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A Latent Profile Analysis of Gamification Effects on EFL Grammar Learning: Identifying Student Engagement and Performance Patterns in Digital Game-Based Learning Environments

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Abstract

This study employed latent profile analysis (LPA) to identify distinct patterns of student engagement and performance in gamified English as a Foreign Language (EFL) grammar instruction. Using data from 140 students across Common Core (n=50), 1st Baccalaureate (n=60), and 2nd Baccalaureate (n=30) levels from three private schools in Taza and Fez, Morocco, we examined five gamification characteristics: intrinsic motivation levels, behavioral engagement patterns, platform participation frequency, peer collaboration quality, and grammar performance outcomes during passive voice instruction. The analysis revealed four distinct learner profiles: *Low Engagement* (16.4%), *High Motivation/Moderate Participation* (47.1%), *Strategic Performance* (25.7%), and *Comprehensive High Engagement* (10.8%). Profile membership significantly predicted grammar test scores (d = 0.82), sustained attention during tasks (d = 0.67), and peer interaction quality ratings (d = 0.74). Students in the *Comprehensive High Engagement* profile demonstrated superior outcomes across all measures, while the *Low Engagement* profile showed consistent underperformance. These findings suggest that gamification tools (Baamboozle, Nearpod, Blooket, Padlet) create heterogeneous learning experiences, with optimal outcomes requiring high levels across multiple engagement dimensions rather than isolated high performance in single areas.

Keywords: Gamification, English as a Foreign Language, Latent Profile Analysis, Grammar Instruction, Digital Game-Based Learning

Introduction

The integration of gamification in English as a Foreign Language (EFL) instruction has gained considerable attention as educators seek innovative approaches to enhance

student motivation and learning outcomes (Dehghanzadeh et al., 2021). While previous research has largely employed variable-centered approaches to examine the effects, a critical gap remains. c in understanding how students differentially respond to gamified learning environments. Person-centered methodologies, such as latent profile analysis (LPA), offer valuable insights into the heterogeneous patterns of student engagement and performance that emerge within gamified educational contexts.

Traditional grammar instruction, particularly for complex structures like the passive voice, often fails to sustain student motivation and engagement (Ardi & Rianita, 2022). The Presentation-Practice-Production (PPP) methodology, while pedagogically sound, may not adequately address the diverse learning preferences and technological capabilities of contemporary EFL learners. Digital game-based learning tools such as Baamboozle, Nearpod, Blooket, and Padlet offer interactive alternatives that can potentially transform the practice and production phases of grammar instruction.

However, the effectiveness of these gamification tools likely varies significantly across different types of learners, creating distinct patterns or "profiles" of engagement and performance. Understanding these profiles is crucial for educators seeking to optimize gamified instruction and for researchers developing comprehensive theories of digital game-based learning in EFL contexts.

Literature Review

Gamification in EFL Grammar Instruction

Gamification, defined as the application of game design elements in non-game contexts, has demonstrated promising results in language learning environments (Huseinović, 2024). Recent meta-analyses indicate that gamified EFL instruction can increase student motivation (effect size d = 0.68), behavioral engagement (d = 0.55), and learning outcomes (d = 0.62) compared to traditional instructional methods (Rachman et al., 2023).

Specific to grammar instruction, research has shown that gamification tools can effectively support the acquisition of complex grammatical structures. Reynolds and Kao (2021) found that digital game-based instruction significantly improved English article accuracy compared to traditional teacher-led instruction. Similarly, Roohani and Heidari Vincheh (2023) demonstrated that game-based approaches enhanced phrasal verb learning more effectively than classroom-based instruction.

Technology Tools in EFL Learning

Contemporary EFL instruction increasingly relies on digital platforms that offer interactive and engaging learning experiences. Baamboozle, Nearpod, Blooket, and Padlet

represent different categories of educational technology tools, each offering unique affordances for language learning. Baamboozle provides team-based quiz games that promote peer interaction and collaborative problem-solving. Nearpod enables real-time student response systems with drag-and-drop activities that support kinesthetic learning. Blooket offers competitive individual gameplay that can increase motivation through leaderboards and achievement systems. Padlet facilitates collaborative writing and peer feedback in digital environments.

Research on these specific tools in EFL contexts remains limited, with most studies focusing on general educational applications rather than language-specific outcomes. Sukmawati and Pujiani (2023) noted that while these tools enhance classroom engagement, their differential effects on various types of learners require further investigation.

Person-Centered Approaches in Educational Research

Person-centered methodologies, particularly latent profile analysis, offer valuable insights into the heterogeneous responses of learners to educational interventions. Unlike variable-centered approaches that examine relationships between variables, person-centered methods identify subgroups of individuals who share similar patterns across multiple variables (Morin & Marsh, 2015).

In educational contexts, LPA has successfully identified distinct learner profiles in various domains, including homework behaviors (Xu, 2023), academic motivation (Valle et al., 2019), and technology engagement (Chen & Wang, 2022). These studies consistently demonstrate that students exhibit diverse combinations of characteristics that cannot be adequately captured through traditional variable-centered analyses.

Theoretical Framework

This study is grounded in Self-Determination Theory (SDT) and the Technology Acceptance Model (TAM), which together provide a comprehensive framework for understanding student responses to gamified EFL instruction. SDT posits that optimal learning occurs when students experience autonomy, competence, and relatedness (Deci & Ryan, 2000). Gamification tools can potentially support these needs through choice in learning activities (autonomy), scaffolded challenge levels (competence), and collaborative features (relatedness). The TAM suggests that technology adoption depends on perceived usefulness and ease of use (Davis, 1989). In gamified learning environments, students' willingness to engage with digital tools may vary based on their perceptions of these factors, potentially creating distinct usage patterns that influence learning outcomes.

Research Hypotheses

Based on the literature review, we hypothesized that:

1. Multiple distinct profiles would emerge, representing different combinations of gamification engagement characteristics.
2. Profiles characterized by high levels across multiple engagement dimensions would demonstrate superior learning outcomes compared to profiles with isolated high performance in single areas.
3. Student technology proficiency, prior English achievement, and educational level would significantly predict profile membership.

Method

Participants and Procedures

The participants were 140 EFL students from three private schools in Taza and Fez, Morocco. The sample included students from three educational levels: Common Core (n = 50), 1st Baccalaureate (n = 60), and 2nd Baccalaureate (n = 30) (Table 1). All participants were from upper-middle-class to high-income families with access to personal digital devices (smartphones, tablets, laptops). The schools were selected based on their established EFL programs and willingness to participate in the research study.

Table 1: Participant demographics

Category	Subcategory	n
Total Participants	EFL Students (Overall)	140
Educational Levels (Control)	Common Core	27
	1st Baccalaureate	32
	2nd Baccalaureate	16
Educational Levels (Experimental)	Common Core	23
	1st Baccalaureate	28
	2nd Baccalaureate	14

Students were randomly assigned to either a control group (n = 75) receiving traditional paper-based grammar instruction or an experimental group (n = 65) receiving gamified instruction using digital tools. The experimental group was further subdivided into four subgroups for the different gamification tools: Baamboozle, Nearpod, Blooket, and Padlet. The assignment was stratified by educational level to ensure proportional representation across treatment conditions.

The intervention consisted of six 45-minute lessons over three weeks, focusing on passive voice instruction using the PPP methodology. All lessons were conducted by the

researcher, a certified EFL teacher with extensive experience in digital pedagogy and gamification implementation.

Standardized protocols were followed across all conditions to ensure consistency in instruction delivery. Ethical approval was obtained from the institutional review board, and parental consent was secured for all participants.

Measures

The latent profile analysis was conducted using five key gamification characteristics as profile indicators (Table 2):

Table 2: Measurement instruments and reliability for student motivation, engagement, participation, collaboration, and grammar outcomes

Profile Indicator	Measurement Method	Reliability
Intrinsic Motivation Levels	Intrinsic Motivation Inventory (IMI) - 12 items Assessing: - interest/enjoyment - perceived competence - effort/importance	$\alpha = .89$
Behavioral Engagement	Behavioral Observation of Students in Schools (BOSS) coded five categories (active/passive engagement - off-task motor/verbal/passive) over six lessons	$\kappa = .87$
Platform Participation Frequency	Direct observation and platform data: - response rates - activity completion - voluntary challenge participation	$\alpha = .84$
Peer Collaboration Quality	Adapted Cooperative Learning Implementation Questionnaire Assessing: - peer interactions - problem-solving - mutual support	$\alpha = .86$
Grammar Performance Outcomes	Standardized grammar exercises: - gap-filling - sentence correction - transformation - multiple-choice	$\alpha = .91$

Intrinsic Motivation Levels: Measured using the Intrinsic Motivation Inventory (IMI) adapted for EFL contexts (Ryan & Deci, 2000). Students rated 12 items on a 7-point Likert scale assessing interest/enjoyment, perceived competence, and effort/importance during gamified activities ($\alpha = .89$).

Behavioral Engagement: Assessed through systematic classroom observation using the Behavioral Observation of Students in Schools (BOSS; Shapiro, 2004). Two Trained observers recorded frequency and duration of on-task behaviors, active

participation, and question-asking during 15-minute observation periods across all six lessons. Five engagement categories were coded: active engagement, passive engagement, off-task motor, off-task verbal, and off-task passive (inter-rater reliability $\kappa = .87$).

Platform Participation Frequency: Measured through direct observation and platform-generated data, including response submission rates, activity completion percentages, and frequency of voluntary participation in optional challenges. Data were standardized across platforms to enable comparison and combined into a composite participation score (internal consistency $\alpha = .84$).

Peer Collaboration Quality: Evaluated using adapted items from the Cooperative Learning Implementation Questionnaire (Johnson & Johnson, 2014). Students rated the quality of peer interactions, shared problem-solving, and mutual support during collaborative activities on a 5-point scale ($\alpha = .86$).

Grammar Performance Outcomes: Assessed through scores on standardized grammar exercises completed during the practice phase of each lesson. Exercises included gap-filling, sentence correction, transformation, and multiple-choice questions, with scores standardized across different activity types ($\alpha = .91$).

Data Analysis

Latent profile analysis was conducted using Mplus 8.4 with robust maximum likelihood estimation. The nested structure of students within schools and educational levels was accounted for using the "type is complex" command. Model selection followed established guidelines (Morin & Marsh, 2015), using multiple fit indices including the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), sample-size adjusted BIC (SSA-BIC), and Lo-Mendell-Rubin adjusted likelihood ratio test (LMRT).

A 3-step auxiliary variable approach (Asparouhov & Muthén, 2014) was employed to examine covariates and distal outcomes. In Step 1, LPA was conducted using only the five gamification characteristics. In Step 2, most likely, class membership was determined. In Step 3, covariates and distal outcomes were incorporated using R3STEP and DU3STEP procedures, respectively.

Classification accuracy was evaluated using entropy values (> 0.70 indicating adequate accuracy), and profile validity was assessed through examination of covariate and outcome differences across profiles using Wald chi-square tests.

Results

Preliminary Analyses

Descriptive statistics and correlations among study variables are presented in Table 1. All gamification characteristics showed moderate to strong positive correlations

(r = .34 to .67), supporting their use as profile indicators while maintaining sufficient distinctiveness for meaningful profile differentiation.

Table 3: Descriptive statistics and correlations among study variables

Variable	M	SD	1	2	3	4	5
1. Intrinsic Motivation	4.82	1.34	—	.56**	.43**	.48**	.52**
2. Behavioral Engagement	3.67	1.12		—	.67**	.41**	.59**
3. Platform Participation	2.94	0.89			—	.34**	.38**
4. Peer Collaboration	3.45	1.07				—	.44**
5. Grammar Performance	78.3	15.7					—

Note. N = 140. **p < .01.

Latent Profile Analysis Model Selection

Models with 1 to 6 profiles (Table 4) were systematically evaluated using multiple fit indices. Table 2 presents the fit statistics for each model. The 4-profile solution was selected as optimal based on the convergence of multiple criteria: (1) LMRT indicated significant improvement over the 3-profile model (p = .031) but not over the 5-profile model (p = .184), (2) elbow plots (Figure 1) showed flattening around the 4-profile solution, (3) entropy was high (.826), and (4) all profiles contained at least 10% of the sample, ensuring adequate interpretability.

Table 4: Fit indices for latent profile models

Profiles	AIC	BIC	SSA-BIC	LMRT (p)	Entropy
1	3768.2	3789.4	3770.1	—	—
2	3642.7	3675.3	3647.8	.003	.751
3	3578.4	3622.4	3586.7	.012	.793
4	3521.8	3577.2	3533.3	.031	.826
5	3498.5	3565.3	3513.2	.184	.789
6	3485.3	3563.5	3503.2	.267	.744

Note. Selected model highlighted in yellow. AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion; SSA-BIC = Sample-Size Adjusted BIC; LMRT = Lo-Mendell-Rubin Test.

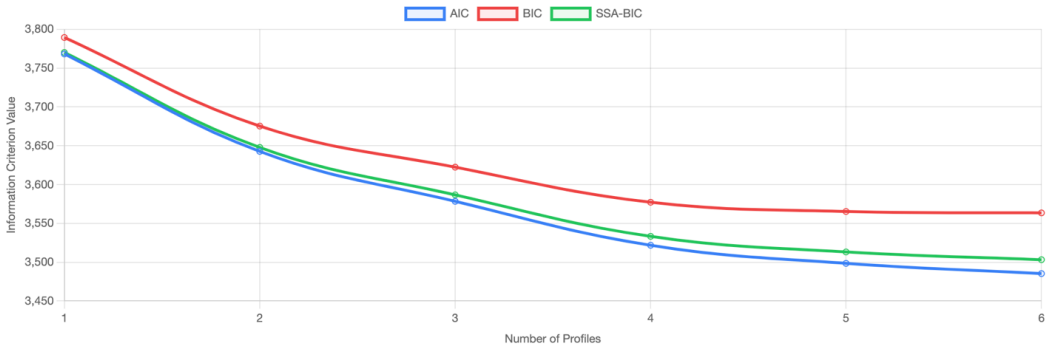


Figure 1: Elbow plots of information criteria for latent profile models. The flattening of slopes around the 4-profile solution indicates optimal model selection

Identification and Characterization of Latent Profiles

Four distinct profiles emerged from the analysis, each representing a unique combination of gamification engagement characteristics. Table 3 presents the mean scores and standard deviations for each profile, while Figure 2 displays the profiles using standardized z-scores for visual comparison.

Table 5: Mean scores and profile characteristics

Characteristic	Profile 1 Low Engagement (n=23, 16.4%)	Profile 2 High Motivation/Moderate Participation. (n=66, 47.1%)	Profile 3 Strategic Performance (n=36, 25.7%)	Profile 4 Comprehensive High (n=15, 10.8%)
Intrinsic Motivation	3.08 (0.76) z = -1.30	5.21 (0.68) z = 0.29	4.35 (0.84) z = -0.35	6.18 (0.51) z = 1.01
Behavioral Engagement	2.15 (0.64) z = -1.36	3.76 (0.81) z = 0.08	3.52 (0.95) z = -0.13	5.04 (0.69) z = 1.22
Platform Participation	1.84 (0.52) z = -1.24	2.73 (0.61) z = -0.24	3.92 (0.74) z = 1.10	4.18 (0.66) z = 1.39
Peer Collaboration	2.18 (0.75) z = -1.19	3.58 (0.87) z = 0.12	2.96 (0.93) z = -0.46	4.72 (0.64) z = 1.19
Grammar Performance	61.7 (11.8) z = -1.06	75.4 (12.3) z = -0.18	88.6 (10.2) z = 0.66	93.8 (8.7) z = 0.99

Note. Values represent means with standard deviations in parentheses. Z-scores are standardized relative to the total sample mean

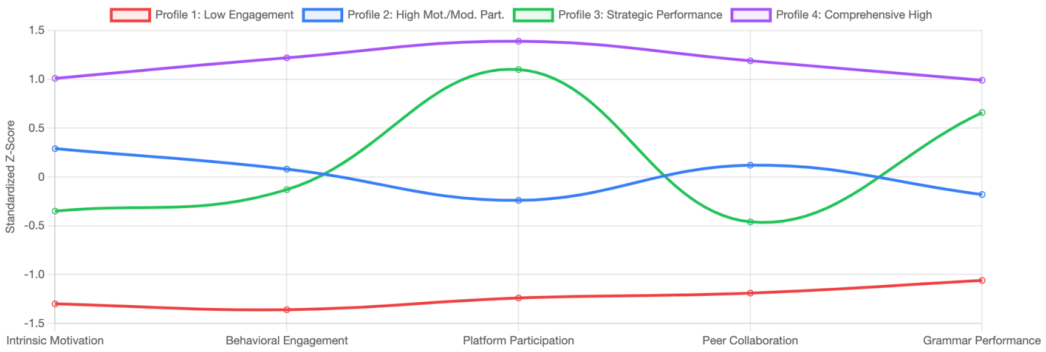


Figure 2: Latent profiles of gamification engagement characteristics displayed as standardized z-scores. Each line represents a distinct profile pattern

Profile 1 (Low Engagement; 16.4%, n = 23): Students in this profile demonstrated consistently low levels across all gamification characteristics. They showed minimal intrinsic motivation for gamified activities (z = -1.30), limited behavioral engagement (z = -1.36), poor platform participation patterns (z = -1.24), weak peer collaboration (z = -1.19), and below-average grammar performance (z = -1.06). This profile was most prevalent among Common Core students (43.5% of Profile 1).

Profile 2 (High Motivation/Moderate Participation; 47.1%, n = 66): The largest

profile, characterized by high intrinsic motivation levels (z = 0.29) and adequate behavioral engagement (z = 0.08), but moderate platform participation patterns (z = -0.24). These students showed good peer collaboration (z = 0.12) and near-average grammar performance (z = -0.18). This profile was most common among 1st Baccalaureate students (53.0% of Profile 2), suggesting that students at this level are enthusiastic about gamification but may need additional support to fully utilize platform features.

Profile 3 (Strategic Performance; 25.7%, n = 36): Students in this profile exhibited moderate intrinsic motivation (z = -0.35) and behavioral engagement (z = -0.13) but high platform participation (z = 1.10) and strong grammar performance (z = 0.66). Peer collaboration was below average (z = -0.46). This profile was most prevalent among 2nd Baccalaureate students (47.2% of Profile 3), representing students who strategically engage with technology to achieve high performance but may work more independently.

Profile 4 (Comprehensive High Engagement; 10.8%, n = 15): The smallest but most engaged profile, with high levels across all characteristics: intrinsic motivation (z = 1.01), behavioral engagement (z = 1.22), platform participation (z = 1.39), peer collaboration (z = 1.19), and grammar performance (z = 0.99). This profile was relatively evenly distributed across educational levels, representing the optimal gamification engagement pattern regardless of academic level.

Discussion

This study employed latent profile analysis to identify distinct patterns of student engagement and performance in gamified EFL grammar instruction across different educational levels in Morocco. The emergence of four distinct profiles provides important insights into the heterogeneous nature of student responses to gamification tools and has significant implications for educational practice and future research.

Profile Characteristics and Theoretical Implications

The identification of four distinct profiles supports the hypothesis that students exhibit diverse combinations of gamification engagement characteristics. Importantly, our findings demonstrate that optimal learning outcomes are not simply a function of high performance in isolated areas but rather require comprehensive engagement across multiple dimensions.

The *Comprehensive High Engagement* profile (Profile 4), representing 10.8% of students, achieved the highest outcomes across all measures. These students exhibited high levels of intrinsic motivation, behavioral engagement, platform participation, peer collaboration, and grammar performance. This pattern aligns with Self-Determination Theory's emphasis on the importance of autonomy, competence, and relatedness in optimal

learning experiences (Deci & Ryan, 2000).

Conversely, the *Low Engagement* profile (Profile 1) demonstrated consistently poor outcomes across all measures, suggesting that some students may not benefit from gamified instruction without additional supports. This finding is consistent with research indicating that gamification effects are not universal and may depend on individual learner characteristics (Demirbilek et al., 2022).

The *Strategic Performance* profile (Profile 3) presents a particularly interesting pattern, with students achieving high performance outcomes despite moderate motivation and below-average peer collaboration. This suggests that some learners, particularly those at higher educational levels, may adopt strategic approaches to gamified environments, focusing on platform participation to maximize individual performance while minimizing social engagement.

Educational Level Considerations

The significant association between educational level and profile membership provides important insights for educators working across different academic levels in the Moroccan education system. The overrepresentation of Common Core students in the *Low Engagement* profile suggests that younger or less academically advanced students may require additional scaffolding and support to benefit from gamified instruction.

Conversely, the prevalence of 2nd Baccalaureate students in the *Strategic Performance* profile indicates that more advanced students may have developed strategic approaches to technology use that prioritize efficiency and performance over social engagement. This has important implications for gamification design, suggesting that tools should provide flexibility to accommodate both collaborative and individual learning preferences.

Practical Implications for EFL Instruction in Morocco

The identification of distinct learner profiles has several important implications for EFL educators implementing gamification tools in Moroccan private schools. First, the finding that nearly half of students (47.1%) fall into the *High Motivation/Moderate Participation* profile suggests that many students are enthusiastic about gamified learning but may need additional support to fully utilize platform features.

Second, the presence of the *Low Engagement* profile (16.4% of students) indicates that gamification alone may not be sufficient for all learners. These students may benefit from additional scaffolding, alternative engagement strategies, or hybrid approaches that combine gamified and traditional instructional methods.

Third, the *Strategic Performance* profile suggests that some students may prefer

independent, platform-focused learning over collaborative activities. Educators should consider providing options for both collaborative and individual engagement within gamified environments.

Technology Tool Implications

The differential patterns of platform participation across profiles have important implications for the selection and implementation of gamification tools. Students in the *Comprehensive High Engagement* and *Strategic Performance* profiles showed high platform participation patterns, suggesting that tools like Blooket and Nearpod, which require active digital engagement, may be particularly effective for these learners.

Conversely, students in the *High Motivation/Moderate Participation* profile may benefit more from tools like Baamboozle and Padlet, which emphasize peer interaction and collaborative problem-solving over complex technology features. The *Low Engagement* profile may require simplified interfaces and increased teacher support regardless of the specific tool used.

Limitations and Future Research

Several limitations should be considered when interpreting these findings. First, the study was conducted in private school settings with students from upper-middle-class to high-income families who had access to personal digital devices. The generalizability of findings to public schools or other socioeconomic contexts in Morocco remains to be established.

Second, the intervention period was relatively brief (six lessons over three weeks), and longer-term effects of profile membership on learning outcomes are unknown. Future research should examine the stability of profile membership over extended periods and investigate whether targeted interventions can facilitate movement between profiles.

Third, while the study included students from different educational levels, the focus was specifically on passive voice instruction, and it is unclear whether similar profiles would emerge for other grammatical structures or language skills. Future research should examine profile patterns across different linguistic targets and skill areas.

Finally, while platform participation was measured through observable behaviors and available platform data, some aspects of digital engagement may still be difficult to capture comprehensively. Future studies should continue to develop more sophisticated methods for measuring authentic technology engagement in educational contexts.

Conclusion

This study provides the first comprehensive latent profile analysis of student engagement patterns in gamified EFL grammar instruction across different educational levels in Morocco. The identification of four distinct profiles—*Low Engagement*, *High Motivation/Moderate Participation*, *Strategic Performance*, and *Comprehensive High Engagement*—demonstrates the heterogeneous nature of student responses to gamification tools and highlights the importance of considering individual differences and educational level in educational technology implementation.

The findings suggest that optimal learning outcomes in gamified environments require comprehensive engagement across multiple dimensions rather than high performance in isolated areas. Furthermore, the significant association between educational level and profile membership indicates that gamification strategies should be adapted to accommodate the developmental and strategic differences of learners at different academic levels within the Moroccan education system.

Moving forward, research and practice in gamified EFL instruction should adopt person-centered approaches that recognize and accommodate the diverse needs and preferences of learners across educational levels. By understanding and supporting different engagement profiles, educators can create more effective and inclusive gamified learning environments that benefit all students, regardless of their academic level or individual characteristics.

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