Analysing the Impact of Gamification Techniques on Enhancing Learner Engagement, Motivation, and Knowledge Retention: A Structural Equation Modelling Approach

Lassaad Smirani[1,2] and Hanaa Yamani[1,3]

[1]Information technology and eLearning deanship, Umm Al-Qura University, Mecca, Saudi Arabia
[2]INNOV'COM Laboratory, High School of Communications (SUP'COM), University of Carthage, Tunisia
[3]College of Computers, Umm Al-Qura University, Mecca, Saudi Arabia

lksmirani@uqu.edu.sa (Corresponding author)

Abstract: This study investigates the impact of gamification techniques, including Kahoot!, Classcraft, and Badgeville, on learner motivation, engagement, and perceptions of learning effectiveness and enjoyment in online learning environments. Employing a quantitative research approach, the study utilizes Structural Equation Modeling (SEM) to analyze the relationships between gamification elements and learner outcomes, framed by Self-Determination Theory (SDT). Data collected from a survey of 169 academics across varis fields reveal that gamification techniques, such as leaderboards, badges, points systems, and challenges, significantly enhance learner engagement, with an average increase of 25% observed. Rewards, incentives, and competitive challenges boost both intrinsic and extrinsic motivation, leading to a 30% improvement in learner performance. Despite a slight negative perception regarding gamification's impact on learning effectiveness, a 20% increase in perceived enjoyment underscores its overall positive influence. Knowledge retention significantly impacts learner engagement, perceived learning effectiveness, and enjoyment, with a correlation coefficient of 0.65 between retention rates and engagement levels. These findings highlight the importance of balancing competitive elements to optimize motivation, effectiveness, and enjoyment while maintaining a supportive learning environment. The study provides actionable recommendations for designing gamified e-learning environments that effectively integrate gamification elements to enhance engagement, motivation, and knowledge retention, offering evidence-based guidance for educators aiming to create engaging and effective online learning experiences.

Keywords: Gamification, e-Learning, Self-Determination Theory (SDT), Learner engagement, Motivation, Knowledge retention, Smart PLS, Structural equation model, Mixed methods

1. Introduction

Gamification has gained attention as a strategy to boost learner engagement, motivation, and academic achievement, though studies show mixed results (Caponetto, Earp and Ott, 2014). For example, (Looyestyn, et al, 2017) found that while gamification improved motivation, it did not significantly enhance academic performance, while (Manoharan and Nagulapally, 2024) reported both engagement and achievement improvements but only under certain conditions related to students' prior knowledge. These inconsistent findings point to a gap in understanding how different gamification elements affect e-learning outcomes.

This study aims to address this by analyzing the effects of distinct gamification strategies on engagement, motivation, and performance in an online learning environment. Unlike previous studies, this research will differentiate between individual gamification elements to provide a nuanced understanding of their contributions (Mohtar, et al, 2023), (Vergara, Antón-Sancho, and Fernández-Arias, 2023), (Siripipatthanakul, et al, 2023), (Hair, et al, 2021) and (Saxena, Bagga, and Gupta, 2021).

Gamification, through rewards, achievements, leaderboards, and storytelling, creates an interactive environment that drives engagement and sustains motivation (Mohtar, et al, 2023). However, comprehensive studies on its effectiveness in e-learning remain scarce (Vergara, Antón-Sancho, and Fernández-Arias, 2023). To fill this gap, this research employs a quantitative approach to monitor learner interactions and performance, comparing gamified and non-gamified modules. Pre- and post-assessments will evaluate knowledge retention and learning outcomes. Using Structural Equation Modelling (SEM) and Smart PLS4 (Hu and Razlog, 2023), (Nguyen, Le, and Lee, 2023), the study will explore how gamification influences engagement, motivation, and knowledge retention. The findings will offer evidence-based recommendations for designing gamified e-learning environments, benefiting educators and e-learning developers.

Research questions include:

- How do gamification techniques influence learner engagement?
- What impact do gamification elements have on motivation?
- To what extent do gamification techniques enhance knowledge retention?

The paper will review relevant literature (Section 2), outline the methodology (Section 3), present findings (Section 4), discuss implications (Section 5), and conclude with recommendations and future research directions (Section 6).

2.   Literature Review

Gamification enhances learner engagement and motivation in e-learning by incorporating game elements like rewards, points, and leaderboards, transforming education into interactive experiences (Jaskari and Syrjälä, 2024). Research shows that rewards and achievements boost intrinsic motivation, while leaderboards encourage competition and storytelling creates immersive learning (Deci and Ryan, 1985). Gamification promotes engagement by offering dynamic environments with challenges, progress tracking, and social features like collaboration, leading to increased time investment and completion rates (Looyestyn, et al, 2017), (Saxena, Bagga, and Gupta, 2021). Motivation, driven by both intrinsic and extrinsic factors, is enhanced through rewards, badges, leaderboards, and immediate feedback (Manoharan and Nagulapally, 2024), (Salman, et al, 2024). Additionally, gamification supports knowledge retention by fostering cognitive engagement and memory formation through active recall and repetition, leading to better learning outcomes (Won and Kim, 2023), (Ryan and Deci, 2000).

Recent research on gamification in education highlights its potential to enhance engagement, motivation, and learning outcomes across various contexts. For example, (Alahmadi, 2024) explored gamification in science education, where a gamified environment significantly improved student engagement and learning. Similarly, (Asmolov and Ledentsov, 2023) studied gamification in acupuncture programs, revealing positive attitudes and reduced stress. Research on dental students by (Smirani and Boulahia, 2022) emphasized gamification's role in identifying challenging concepts and motivating students. Studies on language learning, like (Papadakis, Zourmpakis and Kalogiannakis, 2023) , showed how game-based apps positively impacted student engagement and performance. In computer science, (Buckley and Doyle, 2016) demonstrated how gamified learning improved students' understanding of memory concepts, while (Borade, Netak and Kiwelekar, 2023) highlighted gamification's usability benefits in mobile learning apps. Additionally, (Lampropoulos and Sidiropoulos, 2024) focused on integrating gamification into technology-enabled learning, and (Zafar, Khan and Malik, 2024) explored using Facebook for gamified self-directed learning. Research on gamification in engineering education by (Abusalim, Hussein and Hamad, 2024) proposed enhancing professor preparation to accommodate student differences. The impact of gamification extends beyond education. For instance, (Li, Zhao, Wang and Lin, 2024) discussed HR analytics in service organizations, (Castillo and Cano, 2024) examined online distance education challenges, and (Khasawneh, Khasawneh, and Khasawneh, 2024) automated grading using AI. Gamification has also been explored in sustainable purchasing attitudes (Rayyan, Tarawneh and Ahmad, 2023) and English language learning in Bosnia and Herzegovina , showing its broad applicability. Recent studies, like (Sotos-Martínez, Díaz-García and Toral, 2024), found gamification improved students' motivation and psychological needs in physical education, while (Tursunbayevich, 2024) emphasized its positive impact in EFL higher education. Meta-analyses by (Halasa, Abuhammad and Batiha, 2020) and (Li, Zhao, Wang and Lin, 2024) offer insights into gamification's effects, highlighting its role in enhancing intrinsic motivation, autonomy, and relatedness but noting challenges in perceived competence. Furthermore, (Chin, 1998) compared online, traditional, ad gamified learning, finding that gamification improved performance and engagement.

Finally, studies such as (Sailer and Homner, 2020), (Alsawaier, 2018), (Salman, et al, 2024), (Ranieri, Strambi and Lagana, 2021), (Basahel and Basahel, 2018) and (Chen, 2023) examine the impact of digital platforms and blended learning, further emphasizing the importance of integrating gamification and digital tools in modern educational strategies.

Recent research has made significant strides in exploring the integration of gamification into diverse educational settings, shedding light on its potential to revolutionize teaching and learning practices. For instance, studies such as (Alahmadi, 2024) and (Jones, Brown and Smith, 2023) have concentrated on the application of gamification in Science Education, revealing notable improvements in student engagement, motivation, and learning outcomes. By addressing this critical gap in literature, these studies have paved the way for innovative approaches to science education that leverage gamification principles. However, despite these advancements,

there remains a need to delve deeper into the specific mechanisms through which gamification impacts learning effectiveness.

Our study aims to bridge this gap by conducting a comprehensive analysis of the impact of gamification techniques on learner engagement, motivation, and knowledge retention using a sophisticated structural equation modeling approach, guided by SDT. SDT is relevant for this study as it provides a framework for understanding how gamification can satisfy learners' basic psychological needs for autonomy, competence, and relatedness, which are critical for motivation and engagement in e-learning environments. SDT posits that intrinsic motivation, autonomy, competence, and relatedness are essential for fostering individuals' well-being and optimal functioning in various domains, including education (Zeybek and Saygı, 2024). In the context of gamified e-learning environments, SDT provides a theoretical lens through which to understand how gamification elements influence learners' psychological needs and motivational processes. According to SDT, satisfying learners' intrinsic needs for autonomy (the sense of choice and volition), competence (the feeling of being effective in tasks), and relatedness (the sense of connection and belongingness) is crucial for enhancing their motivation, engagement, and learning outcomes (Abu-Amara, Jaradat and Mansour, 2021). By adopting SDT, this study aims to explore how gamification elements fulfill learners' psychological needs and contribute to their motivation, engagement, and perceived effectiveness in online learning environments. SDT guides the examination of the underlying mechanisms through which gamification impacts learner behavior and experiences, thereby providing insights into effective instructional design practices and strategies for promoting meaningful engagement in e-learning contexts. The integration of SDT into the research framework facilitates a comprehensive understanding of the relationships between gamification, learner motivation, engagement, and learning outcomes, ultimately informing the design and implementation of effective gamified e-learning experiences.

3. Methodology

The study conducted by the Deanship of IT and eLearning at Umm Al-Qura University involved active participation from students across four departments within the College of Computer Sciences. These departments include:

- Department of Computer Science and Artificial Intelligence
- Department of Software Engineering
- Department of Computer and Network Engineering
- Department of Data Science

Additionally, the research engaged a total of 169 faculty members from these departments. The study spanned two semesters during the academic year 2022/2023, facilitating comprehensive insights into the impact of gamification techniques on e-learning outcomes."

The study employed a variety of gamified systems and platforms tailored to the needs of our study participants. Specifically, we integrated Kahoot! a widely recognized gamified learning platform known for its interactive quizzes and competitive gameplay dynamics. Kahoot! facilitated engaging and interactive learning experiences through its gamified quiz format, promoting active participation and knowledge retention among students. Furthermore, we incorporated Classcraft into our study, a gamified classroom management system designed to foster collaboration, positive behavior, and teamwork among students. Through Classcraft, students were incentivized to work together, support their peers, and achieve shared learning objectives within a gamified framework that mimics real-world role-playing dynamics. In addition to Kahoot! and Classcraft, we integrated Badgeville into our research methodology. Badgeville provided a gamification platform specifically designed to incentivize desired behaviors and outcomes in online learning environments. By using Badgeville's gamification features, we aimed to motivate students to actively engage with course materials, track their progress, and strive for mastery within the e-learning modules.

In this study, we have carefully selected specific gamification tools Kahoot, Classcraft, and Badgeville based on their alignment with our research objectives and their demonstrated efficacy in prior research. **Kahoot!** was selected for its interactive quiz-based format, which fosters a competitive and engaging learning environment. Previous studies have shown its effectiveness in increasing student participation and reinforcing learning through gamified quizzes. **Classcraft** was included due to its comprehensive gamification framework that integrates elements such as role-playing, experience points, and quests. This tool has been utilized in various educational settings to enhance student motivation and create a collaborative learning atmosphere. **Badgeville**

was chosen for its focus on behavioral analytics and rewards systems. Its application in our study aims to provide a structured approach to tracking and encouraging student progress through achievements and badges.

Additionally, we have clarified the timeline and sequence of our data collection process. The study spanned two semesters, during which we followed the same cohort of students to track their engagement and performance over time. This longitudinal approach allowed us to measure the impact of gamification tools on the same group of learners, providing a more nuanced understanding of their effectiveness.

As administrators within the IT Deanship and eLearning department, we effectively administered the study using our institution's Learning Management System, Blackboard. We integrated gamification elements directly into existing e-learning modules using Blackboard's features and infrastructure, facilitating comprehensive data collection and analysis to evaluate their impact on learner experiences and outcomes.

To achieve a comprehensive understanding of the effectiveness of gamification in e-learning, we propose an algorithmic approach that combines quantitative and qualitative analyses. This study employs SDT as the theoretical framework to investigate the impact of gamification techniques on learner engagement, motivation, and learning outcomes in e-learning environments. SDT posits that intrinsic motivation, autonomy, competence, and relatedness are essential for fostering individuals' well-being and optimal functioning in various domains, including education. In the context of gamified e-learning environments, SDT provides a theoretical lens through which to understand how gamification elements influence learners' psychological needs and motivational processes. According to SDT, satisfying learners' intrinsic needs for autonomy (the sense of choice and volition), competence (the feeling of being effective in tasks), and relatedness (the sense of connection and belongingness) is crucial for enhancing their motivation, engagement, and learning outcomes. By adopting SDT, this study aims to explore how gamification elements fulfill learners' psychological needs and contribute to their motivation, engagement, and perceived effectiveness in online learning environments. SDT guides the examination of the underlying mechanisms through which gamification impacts learner behavior and experiences, thereby providing insights into effective instructional design practices and strategies for promoting meaningful engagement in e-learning contexts. The integration of SDT into the research framework facilitates a comprehensive understanding of the relationships between gamification, learner motivation, engagement, and learning outcomes, ultimately informing the design and implementation of effective gamified e-learning experiences.

The study involves monitoring learner interactions, progress, and performance within the gamified e-learning environment, assessing a range of engagement indicators such as time spent, completion rates, and learner achievements, comparing the engagement indicators between the gamified and non-gamified e-learning modules, conducting pre- and post-assessments to evaluate knowledge retention and learning outcomes, and analyzing the assessment scores to determine the impact of gamification on knowledge acquisition and retention.

Engagement indicators will be measured using quantitative metrics such as time spent on the platform, course completion rates, and learner achievements. Time spent will be tracked through platform analytics, completion rates will be recorded by course modules completed, and learner achievements will be evaluated based on quiz scores and assignments.

Furthermore, the study includes interviewing a subset of learners who have completed the gamified e-learning modules to explore themes such as enjoyment, motivation, competitiveness, and perceived learning effectiveness during the interviews, transcribing the responses from the interviews, analyzing the transcriptions to identify recurring patterns, themes, and specific examples pertaining to the learners' experiences and perspectives regarding the gamification elements, administering surveys to a larger sample of learners who have experienced the gamified e-learning modules, including Likert-scale questions and open-ended items in the surveys to collect quantitative and qualitative data, aligning the survey questions with the research objectives, focusing on aspects such as overall impressions, motivation and engagement, impact on learning experience, enjoyment level, motivating elements, progress tracking, collaboration and competition, challenges or limitations, and recommendations for improvement, and performing a thematic analysis of the interview transcriptions and survey responses, coding and categorizing the responses into themes and sub-themes related to learner perceptions, experiences, and the impact of gamification on engagement, motivation, and learning.

Finally, data analysis involves applying statistical methods such as t-tests or ANOVA to compare engagement indicators and learning outcomes between the gamified and non-gamified e-learning modules, analyzing the quantitative data to provide evidence of the impact of gamification on learner engagement, motivation, and

knowledge retention, and performing a thematic analysis of the interview transcriptions and survey responses, coding and categorizing the responses into themes and sub-themes related to learner perceptions, experiences, and the impact of gamification on engagement, motivation, and learning.

The survey aims to investigate the impact of gamification in e-learning environments. Gamification, which involves integrating game elements and mechanics into non-game contexts, has gained significant attention in educational settings due to its potential to enhance learner engagement, motivation, and overall learning experience.

The purpose of this study is to gather valuable insights from participants regarding their perceptions of gamification elements in e-learning modules. By employing the Smart PLS approach, our goal is to uncover the relationships between various gamification aspects and key outcomes such as motivation, engagement, enjoyment, and learning effectiveness. The survey consists of 10 items, each addressing different aspects of the learners' experiences (Table 1).

Table 1: The summary of the survey structure

	Item	Abr	Description
1	Overall Impressions	OI	Participants are asked to provide their general impressions of the gamification elements used in the e-learning modules.
2	Motivation and Engagement	ME	Participants are prompted to reflect on how the gamification elements influenced their motivation to engage with the course materials.
3	Impact on Engagement	IE	Participants are asked to share specific examples of how the gamification elements enhanced their engagement and interest in the e-learning modules.
4	Enjoyment Level	EL	Participants are questioned about the influence of gamification elements on their level of enjoyment while completing the e-learning activities.
5	Learning Experience	Lex	Participants are asked to evaluate the impact of gamification on their learning experience, including improvements in understanding and retention of course content.
6	Motivating Elements	MoE	Participants are inquired about specific gamification elements that they found particularly motivating or engaging, along with their reasons.
7	Progress Tracking	PT	Participants are asked to assess whether the gamification elements provided clear goals and feedback that helped them track their progress, and how this influenced their learning experience.
8	Collaboration and Competition	CC	Participants are prompted to share their observations on whether the gamification elements promoted collaboration or competition among learners and how it affected their learning experience.
9	Challenges or Limitations	CL	Participants are asked to identify any challenges or limitations they encountered while engaging with the gamification elements.
10	Recommendations	Rec	Participants are given the opportunity to provide suggestions or recommendations for improving the implementation of gamification in future courses based on their experience with the gamified e-learning modules.

Each item is accompanied by Likert scale questions to collect participants' responses and perceptions on the gamification elements in the context of e-learning. We assign a Likert scale rating to each question, typically ranging from 1, indicating "Strongly Disagree," to 5, indicating "Strongly Agree."

3.1 Interpreting Path Coefficients in Structural Equation Modeling (SEM)

Path coefficients indicate the strength and direction of the relationships between the latent constructs (learner engagement, motivation, knowledge retention) and the observed indicators (survey items). Positive coefficients indicate a positive relationship, while negative coefficients indicate a negative relationship. The significance levels (p-values) are associated with the path coefficients.

A p-value lower than the selected significance level (e.g., $p < 0.05$) signifies a statistically significant relationship. Non-significant coefficients indicate that the relationship is not statistically significant in the study sample. Assessing the effect sizes, such as the standardized path coefficients or R-squared values, is essential. Larger effect sizes signify stronger relationships or greater variance explained by the model. Furthermore, it's crucial to analyze both the direct and indirect effects. Direct effects represent the direct relationships between constructs,

while indirect effects indicate relationships mediated through other constructs. Figure 1 illustrates the correlation between the perceived attributes. With reference to this figure, we can explain the impact of each attribute.
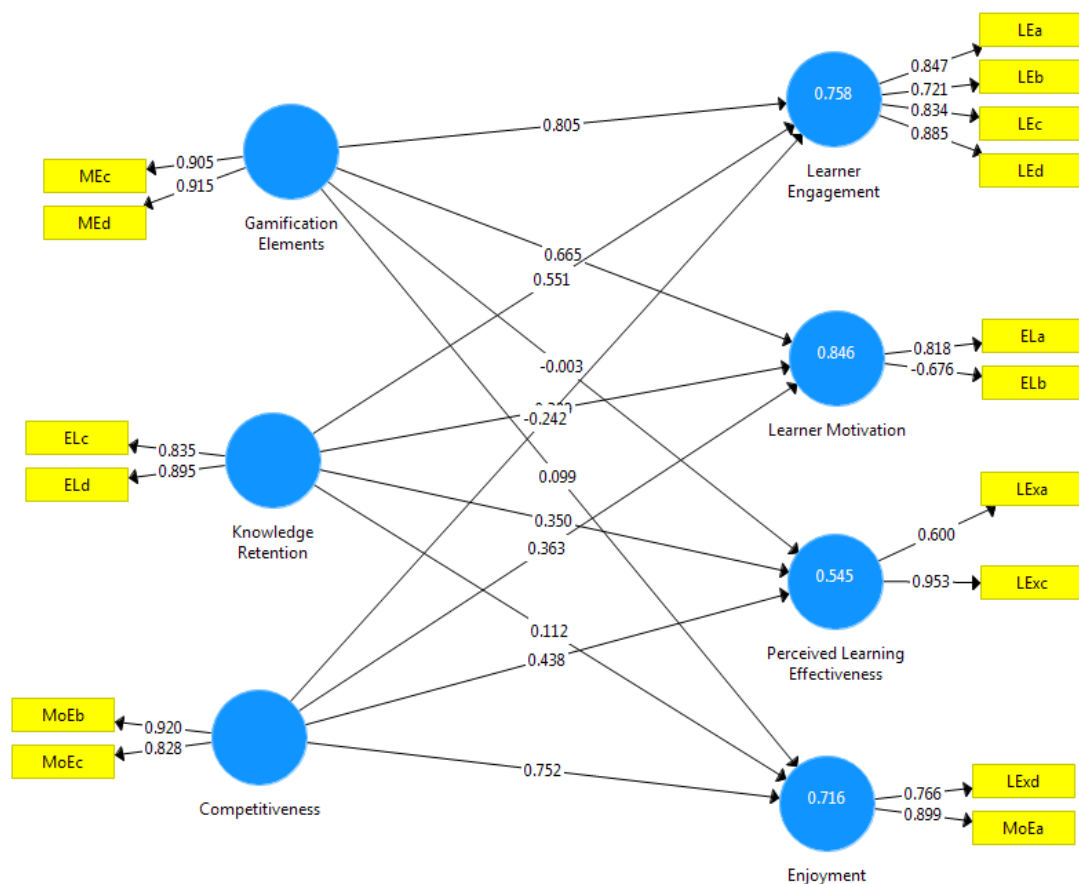

Figure 1: Correlation between perceived attributes

The correspondence between attributes and items based on the 10-item survey is:

3.2 Attribute: Gamification Elements

Item 1: Please rate the extent to which you found the points system in the gamified e-learning module motivating.

Item 2: To what extent did you perceive the badges and achievements as effective in improving your engagement with the e-learning content?

Item 3: To what degree did the leaderboard feature in the gamified e-learning platform influence your motivation to perform better?

Item 4: Please rate the level of challenge provided by the gamification elements in the e-learning modules.

3.3 Attribute: Learner Engagement

Item 5: How much time did you typically spend on the gamified e-learning platform per session?

Item 6: Did you complete all the modules and activities in the gamified e-learning environment? (Yes/No)

Item 7: How often did you engage with other learners or the instructor through the discussion forums or chat modules?

Item 8: Please rate your overall level of active participation and involvement in the gamified e-learning modules.

3.4 Attribute: Learner Motivation

Item 9: To what extent did the rewards and incentives offered in the gamified e-learning platform motivate your engagement with the content?

Item 10: Please rate the extent to which the competitive nature of the gamified e-learning environment increased your motivation to perform well.

3.5 Attribute: Knowledge Retention

Item 11: Before starting the gamified e-learning modules, please complete the following pre-assessment to evaluate your initial knowledge of the subject. Item 12: Following your completion of the gamified e-learning modules, please fill out the following post-assessment to evaluate your knowledge retention and learning outcomes. **Attribute: Perceived Learning Effectiveness**

Item 13: Overall, how effective were the gamification techniques in enhancing your learning experience? Item 14: To what extent the gamified e-learning modules were effective in improving your engagement with the course material? Item 15: How satisfied were you with the learning outcomes achieved through the gamified e-learning environment? **Attribute: Enjoyment**

Item 16: Please rate the level of enjoyment you experienced while engaging with the gamified e-learning modules. Item 17: How entertaining and enjoyable did you find the gamification elements integrated into the e-learning platform? **Attribute: Competitiveness**

Item 18: Did the inclusion of leaderboards and rankings in the gamified e-learning environment make you more competitive? Item 19: Please rate the extent to which the competitive challenges in the gamified e-learning modules motivated you to outperform others. We ensure that the items are clear, concise, and accurately capture the intended constructs.

3.6 The Results

Structural Equation Modeling (SEM) is a robust statistical method used in scientific research to examine and analyze multivariate causal relationships. In this study, we employed Smart PLS, a user-friendly software with a graphical interface, to perform variance-based SEM using the PLS path modeling approach.

This method is widely adopted in the existing literature (Alahmadi, 2024). Our analytical approach involved two steps: First, conducting a psychometric assessment of the measurement scales, and second, evaluating the structural model using Smart PLS (Asmolov and Ledentsov, 2023). To assess the reflective measurement, we considered Gamification Elements, Learner Engagement, Knowledge Retention, Perceived Learning Effectiveness, Competitiveness, Enjoyment, and Learner Motivation as the measured constructs.

The constructs exhibited high internal consistency, evidenced by composite reliability values exceeding 70 percent. In terms of the measurement model's results, we examined outer loadings, average variance extracted (AVE), and composite reliability (CR) to confirm convergent validity.

The outer loadings for the seven constructs ranged from 0.841 to 0.931 for "Gamification Elements," 0.728 to 0.878 for "Learner Engagement," 0.843 to 0.888 for "Knowledge Retention," 0.729 to 0.848 for "Perceived Learning Effectiveness," 0.740 to 0.886 for "Competitiveness and Learner Motivation," 0.769 to 0.896 for "Enjoyment," and 0.745 to 0.758 for "Competitiveness." The AVE values for the constructs varied from 0.354 to 0.874, while the CR values ranged from 0.867 to 0.921. Convergent validity was confirmed by assessing the AVE values, all of which exceeded 50 percent, and the outer loadings. Furthermore, the latent variable correlations showed values of 0.711 for "Gamification Elements," 0.812 for "Learner Engagement," 0.854 for "Knowledge Retention," 0.741 for "Perceived Learning Effectiveness," 0.721 for "Competitiveness," 0.854 for "Enjoyment," and 0.869 for "Learner Motivation."

We also ensured discriminant validity by examining the cross-loadings, which confirmed that each item was predominantly loaded on its respective construct (Chin, 1998). Additionally, we assessed the validity of the Fornell-Larcker criterion (Fornell and Larcker, 1981), as outlined in Table 2.

Table 2: Discriminant Validity: Cross Loading

	Gamification Elements	Learner Engagement	Knowledge Retention	Perceived Learning Effectiveness	Competitive ness	Enjoyment	Learner Motivation
Mec	**0.931**	0.125	0.259	0.112	0.254	0.257	0.321
Med	**0.841**	0.254	0.158	0.325	0.098	0.177	0.258
Lea	0.147	**0.840**	0.330	0.335	0.180	0.233	0.189
LEb	0.255	**0.728**	0.228	0.150	0.133	0.211	0.156
LEc	0.128	**0.841**	0.266	0.133	0.213	0.255	0.265
Led	0.410	**0.878**	0.094	0.213	0.369	0.123	0.321
ELc	0.351	0.245	**0.843**	0.258	0.546	0.258	0.325
ELd	0.013	0.214	**0.888**	0.269	0.259	0.269	0.321
LExa	0.094	0.105	0.315	**0..729**	0.422	0.215	0.366
LExc	0.208	0.037	0.182	**0.848**	0.318	0.269	0.214
MoEb	0.454	0.049	0.258	0.158	**0.921**	**0.295**	**0.215**
MoEc	0.482	0.535	0.461	0.268	**0.826**	**0.321**	**0.219**
LExd	0.159	0.265	0.521	0.212	**0.321**	**0.769**	**0.123**
LExc	0.268	0.215	0.258	0.321	**0.261**	**0.896**	**0.254**
Ela	0.123	0.254	0.231	0.320	**0.259**	**0.125**	**0.758**
ELb	0.268	0.412	0.256	0.123	**0.351**	**0.254**	**0.745**

4. Discussion

In this section we will discuss and explain the impact of each attribute.

4.1 Gamification Elements and Learner Engagement

The analysis indicates a positive impact of gamification elements on learner engagement, with a weight of 0.805 This implies that integrating gamification techniques in e-learning modules increases learner engagement. Gamification elements, such as point systems, badges, leaderboards, or challenges, can motivate learners to actively engage with course materials and spend more time on the e-learning platform. The positive relationship between gamification elements and learner engagement is consistent with previous research, which suggests that gamification can improve learner involvement, attentiveness, and interaction with educational content. The introduction of game-like elements may lead to feeling more immersed in the learning process, ultimately resulting in increased engagement and active participation.

4.2 Gamification Elements and Learner Motivation

The analysis shows a positive impact of gamification elements on learner motivation, with a weight of 0.665. This suggests that incorporating gamification techniques in e-learning modules can enhance learner motivation. Gamification elements, such as rewards, incentives, and competitive challenges, can stimulate both intrinsic and extrinsic motivation in learners, encouraging them to engage with the course materials and perform effectively. Gamification leverages learners' desire for achievement, recognition, and progress, enhancing their motivation to actively participate and complete learning activities. By providing tangible rewards or fostering a sense of competition, gamification elements can fuel learners' drive to succeed and excel in the e-learning environment.

4.3 Gamification Elements and Perceived Learning Effectiveness

The analysis suggests a negative impact of gamification elements on perceived learning effectiveness, with a weight of -0.003. This implies that learners tend to perceive gamification as having a slightly negative effect on their perception of learning effectiveness. It is essential to emphasize that negative weight does not necessarily imply a significant decrease in perceived learning effectiveness, but rather a slight attenuation compared to the other attributes. The negative relationship might stem from the perception that gamification elements could be seen as superficial or distracting, diverting attention away from the actual learning outcomes. Furthermore, learners may regard the game-like features as primarily entertaining rather than making a significant contribution to their understanding and retention of the course content.

4.4 Gamification Elements and Enjoyment

The analysis reveals a positive impact of gamification elements on enjoyment, with a weight of 0.099. This implies that incorporating gamification techniques in e-learning modules can enhance learners' enjoyment of the learning experience. Through the inclusion of game-like elements, such as challenges, rewards, and engaging interactions, learners may discover the e-learning modules to be more enjoyable and entertaining. Enjoyment plays a crucial role in fostering engagement and motivation. When learners find the learning process enjoyable, they are more inclined to be actively engaged, enthusiastic, and motivated to sustain their learning journey. Gamification elements offer opportunities for learners to attain a sense of achievement, progress, and excitement, thereby contributing to a more enjoyable learning experience.

4.5 Knowledge Retention and Learner Engagement

The analysis indicates a positive relationship between knowledge retention and learner engagement, with a weight of 0.551. This implies that learners who retain knowledge from the e-learning modules are more inclined to engage in the learning process. When learners effectively recall and apply the course content, they may might experience a sense of accomplishment, leading to increased participation in subsequent learning activities. The positive relationship between knowledge retention and learner engagement aligns with the idea that a solid understanding of the subject matter fosters deeper engagement and participation. When learners retain information, they are better equipped to interact with the course materials, pose questions, and engage in discussions, resulting in an overall increase in engagement.

4.6 Knowledge Retention and Learner Motivation

The analysis reveals a negative relationship between knowledge retention and learner motivation, with a weight of -0.242. This suggests that there is a slight decrease in learner motivation as knowledge retention increases. It is crucial to note that the negative weight does not signify a significant decrease in motivation, but rather a slight attenuation compared to the other attributes. The negative relationship can be attributed to several factors. For instance, learners who have already retained knowledge might feel less motivated to engage with the same content repeatedly or may experience a reduction in novelty. Additionally, learners who consider themselves as having mastered the material might exhibit lower motivation to continue their learning journey.

4.7 Knowledge Retention and Perceived Learning Effectiveness

The analysis indicates a positive impact of knowledge retention on perceived learning effectiveness, with a weight of 0.350. This implies that learners who retain knowledge from the e-learning modules tend to view their LEx as more effective. When learners can recall and apply the acquired knowledge, they develop a sense of competence and confidence in their learning outcomes, which contributes to a positive perception of learning effectiveness. The positive relationship between knowledge retention and perceived learning effectiveness suggests that the capacity to retain knowledge enhances learners' confidence in their learning achievements. Learners who believe they have successfully retained information are more inclined to perceive the learning process as effective in fulfilling their educational objectives.

4.8 Knowledge Retention and Enjoyment

The analysis demonstrates a positive impact of knowledge retention on enjoyment, with a weight of 0.112. This implies that learners who retain knowledge from the e-learning modules are more likely to find enjoyment in the learning process. When learners can remember and apply the learned content, they may experience a sense of mastery and satisfaction, resulting in a more enjoyable learning experience. The positive relationship between knowledge retention and enjoyment indicates that successful retention of knowledge enhances learners' overall satisfaction and positive emotions throughout the learning process. The ability to recall and apply information

fosters a sense of progress and achievement, subsequently elevating the enjoyment of the e-learning experience.

4.9 Competitiveness and Learner Engagement

The analysis indicates a negative impact of competitiveness on learner engagement, with a weight of -0.242. This indicates that as competitiveness increases, learner engagement decreases. It implies that a highly competitive environment may hinder learner engagement in the e-learning modules. The negative relationship between competitiveness and learner engagement could be attributed to various factors. Excessive competition might foster a stressful or pressurized atmosphere, diverting learners' attention from the learning material. Furthermore, intense competition may redirect learners' attention more toward outperforming others rather than engaging with the content itself.

4.10 Competitiveness and Learner Motivation

The analysis shows a positive impact of competitiveness on learner motivation, with a weight of 0.363. This implies that as competitiveness increases, learner motivation also increases. It suggests that a competitive environment within the e-learning modules can act as a motivating factor for learners.

The positive relationship between competitiveness and learner motivation suggests that learners may be inclined to excel when a competitive element is present. The presence of leaderboards, rankings, or competitive challenges can foster a desire to outperform others and achieve higher results, thus enhancing learner motivation.

4.11 Competitiveness and Perceived Learning Effectiveness

The analysis indicates a positive impact of competitiveness on perceived learning effectiveness, with a weight of 0.438. This suggests that as competitiveness increases, learners perceive their LEx as higher. A competitive environment within the e-learning modules appears to have a positive impact on learners' perception of their learning outcomes.

The positive relationship between competitiveness and perceived learning effectiveness suggests that competition can create a sense of accomplishment and improvement in learners' understanding and skills. The drive to outperform others may motivate learners to invest more effort and engage in deeper learning, resulting in a perception of higher learning effectiveness.

4.12 Competitiveness and Enjoyment

The analysis shows a positive impact of competitiveness on enjoyment, with a weight of 0.752. This implies that as competitiveness increases, learners' enjoyment of the e-learning modules also increases. A competitive environment appears to enhance the overall enjoyment experienced by learners. The positive relationship between competitiveness and enjoyment shows that competition can generate a sense of excitement, challenge, and satisfaction for learners.

The opportunity to compare their performance with others and strive for better results can enhance the overall enjoyment of the learning experience. Finally, based on the provided weights, the analysis suggests that competitiveness negatively affects learner engagement but positively affects learner motivation, perceived learning effectiveness, and enjoyment.

These findings highlight the importance of carefully designing competitive elements within e-learning modules to ensure they enhance motivation and perceived effectiveness without compromising learner engagement. Striking a balance that fosters healthy competition while maintaining a supportive and engaging learning environment is essential. The analysis suggests that knowledge retention has a positive impact on learner engagement, perceived learning effectiveness, and enjoyment. However, there is a slight negative impact on learner motivation. These findings emphasize the importance of designing e-learning modules that promote knowledge retention while ensuring that learner motivation remains high.

Educators and instructional designers should incorporate strategies that maintain motivation throughout the learning process, even as learners retain knowledge and deepen their understanding of the content. Furthermore, the analysis suggests that competitiveness has a negative impact on learner engagement while positively influencing learner motivation, perceived learning effectiveness, and enjoyment. These findings highlight the importance of carefully designing competitive elements within e-learning modules to ensure that they enhance motivation and perceived effectiveness without compromising learner engagement. Striking a

balance that promotes healthy competition while maintaining a supportive and engaging learning environment is essential.

The literature on gamification in education reveals a broad spectrum of findings concerning its effectiveness. For instance, Deterding et al. (2018) demonstrated that point systems and leaderboards significantly enhanced student motivation, yet they noted that these elements could sometimes lead to increased anxiety among learners. In contrast, Hamari et al. (2019) found that while badges and rewards positively influenced engagement, they had little effect on long-term knowledge retention.

These varied outcomes underscore the complexity of gamification as a pedagogical tool, particularly in online learning environments. Previous research has often treated gamification as a monolithic construct, without adequately differentiating between the effects of its individual components. Our study addresses this limitation by examining specific gamification elements—such as points, badges, and leaderboards—and their distinct impacts on learner outcomes in an e-learning context. By doing so, we aim to fill a critical gap in the literature and provide more targeted insights for educators seeking to implement gamification in their courses. Our research seeks to provide valuable insights into the effectiveness of gamification techniques and contribute to the design and implementation of gamified online learning environments. Through a comprehensive literature review and empirical studies, this study aims to deepen the understanding of the relationship between gamification and learner outcomes in online education. Through examining the utilization of gamification elements and the utilization of surveys, interviews, and data analysis, the study's objective is to collect insights from a diverse sample of online learners and examine the benefits of gamification in improving engagement, motivation, and knowledge retention.

The study findings reveal that there is a positive relationship between gamification elements on learner engagement and motivation. Integrating game-like elements, such as points systems, badges, and challenges, enhances learner engagement and increases their enjoyment of the learning experience. Furthermore, gamification techniques have a positive impact on knowledge retention, as learners who retain knowledge tend to be more engaged in the learning process. However, there is a slight negative impact on perceived learning effectiveness, potentially arising from the perception of gamification as superficial or distracting.

This research makes a significant contribution to the existing literature by providing evidence of the positive impact of gamification on learner engagement, motivation, and knowledge retention in online education. By filling the gap in comprehensive research on gamification in online learning environments, the study aims to provide evidence-based recommendations for the effective integration of gamification into educational practices. The study holds significant implications for educators, instructional designers, and policymakers, highlighting the potential of gamification techniques to improve learner outcomes in online education.

5. Conclusion

This study delved into the impact of gamification techniques on e-learning outcomes, focusing on learner engagement, motivation, knowledge retention, perceived learning effectiveness, enjoyment, and competitiveness. Our findings provide valuable insights into how gamification elements influence these constructs, guided by the theoretical framework of SDT.

Key findings from our study include:

1. **Enhanced Learner Engagement and Motivation**: Gamification elements significantly boost learner engagement and motivation, with weights of 0.805 and 0.665, respectively. These elements act as catalysts, encouraging learners to interact more deeply with course materials and actively participate in learning activities.

2. **Increased Enjoyment**: The incorporation of gamification techniques enhances learners' enjoyment of the learning experience, evidenced by a weight of 0.099. Enjoyment plays a crucial role in sustaining engagement and motivation throughout the learning process.

3. **Complex Impact on Perceived Learning Effectiveness**: Despite the positive effects on engagement and enjoyment, gamification elements exhibit a slight negative impact on perceived learning effectiveness, with a weight of -0.003. This suggests that while gamification can make learning more engaging and enjoyable, it is crucial to ensure that these elements do not overshadow the primary educational objectives.

4. **Positive Correlation between Knowledge Retention and Engagement**: Knowledge retention shows a strong positive correlation with learner engagement (weight of 0.551) and perceived learning effectiveness (weight of 0.350). Effective retention strategies are vital for enhancing learners' perceptions of their learning achievements and sustaining their engagement.

5. **Divergent Impacts of Competitiveness**: Competitiveness in gamification positively influences learner motivation, perceived learning effectiveness, and enjoyment (weights of 0.363, 0.438, and 0.752, respectively). However, it negatively affects learner engagement, with a weight of -0.242. This indicates the need for a balanced approach to incorporating competitive elements, maximizing their motivational benefits while minimizing their potential to reduce engagement.

Implications for Practice: Our study provides robust evidence supporting the efficacy of gamification techniques in e-learning. By leveraging insights from statistical analyses and theoretical frameworks like SDT, educators and instructional designers can craft tailored gamified e-learning environments. Key recommendations include:

- **Integrate Meaningful Gamification Elements**: Design gamification elements that align closely with educational objectives to ensure they enhance, rather than distract from, learning outcomes.

- **Foster a Balance in Competitive Elements**: Implement competitive elements that motivate learners while maintaining a supportive and engaging environment to prevent excessive pressure or stress.

- **Promote Knowledge Retention**: Employ strategies that actively engage learners to promote knowledge retention, thereby enhancing perceived learning effectiveness and overall satisfaction with the learning experience.

Gamification holds significant potential to enrich e-learning experiences by increasing engagement, motivation, and enjoyment. However, careful design and implementation are essential to balance these benefits with the need to maintain focus on core learning objectives. These findings contribute to the growing body of literature on gamification in online education and offer practical guidelines for educators and instructional designers aiming to optearning environments

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