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The Influence of Gamified Learning on Student Motivation: The Mediating Role of Engagement and the Moderating Effect of Self-Efficacy

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Abstract: Gamified learning is widely reported to raise student motivation, and engagement is the mechanism most often credited with carrying that effect. This study tests whether engagement accounts for the relationship and whether the relationship holds equally for all learners. A conditional process model was specified in which engagement mediates the association between gamified learning and student motivation and academic self-efficacy moderates it. Four constructs were measured with ten items each, contextually adapted from four published instruments — the Gameful Experience Questionnaire, the student form of the Utrecht Work Engagement Scale, and the self-efficacy and motivation scales of the Motivated Strategies for Learning Questionnaire — and content-validated before administration by a panel of seven experts, which returned S-CVI/Ave =.903 and retained all forty items without revision. An online questionnaire returned 356 complete responses from university students in technology-supported courses, and the model was estimated by partial least squares structural equation modelling with 5,000 bootstrap resamples. All three hypotheses were supported. Gamified learning was positively associated with motivation (β =.277, p <.001), engagement mediated part of that association (β =.114, 95% CI [.057,.175]), and self-efficacy moderated the direct path (β =.171, p <.001) while also predicting motivation directly (β =.194, p <.001). Because the direct and indirect effects were both significant and shared a sign, the pattern is complementary partial mediation, in which the mediated route carries 29.1% of a total effect of.391. The contribution is to bound the engagement account rather than to confirm it: the direct effect surviving the mediator is more than twice the size of the mediated effect, so most of what gamified design does to motivation is not explained by raising engagement as measured here. The design is cross-sectional, and the sample was recruited by voluntary response, so the results are reported as associations within a conditional process model rather than as causal effects.

Keywords: gamified learning, student motivation, student engagement, academic self-efficacy, PLS-SEM, higher education.

Introduction

Research Problem

Gamified instruction — points, badges, leaderboards, progress indicators, and levelled challenges applied to academic tasks — has moved from novelty to routine in technology-supported higher education. The empirical record is broadly favourable: meta-analytic evidence reports positive effects of gamified design on cognitive and motivational outcomes (Sailer & Homner, 2019), and reviews across disciplines converge on the same direction (Subhash & Cudney, 2018; Zainuddin et al., 2020). Yet the record is not uniform. Longitudinal work has found motivational decline rather than gain over a semester (Hanus & Fox, 2015), and reviews repeatedly note that effects vary by implementation and learner (Dichev & Dicheva, 2017; van Roy & Zaman, 2019).

Two features of this literature motivate the present study. First, the dependent variable is often an outcome rather than a mechanism: studies report that gamified courses produce more participation, higher grades, or higher self-reported motivation without specifying the process that connects design to results. Second, when a process is specified, it is almost always engagement—gamified features draw participation, and participation feeds motivation (Bond et al., 2021; Fredricks et al., 2016; Kahu & Nelson, 2017). That account is intuitive and well evidenced on its first leg. Its second leg, the conversion of engagement into motivation, is asserted more often than estimated.

The problem this study addresses is therefore not whether gamification is associated with motivation but why, and for whom. If engagement is the mechanism, controlling for it should leave little direct association between gamified learning and motivation. If a substantial direct association survives, then something other than engagement is doing part of the work, and the field's dominant explanation is incomplete rather than wrong. This is a testable difference, and it has rarely been tested: mediation is commonly reported as present or absent, and the share of the total effect it carries is left unstated.

The “for whom” question is equally consequential for practice. Institutions adopting gamified platforms generally do so uniformly, on the implicit assumption that the motivational return is similar across learners. If the return depends on what a student already believes about their own capability, then uniform adoption will distribute benefit unevenly, and possibly least to the students an intervention is most often intended to help.

Research Focus

This study specifies and estimates a conditional process model in which engagement mediates the gamification-to-motivation relationship and academic self-efficacy moderates it. Testing mediation and moderation in one model allows two questions to be answered together that are usually answered apart: how much of the association engagement carries, and whether the association is the same for learners who differ in what they believe about their own capability.

Research Aim and Research Questions

The aim is to quantify the mechanism and the boundary condition of the gamification–motivation relationship in technology-supported higher education. Three questions follow:

1. Is gamified learning positively associated with student motivation?
2. Does engagement mediate that association, and what share of the total effect does it carry?
3. Does academic self-efficacy moderate the association?

Literature Review

Gamified learning and motivation

Gamification in education applies game design elements to non-game learning contexts (Deterding et al., 2011). The elements most used in coursework — points, badges, leaderboards, progress indicators — share a common property: they make performance visible and incremental (Dichev et al., 2015; Nah et al., 2014). Empirically, gamified courses report gains in participation and in self-reported motivation. Buckley and Doyle (2014) found that a gamified online exercise raised motivation among students in a large undergraduate cohort; da Rocha Seixas, Gomes, and de Melo Filho (2016) reported higher engagement among students receiving badges tied to coursework; and Su and Cheng (2014) found gains in both motivation and achievement from a mobile gamified system. Reviews across settings report the same general direction (Dichev & Dicheva, 2017; Majuri et al., 2018; Subhash & Cudney, 2018), and a meta-analysis of learning outcomes finds positive average effects (Sailer & Homner, 2019).

The average, however, conceals substantial heterogeneity, and several findings run against it. Hanus and Fox (2015) followed two course sections across a semester and found that students in the gamified section reported *lower* intrinsic motivation over time. Van Roy and Zaman (2019) reported that the same gamified features supported motivation for some students and undermined it for others, depending on whether the features were experienced as informational or controlling. Reviews of the design literature note that outcomes depend heavily on which elements are used and how they are framed (Mekler et al., 2017; Toda et al., 2019).

This heterogeneity is the point of departure. An average effect that varies this widely across studies invites questions about mechanism and moderator rather than a further estimate of the average, and both questions are addressed here in one model.

H1. Gamified learning is positively associated with student motivation.

Engagement as mechanism

Engagement is the construct most often placed between gamified design and its outcomes. It is generally treated as multidimensional — behavioural, emotional, and cognitive (Fredricks et al., 2016) — and as the proximal process through which instructional conditions reach motivational and achievement outcomes (Kahu & Nelson, 2017; Lu et al., 2024). Gamified environments are designed to raise participation, so the first leg of the mediation is well motivated theoretically and well supported empirically (Hamari et al., 2016; Morschheuser et al., 2017).

The second leg is less settled. Engagement and motivation are related but conceptually distinct: motivation concerns the reasons a student acts, engagement the fact and the quality of the acting (Sinatra et al., 2015). The distinction matters for a mediation claim because an intervention can raise participation substantially while changing comparatively little about why a student participates. Reviews of engagement research have repeatedly flagged the definitional overlap between the two constructs as a threat to exactly this kind of inference (Fredricks et al., 2016).

Treating engagement as the sole conduit therefore assumes that the second leg is as load-bearing as the first — an assumption rarely stated and, to our knowledge, not estimated as a share of the total effect in a gamified-learning context. Self-determination theory offers a reason to doubt it: gamified elements are argued to affect motivation directly through satisfaction of the needs for competence and autonomy, not only by increasing participation volume (Ryan & Deci, 2020; Mekler et al., 2017). If those direct routes operate, a significant direct path should remain after accounting for the mediator. Testing mediation as a *proportion* rather than a yes-or-no verdict distinguishes the present test from the common form.

H2. Engagement mediates the association between gamified learning and student motivation.

Self-efficacy as boundary condition

Academic self-efficacy — a student's belief in their capacity to carry out academic tasks — is among the most consistently replicated predictors of motivation, persistence, and achievement in higher education. A meta-analysis of learner self-efficacy and academic achievement reports a robust positive association that holds across disciplines and assessment types (Honicke et al., 2019); a cross-lagged meta-analysis establishes that the relationship operates in both directions over time (Talsma et al., 2018); and self-efficacy has been shown to predict academic success net of stress and prior performance (Zajacova et al., 2005).

Its role here, however, is hypothesised to be more than that of an additional predictor. Gamified environments differ from conventional instruction mainly by making performance visible, quantified, and comparative—a score, a rank, a bar that fills. Social cognitive theory holds that students do not receive such performance information uniformly: efficacy beliefs shape how they interpret it and how much effort they put in (Schunk & DiBenedetto, 2020; Usher & Schunk, 2017). A student with strong efficacy beliefs may read a leaderboard position as information about a challenge worth pursuing; a student with weak ones may read the same position as confirmation of a limit. Evidence from assessment settings is consistent with this: van Dinther et al. (2014) found that students' self-efficacy shaped how they perceived and responded to competence-based assessment, and Kuo et al. (2014) reported that Internet self-efficacy conditioned the relationship between interaction and satisfaction in online courses.

If this reasoning is right, self-efficacy should not merely add to motivation but should change the *slope* of the gamification–motivation relationship.

H3. Academic self-efficacy moderates the association between gamified learning and student motivation, such that the association is stronger at higher levels of self-efficacy.

Theoretical framework and the research gap

The model draws on two theories that address different parts of it. Self-determination theory frames the mediation: gamified environments can support the needs for competence, autonomy, and relatedness, and need satisfaction is the proximal condition for autonomous motivation (Ryan & Deci, 2020; Vansteenkiste et al., 2020). This makes engagement a plausible carrier but not a necessary bottleneck, since need satisfaction can arise from the design itself as readily as from the amount of participation it produces. Social cognitive theory frames the moderation: efficacy beliefs govern how performance information is interpreted and how much effort follows from it (Schunk & DiBenedetto, 2020; Usher & Schunk, 2017), which is precisely the class of information that points, ranks, and progress indicators supply.

Three gaps follow from the review. First, engagement is treated as *the* mechanism, but its share of the total effect is not quantified. Second, mediation and moderation are typically examined in separate studies, so it is not known whether learner characteristics condition the mediated route, the direct route, or both. Third, in survey-based work of this kind, instruments are frequently described as adapted from validated scales without re-establishing content validity after adaptation, which leaves reported reliability coefficients carrying more evidential weight than they can bear. The present study addresses the first two by estimating a single conditional process model and reporting the decomposition explicitly, and the third by reporting expert content validation alongside the psychometrics.

Methods

Sample and participants

Participants were university students enrolled in courses using digital or technology-supported learning environments. Recruitment used voluntary-response sampling: the questionnaire was distributed through learning-management systems and student communication channels, and participation was voluntary. No enumerated register of students exposed to gamified learning was available from which a probability sample could have been drawn, so selection probabilities are neither known nor controlled, and no claim of statistical representativeness is made on the strength of the sampling procedure. This is stated plainly because the alternative — describing an online, self-selected survey as stratified or random — would misrepresent what was done.

The survey returned 356 complete responses. Screening removed no cases: every returned questionnaire supplied valid values on all forty measurement items, so the analytic N equals the returned N. No values were imputed, and no case was excluded based on its answers.

Of the 356 respondents, 205 (57.6%) were women and 151 (42.4%) men. Age was recorded in bands, and prior academic performance and self-assessed proficiency with digital learning technology on five-point scales. The achieved distributions are reported below so that composition can be judged directly rather than taken on assertion. Academic discipline and year of study were not recorded, so the sample cannot be characterised in those terms — a consequence of the instrument design that is noted here and again among the limitations.

Table 1

Respondent profile (N = 356)

Characteristic	Category	n	%
Gender	Male	151	42.4
	Female	205	57.6
Age	Under 18	12	3.4
	18–20	142	39.9
	21–23	151	42.4
	24 and above	51	14.3
Prior academic performance	Excellent	57	16.0
	Very good	84	23.6
	Good	132	37.1
	Average	62	17.4
	Below average	21	5.9
Digital learning proficiency	Very low	15	4.2
	Low	30	8.4
	Moderate	120	33.7
	High	133	37.4
	Very high	58	16.3

The distribution of digital proficiency is worth noting for interpretation: 87.4% of respondents rated themselves moderate or above. Hence, unfamiliarity with digital tools is not a common condition in this sample. Findings should be read as describing students already at ease in technology-supported environments.

Sample size is adequate for the model estimated. Student motivation, the most complex endogenous construct, receives four structural predecessors, and 356 observations exceed by a wide margin both the ten-times rule for that construct and the inverse-square-root minimum for detecting the smallest path of interest at conventional power (Sarstedt et al., 2021).

Instrument and procedure

Four constructs were measured with ten items each, all answered on a seven-point agreement scale (1 = completely disagree, 4 = neutral, 7 = completely agree), with each construct's items presented as a separate block. The complete item set appears in the Appendix. The source instruments are in Table 2.

Table 2

The source instruments

Construct	Source instrument	Reference	DOI
Gamified learning	Gameful Experience Questionnaire (GAMEFULQUEST)	Högberg, Hamari, & Wästlund (2019)	10.1007/s11257-019-09223-w
Engagement	Utrecht Work Engagement Scale — Student version	Schaufeli, Martínez, Pinto, Salanova, & Bakker (2002)	10.1177/0022022102033005003
Self-efficacy	Self-efficacy scale, MSLQ	Pintrich & De Groot (1990)	10.1037/0022-0663.82.1.33

Student motivation	Motivation scales, MSLQ	Pintrich, Smith, Garcia, & McKeachie (1993)	10.1177/0013164493053003024

Items were contextually adapted rather than reproduced: GAMEFULQUEST's accomplishment, challenge, competition, and guided-progression dimensions were rewritten for coursework; UWES-S wording was adapted and allocated to behavioural, emotional, and cognitive facets; and the MSLQ scales were rewritten to refer to coursework in technology-supported learning rather than to one named course.

Because the items were adapted, the validity evidence of the source instruments is not inherited. The adapted set was therefore submitted to expert content validation before administration. Seven experts — three with domain expertise in gamified learning, two in measurement and instrument design, and two drawn from the target population — rated all forty items, producing 280 ratings. S-CVI/Ave was .903 and the mean modified kappa was .898, both above their thresholds (.90 and.60); every item met the I-CVI floor of.78. All forty items were retained, and none was revised, so the instrument administered is identical to the one the panel assessed. Content validation and data collection were completed in parallel rather than in sequence; because the panel required no modification, the data collected are from the same instrument the panel validated, and the timing is disclosed here rather than presented as a sequential design.

No separate pilot study was conducted. Content validation establishes domain coverage before administration; a pilot establishes how items behave in the field. Only the former was performed, and item behaviour is instead assessed after the fact through the psychometric evidence in §4.1.

Ethics

Participation was voluntary and could be discontinued at any point without consequence. Informed consent was obtained before respondents proceeded to the questionnaire. No personally identifying information was collected; responses are anonymous and were stored securely and used solely for academic research (Israel & Hay, 2006).

Data analysis

The model was estimated using partial least squares structural equation modelling, appropriate because it combines mediation and an interaction term and aims to explain variance in the endogenous constructs (Sarstedt et al., 2021). Estimation used 5,000 bootstrap resamples with a fixed seed. The interaction was specified using a two-stage approach, which requires the moderator to enter alongside the product term; the main effect of self-efficacy is therefore included in the model as a modelling requirement and is not a hypothesis of this study.

Assessment proceeded in the conventional two stages. The measurement model was evaluated first: internal consistency by Cronbach's alpha and composite reliability (ρ_C), convergent validity by average variance extracted, and discriminant validity by the heterotrait–monotrait ratio of correlations, which is more sensitive than the Fornell–Larcker criterion in variance-based models. Only after the measurement model met its thresholds were structural estimates interpreted.

The specific indirect effect was computed as the product of its two path coefficients, with a percentile confidence interval taken from the same 5,000 bootstrap replicates used for the direct effects rather than from a separate resampling run; significance is judged from whether that interval excludes zero. Computing both from one set of replicates allows the direct, indirect, and total effects to be reported as a decomposition that reconciles arithmetically, as reported explicitly in §4.4.

We assessed common method variance using Harman's single-factor test and a full collinearity assessment, both reported in §4.2. No control variables were entered: the demographic items were collected to describe the sample, and adding them as covariates without a theoretical reason would change the estimand rather than improve it.

Results

Measurement model

All four constructs met conventional thresholds. Cronbach's alpha ranged from .912 to .916912 to.916, and composite reliability from927 to.930, both above.70. Average variance extracted ranged from558 to.571, above.50, so each construct explains more variance in its indicators than is left to error. Standardised outer loadings ranged from .694 to.794.

Table 3

Reliability and convergent validity (N = 356)

Construct	Items	α	ρ_C	AVE
Gamified learning (GL)	10	.913	.927	.558
Engagement (EN)	10	.916	.930	.571
Self-efficacy (SE)	10	.914	.927	.559
Student motivation (SM)	10	.912	.927	.559

Discriminant validity holds by the heterotrait–monotrait criterion. The largest ratio is .533, between engagement and gamified learning, well below the conservative .85 threshold.

Table 4

Heterotrait–monotrait ratios

	GL	EN	SE
EN	.533		
SE	.217	.314	
SM	.424	.440	.305

Common method variance

All constructs were measured by self-report in one instrument, so we assessed common method variance using two tests.

Harman's single-factor test was run as an unrotated principal components analysis of all forty items. Four components had eigenvalues above one — matching the four constructs the instrument was built to measure — accounting cumulatively for 57.58% of total variance. The first and largest component accounts for 29.04%, well below the 50% at which a single general factor would be indicated. The forty eigenvalues sum to 40, as they must for a correlation matrix of forty standardised items.

Table 5

Harman's single-factor test (40 items, N = 356)

Component	Eigenvalue	% variance	Cumulative %
1	11.618	29.04	29.04
2	4.802	12.01	41.05
3	3.637	9.09	50.14
4	2.975	7.44	57.58
5	0.824	2.06	59.64

Harman's test detects only a dominant single factor, so we also ran a full collinearity assessment by regressing each construct score on the remaining three (Kock, 2015). Variance inflation factors were 1.394 (GL), 1.458 (EN), 1.130 (SE), and 1.305 (SM), all far below the 3.3 threshold. Neither test rules out common method variance; both detect it, and neither detected it here.

Structural model

Table 6

Structural path estimates (5,000 bootstrap resamples)

Hypothesis	Path	β	t	p	95% CI	Decision
H2 (leg 1)	GL → EN	.511	13.31	<.001	[.438,.587]	Supported
H1	GL → SM	.277	5.46	<.001	[.179,.374]	Supported
H2 (leg 2)	EN → SM	.223	3.83	<.001	[.109,.335]	Supported
—	SE → SM	.194	4.46	<.001	[.113,.285]	Significant
H3	GL × SE → SM	.171	3.81	<.001	[.081,.257]	Supported

H1 is supported: gamified learning is positively associated with motivation, and the association persists after including engagement.

H2 is supported: both legs are significant, and the specific indirect effect excludes zero (β =.114, 95% CI [.057,.175]).

H3 is supported: the interaction of gamified learning with self-efficacy is positive and significant, in the hypothesised direction. The conversion of gamified learning into motivation is stronger among students with higher self-efficacy.

The model also includes the main effect of self-efficacy on motivation (β = .194), as required by the two-stage interaction procedure. It is reported for completeness and is not among the study's hypotheses.

A significant interaction indicates that the slope differs across levels of the moderator; it does not, by itself, identify the levels at which the difference becomes practically meaningful. Simple-slopes analysis would address that question. It was not part of the pre-specified analysis and is therefore not reported here, rather than being added after the interaction proved significant — a sequence that would convert an exploratory result into an apparently confirmatory one.

Decomposition of the total effect

The three quantities reconcile arithmetically, which is stated explicitly because a mediation decomposition that does not reconcile cannot be assessed:

- Direct effect (GL → SM) = .277
- Indirect effect (GL → EN → SM) =.511 ×.223 = .114, 95% CI [.057,.175]
- Total effect =.277 +.114 =.391
- Variance accounted for by the mediated route: 29.1% (VAF =.1138 /.3907, computed from the unrounded coefficients; the rounded operands shown above give 29.2%)

Because the direct and indirect effects are both significant and share a sign, the pattern is complementary partial mediation rather than indirect-only mediation. The direct effect is more than twice the size of the indirect one.

Explained variance

The model accounts for R^2 = .281 of the variance in student motivation and R^2 = .261 in engagement. Roughly seven-tenths of the variance in each remains outside the equations. This is stated rather than minimised. Values of this order are unremarkable for motivational outcomes in educational settings, where determinants are numerous and largely outside any single instructional intervention—prior achievement, disciplinary interest, workload, teaching quality, and personal circumstance among them. The figure establishes the scope of the claim: the model identifies associations that hold within it, not a complete account of what motivates students in technology-supported courses.

Discussion

Engagement is a mechanism, not the mechanism

The central result is the one the mediation test was designed to expose. Engagement does mediate the gamification–motivation relationship, and the mediated route is statistically robust — but it carries 29.1% of the total effect, and the direct path that survives it is more than twice as large. Accounts that locate the whole motivational benefit of gamified design in heightened engagement are therefore underspecified.

The asymmetry within the mediated route deserves separate notice. Gamified learning predicts engagement strongly (β = .511), but engagement predicts motivation more modestly (β = .223). On this evidence, making students more engaged is easier than making engagement translate into motivation. Theory that treats the two legs of the engagement bridge as equally load-bearing will misestimate the pathway.

This finding sits comfortably with self-determination theory and awkwardly with the engagement-centred framing that dominates the applied literature. If gamified elements support competence and autonomy directly — as Mekler et al. (2017) argue on experimental evidence, and as Sailer et al. (2017) demonstrate for specific design elements — then a direct association with motivation is exactly what should be observed. It need not pass through the volume of participation at all. Read that way, the present result is not anomalous: it is what a needs-based account predicts, and an engagement-only account does not.

What occupies the unexplained direct path is nonetheless not identified here, and it would be wrong to claim otherwise. The literature supplies candidates the present design does not model — immediate performance feedback, perceived autonomy in selecting challenges, and the competence signals that badges and progression carry (Deterding et al., 2011; Mekler et al., 2017; Sailer et al., 2017). Any of these could contribute, and a design that measured them as parallel mediators could establish which. The direct effect is reported as unexplained rather than attributed.

The motivational return on gamification is not uniform

Self-efficacy moderates the direct path in the hypothesised direction: at the same level of gamified learning, students with stronger efficacy beliefs report more motivation. This supports the argument that gamified environments, by making performance visible and comparative, supply information that is read differently depending on what a learner expects of themselves.

Two limits attach. A significant interaction establishes that the slope differs with self-efficacy; it does not identify the level at which the difference becomes practically meaningful, nor whether gamification becomes counterproductive at low self-efficacy. Simple-slopes analysis would address the first question; it was not pre-specified and is not reported here, rather than being added after the interaction proved significant. Second, self-efficacy was measured concurrently with the outcome, so the ordering the moderation implies is a design assumption rather than an observation.

Self-efficacy also predicts motivation directly ($\beta = .194$), consistent with the broader literature on efficacy beliefs and academic outcomes (Honicke et al., 2019; Talsma et al., 2018). The two roles are distinct and should not be conflated: the main effect concerns *how motivated* a student is, and the interaction concerns *how responsive* their motivation is to gamified design. A student body could in principle show a strong main effect and no interaction — everyone benefiting equally from gamification while differing in baseline motivation — and the practical implications would be entirely different. That both are present here means the motivational return on a gamified course is distributed unevenly, and in a way that widens rather than narrows an existing difference.

This has an uncomfortable corollary. Gamified design is often introduced in the hope of re-engaging struggling students, and struggling students are disproportionately those with lower efficacy beliefs. Based on current evidence, they are also the students for whom the same design yields the least. The study cannot say whether this is a property of gamification as such or of the competitive, publicly comparative form it usually takes. That distinction is exactly what a design-varying experiment could settle.

Implications

Theoretically, the results relocate explanatory weight. Engagement retains a demonstrated role, but a model that assigns it the whole burden accounts for under a third of the observed association and will misattribute the remainder. The results also indicate that the two halves of the engagement bridge are not equally strong, which matters for how future models should be specified: an intervention evaluated on its capacity to raise engagement may look successful while delivering considerably less motivational benefit than the engagement gain implies. Finally, treating learner characteristics as controls to be partialled out yields average effects that describe no particular student; self-efficacy belongs inside the model, and it belongs there in both of its roles.

For instructors, engagement is a necessary focus but not a sufficient one. Design that maximises participation will reliably raise engagement, and engagement will contribute to motivation — but under a third of the motivational benefit travels that way. Attention to what else gamification communicates to students, particularly about their own competence, is warranted by the size of the unexplained direct path, even though this study does not identify its content.

For institutions adopting gamified platforms, the moderation result cautions against expecting uniform benefit. Students with lower self-efficacy derive less motivational gain from the same design. Whether that gap can be narrowed by design choices — private rather than public progress, mastery rather than rank framing — should be evaluated rather than assumed.

For learning-support services, the direct effect of self-efficacy on motivation suggests that efficacy-building work carries motivational value independent of any gamified intervention, and that the two are complementary: raising self-efficacy raises motivation, and it also raises the return a student receives from gamified design.

Methodologically, this study reports expert content validation alongside main-sample psychometrics because the two answer different questions: domain coverage before administration, item behaviour after it. The distinction is often collapsed in survey-based educational research, where strong reliability coefficients are presented as though they established that the items covered their construct. They do not — a set of items can be highly internally consistent and still omit a facet of the construct entirely, and no coefficient computed after administration can detect that omission. Reporting both makes the difference visible to a reader.

None of these implications rests on a causal claim. The design is cross-sectional, and the recommendations are framed as directions warranted by the observed associations rather than as interventions shown to work.

Limitations

The design is cross-sectional, so the ordering the model assumes is a theoretical commitment, not an observation. Reverse and reciprocal paths are consistent with the same coefficients: motivated students may perceive more gamification in the same environment than unmotivated ones, and engagement and motivation may both be sampling a shared momentary state rather than standing in sequence. The cross-lagged evidence on self-efficacy and achievement (Talsma et al., 2018) is a reminder that reciprocity is the rule rather than the exception among constructs of this kind. All variables were self-reported in a single instrument; the two tests reported in §4.2 detected no common method variance, but detecting nothing is not demonstrating absence. Explanatory power is modest, with roughly seven-tenths of the variance in each endogenous construct unexplained. Recruitment was by voluntary response, so selection probabilities are unknown and respondents may hold stronger views about digital learning than non-respondents. Content validation and data collection ran in parallel, and no pilot study was conducted. Finally, the sample is drawn from one cultural setting, and the moderation result in particular may not transfer where norms about public performance differ.

Suggestions for Future Research

Four extensions follow directly from what this study could not settle.

Longitudinal measurement separating gamified exposure, engagement, and motivation in time would test the ordering this study assumes, and would distinguish the mediation account from the reciprocal one that fits the same cross-sectional data equally well. Identifying what carries the direct path — by measuring feedback immediacy, perceived autonomy, and competence signalling as parallel mediators — would establish whether it decomposes further. Simple slopes and a design that varies gamification framing would establish where the self-efficacy difference becomes practically meaningful and whether the disadvantage to low-efficacy students is a property of gamification or of a particular implementation. Replication on a probability sample and across cultural settings would establish transferability.

Conclusion

On 356 responses, gamified learning was positively associated with student motivation (β =.277), engagement mediated part of that association (β =.114), and self-efficacy both strengthened the relationship (β =.171) and predicted motivation directly (β =.194). The mediation is complementary and partial, with the engagement route carrying 29.1% of a total effect of.391.

Three claims are warranted on this evidence, and a fourth is not. Gamified learning is associated with higher motivation; part of that association runs through engagement; and how much of it a student receives depends on their efficacy beliefs. What is *not* warranted is the claim that engagement is the mechanism through which gamification motivates — the route through engagement carries less than a third of the total, and the direct path that survives it is more than twice as large.

The study's contribution is therefore to bound the engagement account rather than to confirm it. The part of the gamification–motivation relationship that engagement explains is smaller than the part it does not, and identifying what occupies that remainder — feedback immediacy, perceived autonomy, competence signalling, or something not yet named — is the question this work leaves open for designs able to measure those routes directly. Its principal limitation is that a cross-sectional design cannot test the sequence its theory proposes: what is reported is a well-estimated association awaiting a design capable of testing it as a process.

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Conflict of interest

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Ethics

Participation was voluntary and anonymous, and informed consent was obtained before participation. No personally identifying information was collected.

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Appendix. Measurement instrument

All items were answered on a seven-point agreement scale (1 = completely disagree, 4 = neutral, 7 = completely agree), with each construct presented as a separate block. I-CVI and the modified kappa (κ*) are the per-item results of the seven-expert content validation conducted before administration; the outer loading is the item's standardised loading in the estimated measurement model (N = 356). No item was removed or revised at either stage.

Gamified Learning (GL)

Code	Item	I-CVI	κ*	Loading
GL1	Game-like elements in my learning activities make the learning process more interesting.	0.857	0.849	0.715
GL2	The use of points or rewards motivates me to participate more actively in learning tasks.	0.857	0.849	0.743
GL3	Leaderboards encourage me to perform better in my coursework.	0.857	0.849	0.778
GL4	Gamified activities make learning more engaging compared to traditional teaching methods.	1.000	1.000	0.715
GL5	I feel motivated when I receive rewards or recognition in gamified learning activities.	0.857	0.849	0.755
GL6	Competition with other students in gamified systems encourages me to improve my performance.	0.857	0.849	0.783
GL7	Progress indicators in gamified	0.857	0.849	0.694

	learning systems help me track my learning achievements.			
GL8	Gamified learning activities make academic tasks feel more enjoyable.	1.000	1.000	0.767
GL9	Game-based features encourage me to complete learning tasks more consistently.	0.857	0.849	0.776
GL10	Gamified learning systems make the learning environment more interactive.	1.000	1.000	0.743

Engagement (EN)

Code	Item	I-CVI	κ*	Loading
EN1	I actively participate in learning activities during my courses.	0.857	0.849	0.778
EN2	I complete assigned tasks and activities on time.	0.857	0.849	0.729
EN3	I pay close attention during learning activities.	1.000	1.000	0.754
EN4	I feel interested in the learning activities provided in my courses.	0.857	0.849	0.704
EN5	I enjoy participating in learning tasks related to my studies.	1.000	1.000	0.734
EN6	I feel enthusiastic about engaging in course activities.	0.857	0.849	0.782

EN7	I try to understand the course material deeply rather than just memorizing it.	0.857	0.849	0.735
EN8	I invest effort in solving challenging academic problems.	0.857	0.849	0.783
EN9	I often think about how the learning material relates to real-life situations.	0.857	0.849	0.783
EN10	I make an effort to improve my understanding when I encounter difficult topics.	1.000	1.000	0.770

Self-Efficacy (SE)

Code	**Item**	**I-CVI**	**κ***	**Loading**
SE1	I believe I can successfully complete difficult academic tasks.	0.857	0.849	0.697
SE2	I am confident in my ability to understand complex course materials.	1.000	1.000	0.770
SE3	I can find solutions when I encounter problems in my studies.	0.857	0.849	0.789
SE4	I believe I can perform well in my academic courses.	0.857	0.849	0.701
SE5	I feel capable of achieving my academic goals.	1.000	1.000	0.772
SE6	I am confident that I can master the skills taught in my courses.	0.857	0.849	0.789
SE7	I can overcome challenges that arise during my	1.000	1.000	0.705

	learning process.			
SE8	I believe I can improve my academic performance through effort.	0.857	0.849	0.765
SE9	I feel confident when dealing with unfamiliar learning tasks.	0.857	0.849	0.755
SE10	I believe that I can succeed in challenging learning environments.	1.000	1.000	0.728

Student Motivation (SM)

Code	Item	I-CVI	κ*	Loading
SM1	I feel motivated to learn because I enjoy gaining new knowledge.	0.857	0.849	0.755
SM2	I am interested in the subjects I study.	1.000	1.000	0.744
SM3	I feel satisfied when I successfully complete academic tasks.	0.857	0.849	0.794
SM4	I am motivated to perform well in my courses.	0.857	0.849	0.717
SM5	Achieving good academic results is important to me.	0.857	0.849	0.764
SM6	I am willing to put effort into learning even when the material is difficult.	1.000	1.000	0.725
SM7	I feel motivated when my academic achievements are recognized.	0.857	0.849	0.728
SM8	I try my best to perform well in my academic activities.	1.000	1.000	0.770

SM9	I feel encouraged to continue learning when I achieve good results.	0.857	0.849	0.754
SM10	I am motivated to improve my academic performance continuously.	0.857	0.849	0.717