana de Educación a Distancia, 28(1), 127–155. https://doi.org/10.5944/ried.28.1.41565

Rodrigues, L., Pereira, F. D., Toda, A. M., Palomino, P. T., & Isotani, S. (2022). Gamification suffers from the novelty effect but benefits from the familiarization effect: Findings from a longitudinal study. International Journal of Educational Technology in Higher Education, 19, 13. https://doi.org/10.1186/s41239-021-00314-6

Sanchez, D. R., Langer, M., & Kaur, R. (2020). Gamification in the classroom: Examining the impact of gamified quizzes on student learning. Computers & Education, 144, 103666. https://doi.org/10.1016/j.compedu.2019.103666

Vanduhe, V. Z., Nat, M., & Hasan, H. F. (2020). Continuance intentions to use gamification for training in higher education: Integrating the Technology Acceptance Model (TAM), social motivation, and task-technology fit (TTF). IEEE Access, 8, 21473–21484. https://doi.org/10.1109/ACCESS.2020.2966179

Yang, H., Wang, L., Hu, Z., & Li, D. (2024). Understanding the failing of social gamification: A perspective of user fatigue. Electronic Commerce Research and Applications, 64, 101369. https://doi.org/10.1016/j.elerap.2024.101369

Appendix A: Survey Instrument (for Longitudinal Study)

All items are measured on a 5-point Likert scale (1=Strongly Disagree … 5=Strongly Agree). Items PU/PEOU/GAMQ/BIU align with the pilot instrument; SAT and GF are added for the post-adoption model. Researchers may adapt wording to the specific TEL platform, ensuring consistent meaning across waves.

Construct	Item code	Item wording
Perceived Usefulness (PU)	PU1	Using the gamified TEL platform helps me accomplish learning tasks more quickly.
Perceived Usefulness (PU)	PU2	Using the gamified TEL platform improves the quality of my learning.
Perceived Usefulness (PU)	PU3	The gamified TEL platform is useful for my academic studies.
Perceived Usefulness (PU)	PU4	The gamified TEL platform improves my retention of course concepts.
Perceived Usefulness (PU)	PU5	The gamified TEL platform increases my productivity in learning.
Perceived Ease of Use (PEOU)	PEOU1	It is easy for me to learn how to use the gamified TEL platform.
Perceived Ease of Use (PEOU)	PEOU2	The gamified TEL platform is user-friendly.
Perceived Ease of Use (PEOU)	PEOU3	Navigating the gamified TEL platform requires little effort.
Perceived Ease of Use (PEOU)	PEOU4	I feel confident using the gamified TEL platform without support.
Perceived Ease of Use (PEOU)	PEOU5	Using the gamified TEL platform requires less effort than traditional alternatives.
Perceived Gamification Quality (GAMQ)	GAM1	Points encourage me to complete learning tasks.
Perceived Gamification Quality (GAMQ)	GAM2	Leaderboards motivate me to improve my performance.
Perceived Gamification Quality (GAMQ)	GAM3	Badges increase my engagement in learning activities.

Perceived Gamification Quality (GAMQ)	GAM4	Storylines or themes make the learning experience more interesting.
Perceived Gamification Quality (GAMQ)	GAM5	Unlocking content based on progress motivates me to continue.
Perceived Gamification Quality (GAMQ)	GAM6	Timed challenges help me focus and stay engaged.
Satisfaction (SAT)	SAT1	Overall, I am satisfied with my experience using the gamified TEL platform.
Satisfaction (SAT)	SAT2	The gamified TEL platform meets my expectations for supporting learning.
Satisfaction (SAT)	SAT3	I am pleased with how the gamified features support my progress.
Satisfaction (SAT)	SAT4	If I had to decide again, I would choose to use this gamified TEL platform.
Gamification Fatigue (GF)	GF1	Over time, the gamified features feel repetitive.
Gamification Fatigue (GF)	GF2	I feel less motivated by points/badges now than when I first used the platform.
Gamification Fatigue (GF)	GF3	Competitive features (e.g., rankings) sometimes make me want to disengage.
Gamification Fatigue (GF)	GF4	I would prefer fewer gamified prompts or rewards during learning.
Continuance Intention (CI)	CI1	I intend to keep using the gamified TEL platform throughout the semester.
Continuance Intention (CI)	CI2	I am likely to return to the gamified TEL platform for future study sessions.
Continuance Intention (CI)	CI3	I will recommend the gamified TEL platform to classmates for ongoing study.
Continuance Intention (CI)	CI4	Even without assessment pressure, I would continue using the gamified TEL platform.

Appendix B: Implementation Notes for Practitioners (Supplementary)

This supplementary appendix provides implementation notes to assist educators and platform teams in operationalising the continuance-oriented model. First, establish a baseline: before adding gamification, measure current engagement trajectories (weekly logins, practice attempts, completion rates) to understand natural decay patterns. Second, design for progression: map mechanics to curriculum milestones (e.g., week-by-week mastery) and introduce new goals periodically to reduce habituation. Third, reduce social pressure: if leaderboards are used, consider anonymous rankings, team-based cooperative leaderboards, or self-comparison dashboards (personal best) to reduce harmful comparison. Fourth, support autonomy: allows learners to choose among challenge types or to hide gamified elements. Autonomy can reduce fatigue by preventing feelings of coercion. Fifth, audit fairness: check whether scoring rules advantage certain learners (e.g., those with more free time). Provide alternative ways to earn progress that value quality over quantity. Finally, integrate reflection: pair gamified activity with reflective prompts that help learners connect achievements to learning outcomes; this strengthens perceived usefulness and mitigates perceptions of superficiality. These practices align with the model’s mechanisms: they increase satisfaction, reduce fatigue pathways, and thereby support continuance intention.

Appendix C: Longitudinal Data-Collection and Analysis Checklist (Supplementary)

To support rigorous publication outcomes, the following checklist operationalises the longitudinal protocol proposed in Section 3.5. First, define the unit of analysis (individual student) and specify the platform context (LMS plugin, quiz system, practice portal, or virtual lab). Second, document the gamification configuration in reproducible terms: mechanics enabled, reward rules, visibility of social comparison, progression logic, and reset conditions. Third, specify timepoints using pedagogically meaningful anchors rather than calendar dates—for example, Wave 1 after onboarding and first graded activity, Wave 2 after mid-semester assessment, and Wave 3 near the final assessment period. Fourth, pre-register key hypotheses and outcomes to avoid hindsight bias when interpreting time-varying effects.

For measurement quality, apply item-level screening at each wave, assess internal consistency, and evaluate measurement invariance (configural and metric) so that changes across waves can be interpreted as real changes rather than instrument drift. For structural analysis, estimate the post-adoption model using SEM/PLS-SEM, including mediation paths through satisfaction and direct paths from fatigue to continuance intention. Where telemetry is available, model continuance using both self-report intention and behavioural outcomes (e.g., voluntary practice counts, average weekly sessions, and proportion of optional tasks completed). When interpreting novelty and familiarization, examine trajectories by plotting wave-level means and by estimating latent growth or cross-lagged paths to differentiate temporary dips from sustained decline.

Finally, report contextual controls that frequently confound education data: assessment deadlines, instructor reminders, mandatory participation requirements, and cohort composition. These controls strengthen the credibility of claims about fatigue and novelty by clarifying whether engagement changes are attributable to gamification dynamics or to external academic pressures.

Appendix D: Threats to Validity and Mitigation Strategies (Supplementary)

Internal validity threats are primarily temporal and contextual. Engagement can change because of assessment schedules, instructor interventions, or cohort effects rather than gamification. Mitigation includes multi-wave design, explicit recording of contextual events, and triangulation with telemetry. Construct validity threats include conflating ‘fatigue’ with ‘low motivation’ or ‘time scarcity.’ The proposed fatigue items focus on change over time, repetitiveness, and pressure, which helps distinguish fatigue from stable low interest. Common-method bias remains a concern when all constructs are surveyed at the same time; mitigation includes separating measurement of predictors and outcomes across waves and incorporating behavioural logs.

External validity threats include domain specificity and sampling limitations. Gamification fatigue may form differently in compulsory versus elective courses, in high-stakes contexts, and across cultures. Mitigation includes replicating across multiple courses and reporting cohort characteristics. Statistical conclusion validity threats include multicollinearity among TAM constructs and gamification perceptions; mitigation includes reporting VIF, using SEM with latent variables, and testing alternative model specifications. Overall, transparent reporting of study context and time-varying forces is essential for credible claims about sustainability in gamified TEL.

Appendix E: Example Reporting Template for AJBSS Submissions (Supplementary)

To facilitate transparent reporting, authors can adopt a consistent structure aligned with AJBSS expectations. In the Methodology section, report (i) platform and course context; (ii) gamification configuration (mechanics, rules, visibility); (iii) sampling frame and response rates by wave; (iv) ethical approval and consent; and (v) analysis plan and software. In Results, separate measurement results (item loadings if SEM, reliability, convergent and discriminant validity) from structural results (path coefficients, confidence intervals, R^2, effect sizes). For longitudinal studies, include wave-level descriptives and plots showing engagement trajectories and fatigue trajectories, and report any contextual events (assessment deadlines) alongside those plots.

In Discussion, explicitly distinguish what the data support (e.g., association, mediation patterns, time-varying change) from what remains interpretive (e.g., psychological mechanism). When claiming novelty or fatigue effects, report the timing of observed changes and justify why alternative explanations are less plausible. In Implications, link design recommendations to model mechanisms: recommendations that reduce repetitiveness map to fatigue mitigation, and recommendations that reduce clicks and confusion map to PEOU and satisfaction. In Limitations, disclose missing telemetry, sampling constraints, and potential biases; then propose specific corrective designs (three-wave, multi-course replication, experimental redesign comparisons). This reporting discipline increases reviewer confidence in the credibility of post-adoption claims.