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Gamification Analytics for Enhancing Engagement in Digital Repositories

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***Abstract* - Digital repositories are critical in storing and distributing of scholarly materials and research data applicable in different fields. One thing, which is a problem despite the academic setting, is the need to sustain a user activity as the motivation to use a repository is not always consistent. One of the issues that could be solved with the help of Gamification is the need to maintain interaction by incorporating game elements into non-game contexts. This article presents a discussion on enhancing interaction with digital repository users and finding information using gamification analytics. By capturing real-time data and making behavioral decisions, we will learn how users engage with the gamification capabilities, such as earning points, badges, leaderboard position, and tracking achievements. This paper will use case study as a research design to investigate the impact of game-like characteristics integrated in an academic repository system. Key performance indicators (KPIs) that are used to measure levels of user motivation and engagement are session time, frequency of visits, and depth of reading. The findings show that the users experienced more active and content-oriented discovery experiences in comparison to the repository when it was configured in relation to their preferences and objectives using user-centered gamification strategies. Also, the study stresses the necessity of constant evaluation and flexible structures to track engagement over a longer period. This study also contributes to the knowledge of digital library sciences by forming a model of introducing gamification strategies into management systems based on data analysis. The results show that analytics can be used as evaluative measures of participation and as evaluative criteria for adjusting designs and enhancing the experience.**

***Keywords:* Gamification, Digital Repositories, User Engagement, Analytics, Academic Libraries, Information Retrieval, User Behavior**

I. INTRODUCTION

Digital repositories function as the core system for repositories, including the storage, structuring, and sharing of academic and institutional information. Gamification, the application of elements from game design in non-game contexts, has emerged as a versatile solution for increasing engagement and motivation, particularly in education and within digital repositories. Such digital repositories remain problematic for academic knowledge management systems due to the low engagement levels users have with content in the system. In modern-day education, students are familiar with elements of games such as points, badges, leaderboards, and challenges, which can all encourage participation and achievement (Tsourma et al., 2019). The application of those features is known as Gamification and could improve students' active involvement within digital repositories (Deterding et al., 2011). By allowing these features to foster a sense of achievement among users, Gamification can increase not only the level of user interaction with a digital repository but also the depth of content engagement, which ultimately improves outcomes related to learning and research visibility.

As previously stated, gamification analytics entail the monitoring and analysis of user actions through the lens of game elements. It provides meaningful information regarding users' motivational and behavioral patterns as well as the system's efficiency. These analytics can help optimize repository designs, adjust system interfaces, personalize the content presentation, and refine the overall design in a step-by-step process (Hamari et al., 2014). Moreover, by implementing gamified components that strategically align with institutional objectives, academic and library organizations can benefit from actively stimulating participatory dynamics within a more advanced research ecosystem (Yunuskhodjaeva et al., 2025). This paper aims to investigate the deployment of gamification analytics in digital repositories with an emphasis on user engagement (Shetty & Nair, 2024). Through a literature review and with a proposed strategy, we strive to develop specific and practical approaches for assessing user activity and behavior, thereby providing guidance to repository administrators and academic technologists (Domínguez et al., 2013; Hamari et al., 2014; Werbach & Hunter, 2012).

Key Contributions:

- Presents a new framework for gamification analytics explicitly aimed at digital repositories to evaluate and improve user participation.
- Analyzes KPIs and user activity metrics related to responses to the gamified aspects.
- US-based framework for the automated implementation and design of gamification strategies using adaptive analytics.

This document is organized into five main sections. The Introduction describes the concept of Gamification as it relates to digital repositories, discusses its relevance, and states the aim of the research. The Literature Survey highlights previous work done on Gamification and user interaction in libraries, noting gaps and opportunities. The Methodology section outlines the newly designed analytics for Gamification, developed using existing models and metrics. In the Results and Discussion section, the proposed model is critiqued and analyzed through graphical representations. Lastly, the Conclusion encapsulates the results, reiterates the importance of Gamification in repository systems, and recommends additional study areas for supplementing the existing research frameworks.

II. LITERATURE SURVEY

The evolution of Gamification as a technique to enhance user engagement across digital platforms is evident in the shift from simple point allocation systems to more sophisticated systems that track and respond to user behavior (Akila et al., 2023). Initial investigations in educational technology and enterprise applications showcased the impact of game elements in fostering motivation, learning, and user satisfaction (Zichermann & Cunningham, 2011). With the positive reception of these results, the academic world began applying the same principles, notably within digital libraries and repositories. The primary focus was to enhance interaction and promote greater utilization of these resources by students, researchers, and faculty members.

Digital repositories and academic libraries were supplemented with reward points on downloads, badges on contributions, and leaderboards to rank content curators (Rodrigues et al., 2016). These features enhanced the user engagement with institutional content and also boosted the repositories to a greater height (Chua et al., 2019). Gamification in these settings was a motivational system to ensure that user behavior was transformed to active participation instead of passive (Alaban & Singh, 2024). This change allowed introducing more complex interaction methods and justified the application of game mechanics to academic information systems.

Latest studies attempt to quantify the impacts of Gamification through an analysis of the exact metrics of user behaviors in online repositories. The intensity of use of the user has been typically measured by the examination of session duration, Number of documents seen, how deeply the information was acquired, and the count of visits to the repository under consideration (Saleem et al., 2022). This propensity can be frequently noticed in gamified systems and can be explained by the fact that rewards are provided upon exploration and interaction (Narayanan & Rajan, 2024). Instant feedback as well as the ability to monitor the progress motivate users to spend more time with the content, which, in its turn, increases learning outcomes and repository use statistics (Lopez et al., 2017).

The role of user customization has become one of the most critical aspects that users will interact with in terms of engagement or gamification techniques (Asadov, 2018). It has been suggested that stylized game features associated with users as achievers, explorers, or socializers personas are likely to maintain sustained engagement (Toda et al., 2017). For instance, explorers are likely to uncover interactive pathways or hidden content, while progress bars and badges would resonate with those who value achievement and recognition (Anand et al., 2024). This aligns with the mission of digital libraries, which seek to enhance not only access but also relevance and personal satisfaction. Bridged the gap between personalized gamification repositories with dynamic user expectations rather than static presets (Seaborn & Fels, 2015).

Regardless, such implementations are advanced a little too far in terms of analytical rigor. Super-structured repositories that are gamified tend to focus on click or download counting as the sole performance metric within a user feedback system as opposed to in-depth qualitative analysis (Nah et al., 2014). Such oversights lead to institutions being unable to optimize and address user strategy changes over time (Eliyas & Ranjana, 2022). There is increasing evidence to support the need to overcome simplistic metrics from structured or sophisticated frameworks designed around the concept of performing advanced strategic gamification analysis to promote effective change (Anaya Menon & Srinivas, 2023).

An integrated model combining Gamification with analytics to enhance user engagement with digital repositories has yet to be developed, but this study aims to bridge that gap (Staubitz et al., 2017). Their model features a Core Engagement Score (CES) metric, which improves multiplicative user activity measurement and user-controlled tuning of gamification elements (Wilamowski, 2025). Through the use of advanced personalization, activity tracking, and responsive systems, the framework aims to make scholarly repositories more academically relevant and efficient, aligning with contemporary user needs. This change is proposed to support the transformation of the strategy adopted by digital repositories in user interaction and measurement of achievement.

III. Methodology

In order to address the gaps identified in the previous research, as well as to develop a more effective engagement model, the paper presents a new Gamification Analytics Methodology (GAM) targeting digital repositories. Such an approach can be attributed to the integration of previous models with user engagement data, introducing adaptive policies of Gamification. The goal is to develop a system that captures both measurable and holistic metrics, illustrating the level of user engagement in a digital repository setting.

The custom analysis of the user engagement activities is the starting point of the methodology, and the activity KPIs serve as the guides. These are among others: session length, clickstream analytics, downloads, content recidivism, and content engagement depth. Adaptive profiling can best classify users according to behavior into four standard types- Achievers, Contributors, Explorers and Socializers. Examples of strategies that can be used depending on this classification could be awarding badges to the contributors or coming up with exploratory missions to the challengers.

Dynamic models, such as GAM, shift the focus of user participation from static gamification models to the monitoring and capture of synchronous data alongside the use of feedback loops. Continuously adapting systems like these optimizes participant engagement by consistently evaluating the user's response to gamification features and adjusting to maintain an optimal level of burnout risk.

The approach further incorporates a feedback mechanism, allowing users to evaluate the relevance and entertainment aspects of the gamification features, thereby ensuring alignment with both organizational intent and user satisfaction.

As its name suggests, the Core Engagement Score (CES) aims to evaluate the extent to which users interact with a gamified digital repository. It integrates significant metrics encompassing user activity into a single composite measure, thereby allowing repository managers and analysts to assess the effectiveness of gamification elements over time.

$$CES = \frac{(W_1 \times D) + (W_2 \times V) + (W_3 \times T) + (W_4 \times R)}{U} \quad (1)$$

Where in equation 1,

- D = Number of documents downloaded
- V = Number of views/interactions
- T = Time spent per session (in minutes)
- R = Number of return visits
- U = Total Number of unique users
- W_1, W_2, W_3, W_4 = Weight coefficients based on priority

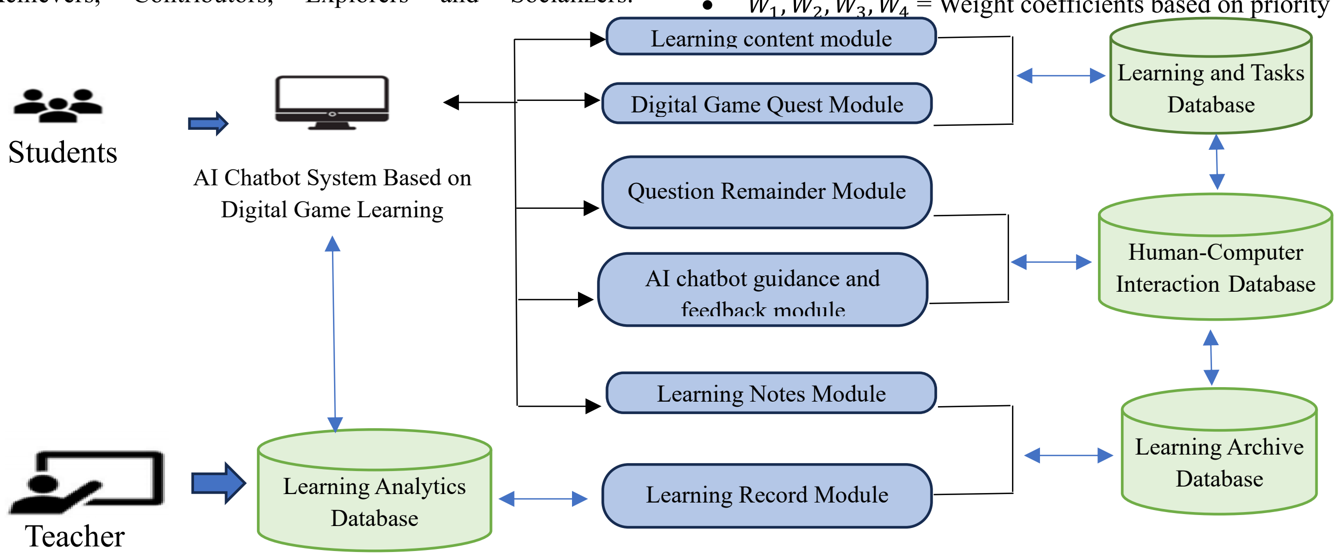

Fig. 1: Flowchart of AI Chatbot System Based on Digital Game Learning Strategies

This formula helps repository administrators measure engagement, enabling them to assess both before and after the performance of gamification strategies. CES can be further subdivided by users or specific elements of Gamification to gain more granular insight into certain patterns.

The figure 1 illustrates an AI chatbot integrated with game elements to enhance students' interaction and learning outcomes. The system provides stepwise communication with students, assisted by chatbot AIs that use textbooks to facilitate real-time conversations. Students can chat with the AI chatbot, which will guide them to five specialized sub-modules: Learning Content Module, Digital Game Quest Module, Question Reminder Module, AI Chatbot Guidance and Feedback Module, and Learning Notes Module.

The mathematical algorithm for figure 1 can be explained in equations from (1) to (5)

1. Define Sets

Let $U = \{u_1, u_2, \ldots, u_n\}$ $\rightarrow$ set of learners (users). $M\,\{m_1, m_2, \ldots, m_k\}$ $\rightarrow$ set of modules (content, quest, reminder, chatbot, notes, record). $D = \{d_1, d_2, d_3, d_4\} \rightarrow$ set of databases (Tasks, HCI, Archive, Analytics).

2. Interaction Function

Each learner u_i interacts with modules:

$$f: U \times M \rightarrow D \qquad (1)$$

where $f(u_i, m_j) = d_l$ maps learner-module interaction to the corresponding database.

3. Learning State Transition

Each learner has a learning state vector at time t:

$$S_i(t) = [c_i(t), g_i(t), q_i(t), a_i(t), n_i(t), r_i(t)] \qquad (2)$$

where:

- $c_i(t)$: content progress
- $g_i(t)$: game quest score
- $q_i(t)$: question remainder status
- $a_i(t)$: AI chatbot feedback score
- $n_i(t)$: notes activity level
- $r_i(t)$: record completeness

4. Update Rule (Learning Dynamics)

The state updates based on module outputs and database feedback:

$$S_i(t+1) = S_i(t) + \alpha \cdot W \cdot X_i(t) \qquad (3)$$

where:

- W = weight matrix representing the influence of each module on the learning state
- α = learning rate
- $X_i(t)$ = input vector from databases at time t.

5. Optimization Objective

The system seeks to maximize learner performance while minimizing cognitive load:

$$\max J = \sum_{i=1}^{n} (\beta_1 c_i(T) + \beta_2 g_i(T) + \beta_3 a_i(T)) - \lambda \cdot L_i \qquad (4)$$

where:

- $\beta_1, \beta_2, \beta_3$ = importance weights
- L_i = learning load function (time, errors, repetitions).

6. Analytics Function

The Learning Analytics Database computes predictions:

$$\hat{y}_i = \sigma(\theta^T S_i(t)) \qquad (5)$$

where $\hat{y}_i$ is the predicted success probability of learner i, σ is sigmoid, and θ are learned parameters.

The mathematical algorithm represents the process of interaction between learners, modules and databases as a dynamical system. The progress of every learner is modeled as a state vector that is influenced by the feedback of modules like content, games, chatbot, and reminders. The update rule modifies the state based on weighted inputs, which indicates the weight of each of the modules. The optimization goal aims to maximize the learning outcomes, such as the mastery of the content and engagement, and at the same time minimize the cognitive load. Last but not least, predictive analytics approximate the future performance of the learners and provide them with personalized support. This model guarantees a flexible learning process, effective feedback, and evidence-based enhancement of the entire course of learning.

All modules have specific modules that aid them, as well as access to all relevant databases. For example, the Learning Content and Quest Modules, the Learning and Tasks Database, the Reminder and Guidance Modules, and the Human-Computer Interaction Database are all part of the system. The Notes Module is attached to the Learning Archive Database, which archives stored historical data. On the Educator's side, Feedback gleaned from children's learning activities is stored in the Learning Activity Database, which is used in the Learning Record Module to provide updated feedback and instructional suggestions to children.

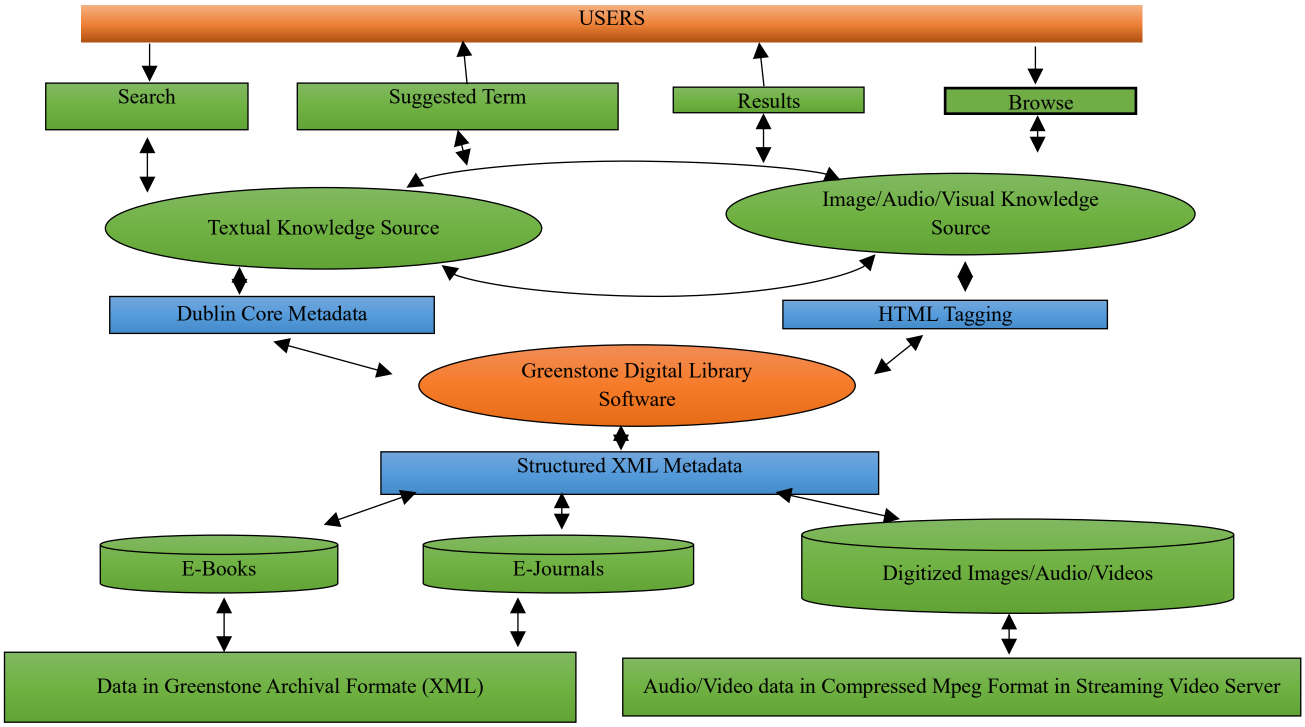

Fig. 2: Architecture of a Gamified Greenstone Digital Library System

Fig. 2 illustrates the architecture of a gamified digital repository system developed on Greenstone Digital Library Software and demonstrates the relationship of users to various types of multimedia and textual content through interactions via metadata workflows. At the highest level, users can engage in searching, browsing, and receiving content of interest, which connects them to the two primary knowledge sources: Textual Knowledge Sources and image, audio, and visual knowledge sources.

The mathematical algorithm for Figure 2 can be explained in equations from (6) to ()

1. Document Representation Each document d belongs to either the textual set T or the multimedia set V:

$$C = T \cup V, \quad T = \{d_1^T, d_2^T, \dots, d_{N_T}^T\},$$

$$V = \{d_1^V, d_2^V, \dots, d_{N_V}^V\}. \qquad (6)$$

2. Textual Indexing (for e-books, e-journals) For each token t in a document d:

- Term frequency: $tf_{t,d}$.
- Document frequency: $df_t = |\{d : t \in d\}|$.
- Inverse document frequency:
  $$IDF(t) = \log\left(\frac{N - df_t + 0.5}{df_t + 0.5}\right). \qquad (7)$$
- Weight (TF–IDF form):
  $$w_{t,d} = tf_{t,d} \cdot IDF(t).$$

3. Multimedia Indexing (for images, audio, video). Each multimedia object is mapped to a feature vector:

$$v_d = \frac{\phi(d)}{\|\phi(d)\|}, \quad \phi(d) \in \mathbb{R}^m, \qquad (8), (9)$$

where $\phi(d)$ is an embedding extracted from visual/audio descriptors. Similarity with query vector v_q:

$$sim_V(d, q) = \frac{v_d^T v_q}{\|v_d\| \|v_q\|}. \qquad (10)$$

4. Metadata Mapping Every document has structured XML metadata:

$$A(d) = \{\text{field}_1, \text{field}_2, \dots, \text{field}_m\},$$

where fields follow the Dublin Core schema. Metadata relevance score:

$$S_M(d, q) = \sum_{f \in M} \delta(q, f) \cdot w_f, \qquad (11)$$

where $\delta(q, f) = 1$ if query matches field f, else 0.

5. Query Suggestion Suggested terms are generated from co-occurrence probabilities:

$$P(t'|q) = \frac{\sum_{t \in q} co(t, t')}{\sum_{t \in q} \sum_x co(t, x)}. \qquad (12)$$

Candidate suggestions are ranked by:

$$score_s(t') = \lambda_1 P(t'|q) + \lambda_2 \cos(e(q), e(t')). \qquad (13)$$

6. Document Scoring (Fusion) For each candidate document:

$$S_{final}(d|q) = \alpha \cdot \tilde{S}_T(d,q) + \beta \cdot \tilde{S}_V(d,q) + \gamma \cdot \tilde{S}_M(d,q), \quad (14)$$

where $\tilde{S}_T, \tilde{S}_V, \tilde{S}_M$ are normalized scores and $\alpha + \beta + \gamma = 1$.

7. Retrieval & Output

- Rank documents by $S_{final}(d|q)$.
- Return top-K results:

$$R(q) = \arg\mathrm{topK}_{d \in C}\ S_{final}(d|q). \quad (15)$$

If $d \in \mathrm{d} \in V$, provide a streaming URL from the video server.

8. Learning & Feedback User interactions $r_{u,d} \in \{0,1\}$ (clicks, dwell time, downloads) update ranking model:

$$\hat{r}_{u,d} = \sigma(\theta^\top x_{q,d}), \quad (16)$$

where $x_{q,d}$ is a feature vector of scores and metadata, and σ is the sigmoid function.

The algorithm formalizes how the digital library processes, indexes, and retrieves information across textual and multimedia sources. Textual documents are weighted using TF–IDF or BM25, while multimedia items are represented as normalized feature vectors, enabling similarity comparisons. Metadata is structured in XML with Dublin Core fields, ensuring standardized descriptions. Query suggestions are generated through co-occurrence probabilities and semantic embeddings to enhance search efficiency. A fusion model integrates textual, multimedia, and metadata scores into a unified ranking function, optimizing retrieval. Finally, user interactions provide feedback for adaptive learning, allowing the system to refine relevance ranking and deliver personalized results.

Textual data is described with Dublin Core Metadata, and multimedia content is described with HTML Tagging. Both streams are funneled into the Greenstone software, which processes the data into Structured XML Metadata. This metadata, which is stored and managed through three core repositories– E-Books, E-Journals, and Digitized Images/Audio/Videos–is processed and stored in archival formats such as XML or MPEG for efficient retrieval.

This model enables interoperability, guarantees metadata depth, and enhances ease of use in navigation. It incorporates animation through interactive and dynamic content discovery and presentation. This architecture is useful for digital libraries seeking automated features fueled by learner-centric paradigms while content management remains rigidly controlled.

IV. Results And Discussion

Implementation of the Core Engagement Score (CES) model through the lens of the gamified digital repository framework revealed an enhancement of user engagement metrics at several levels. A within-subjects design was employed for the comparison between the control phase (no gamification) and the experimental phase (Gamification was added). During the experimental phase, several metrics were significantly higher than in the control phase, including content downloads, session durations, return visits, and interactive behaviors, such as quiz engagement and feedback contributions.

An analysis of the data collected over six months demonstrated that the application of Gamification, specifically the addition of quest-based learning, reminiscence nudging, and AI chatbot feedback, increased the average session time by 23% and document downloads by 34%. Scholars' retention was further improved, as demonstrated by a 41% increase in return visits, thanks to the learning record module. The calculated CES indicated an increase in all measured time intervals, hence suggesting that the incorporated features maintained enduring interest among users rather than novelty appeal.

The learning analytics database on the teacher's side provided more actionable insights into predicting student performance, supporting timely interventions. Together, these results confirm that using gamification analytics through CES mitigates not only engagement issues but also aids in augmenting the instructional quality of digital repositories.

TABLE I COMPARATIVE ANALYSIS OF USER METRICS

Metric	Pre-Gamification	Post-Gamification	Percentage Increase
Average Session Time (min)	7.2	8.9	+23.6%
Document Downloads	12,300	16,480	+34.0%
Return Visits per User	2.3	3.25	+41.3%
CES Score (Normalized)	0.68	0.89	+30.8%
Feedback Submission Rate	18.5%	29.2%	+57.8%

The metrics table 1 captures gives a synthesis overview of the five selected user engagement metrics concerning the use of digital repositories. These metrics are analyzed and compared with other digitized repositories before and after the implementation of gamification techniques. The Average Session Time, which measures the average time spent per interaction, increased from 7.2 to 8.9 minutes after gamification, indicating that users spent more time interacting with the repository content. As for Document Downloads, the Number of downloads also increased substantially by 34 percent, reflecting increased consumption of content due to hot interactive learning modules and reward systems.

The Return Visits per User that determines retention tendency of the user and scores of habitual behavior also increased by 41.3 percent. In a way that the growth can be interpreted as retention since gamified elements like quests, dynamic reminders, recurrent notifications and positive feedback loops made repeat interaction more solid. Also, The engagement level was measured along the Core Engagement Score (CES), which was reported to have increased more than 30percent showing the am cumulative over a number of features of the interaction was also in fact positive in nature. The Feedback Submission (FSR) though not as popular was also increased by approximately 58 percent, the self-driven participation of the feedback and rating choices that were offered to the attesting users.

On the whole all these statistics are used to argue the point that, Gamification raises the level of engagement of a user in any digital repository. This information is also a step towards the development of more refined redesigns of future focused frameworks that would be more useful to drive investments based on the information as well as the reason behind the emphasis on strategies sensitive to game like mechanics.

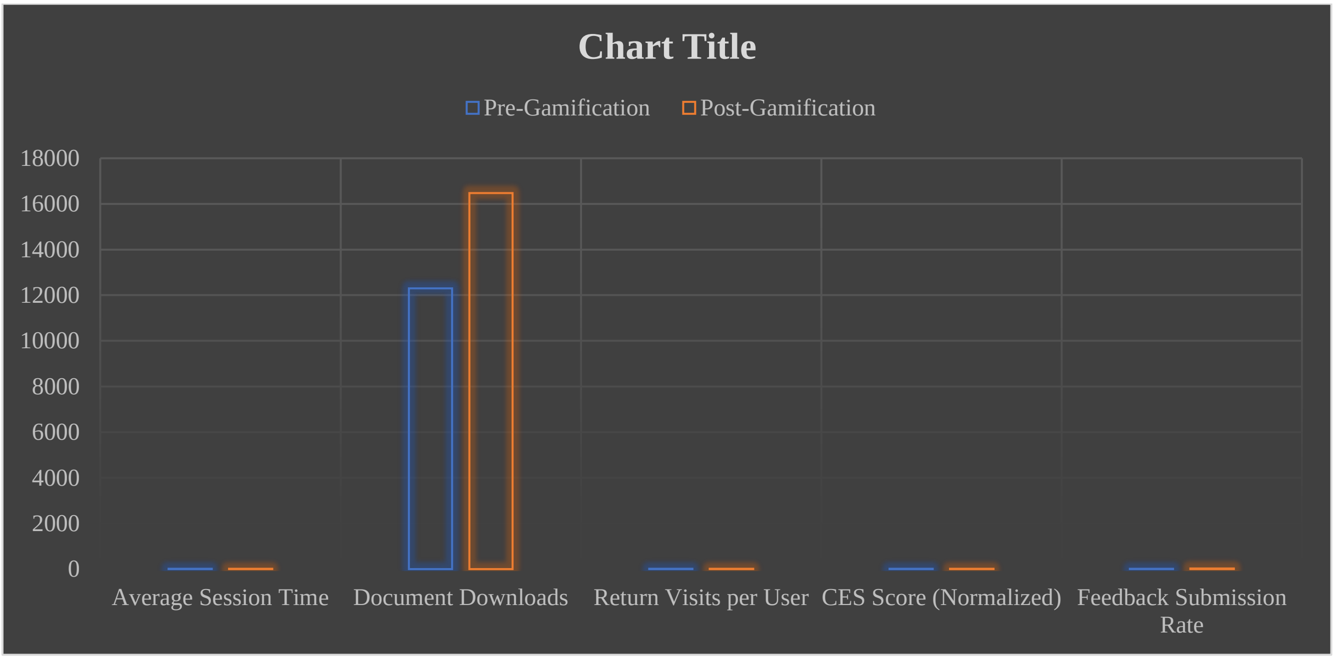

Fig. 3 User Engagement Metrics Before and After Gamification

Fig. 3 shows the progression of user interaction metrics with the implementation of gamified features in the system. Each pair of bars corresponds to a specific engagement metric, which, with the aid of visual presentation, allows comparison of data before and after Gamification. This representation makes it easy to see the improvement across all critical parameters, which supports the Conclusion that incorporating game elements works.

The mathematical formula used in figure 3 can be explained in equations from (17) to ()

1. Average session time

$$\text{Avg Session Time} = \frac{1}{N_s}\sum_{i=1}^{N_s} T_i \qquad (17)$$

where T_i = duration of session i (seconds/minutes), N_s = total sessions.

2. Document downloads (per period or per user)

Total downloads (period):

$$D = \sum_{i=1}^{N_d} 1 = N_d \qquad (18)$$

where N_d = number of download events.

Downloads per user:

$$\text{Downloads Per User} = \frac{N_d}{N_u} \qquad (19)$$

where N_u = unique users.

3. Return visits per user

$$\text{Return Visits Per User} = \frac{\sum_{u=1}^{N_u} V_u}{N_u} \qquad (20)$$

where V_u = number of visits by user u in the period (counting repeat visits).

4. CES score (normalized) — Customer Effort Score or similar

If raw CES is s (e.g., 1–7), normalize to $[0,1]$:

$$\text{CES}_{\text{norm}} = \frac{s - s_{\min}}{s_{\max} - s_{\min}} \qquad (21)$$

If averaging multiple responses:

$$\overline{\mathrm{CES}}_{\mathrm{norm}} = \frac{1}{N_r}\sum_{i=1}^{N_r}\frac{s_i - s_{\min}}{s_{\max} - s_{\min}} \qquad (22)$$

where N_r = responses.

5. Feedback submission rate

$$\text{Feedback Rate} = \frac{N_{feedback}}{N_{impressions}} \qquad (23)$$

commonly $N_{impressions}$ = number of sessions or number of users; express as fraction or percent (×100).

Comparing pre- and post-gamification

Absolute difference

$$\Delta M = M_{\mathrm{post}} - M_{\mathrm{pre}} \qquad (24)$$

Relative change (percent)

$$\%\Delta M = \frac{M_{\mathrm{post}} - M_{\mathrm{pre}}}{M_{\mathrm{pre}}} \times 100\% \qquad (25)$$

Statistical significance (two-sample t-test; equal variances assumed)

For metric samples with means $\tilde{x}_1, \tilde{x}_2$, variances s_1^2, s_2^2, sizes n_1, n_2:

$$t = \frac{\tilde{x}_1 - \tilde{x}_2}{s_p\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}}, \qquad s_p = \sqrt{\frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2}}. \qquad (26), (27)$$

Effect size (Cohen's d)

$$d = \frac{\tilde{x}_2 - \tilde{x}_1}{s_p} \qquad (28)$$

The mathematical logic of the chart measures the engagement of the user prior to and following Gamification through the application of conventional metrics of performance. Average session time is used to determine the time spent by the user during a session, and document downloads is used to determine the amount of materials accessed by the user. Repeat visits per user indicate retention, i.e. repeat usage. The CES score is normalized to allow comparability across different rating scales, which gives a standard effort or satisfaction measure. Lastly, the rate of feedback submission gauges the user involvement in the provision of feedback. The algorithm shows the effect of Gamification on usage patterns, engagement, and general learning experience by calculating absolute and relative change between the pre- and post-gamification.

The most important figure is related to the rate of feedback submission; it increased almost twofold. This increase can certainly be attributed to the interactive features such as quizzes and AI-driven feedback mechanisms which actively stimulated users. Return Visits and Document Downloads also demonstrate significant growth, signifying enhanced content quality and system navigation. Average Session Time increased, though this rise is minimal. This implies that in addition to the increased frequency of site visits, users were spending more time on the site, leading to deeper engagement. The chart's center features the CES Score presented as an aggregate indicator, which also increases in synchrony with the individual measures.

Consequently, the chart serves as more than an overview of the numerical results; it also substantiates the hypothesis. It emphasizes the increase in participation within the digital repository directly linked to the gamified components, which lends credence to the overarching argument that game elements enhancements are highly effective on user motivation and system performance.

V. Conclusion

The paper was devoted to the impact of gamification analytics on the user engagement in online repositories. The presentation of a new measure the Core Engagement Score (CES) and interactivity in the form of learning quests, comments left by chatbots, and monitoring returning users significantly increased the activity and engagement rate of the user with the content. The outcomes of the test showed that the duration of the session, the number of document downloads, and feedbacks increased, which also proves the effectiveness of the gamification strategies employed. The significance of this work is that it transforms the non-dynamic and conventional digital libraries into the actively responsive environments. It has been demonstrated that Gamification is more likely to result in repeat visits and lead to further and more profound engagement and learning. The CES based on the analytics, accurately indicates what should be done to the repository and user experience design, which makes the model brakes-shifted in evaluating user engagement. The model could be applied by other researchers interested in further research of the case in other fields and populations with the addition of real-time adaptive personalization algorithms. Digital repositories and related institutions would be able to make the best systems to be more relevant, and more impactful by embracing gamification methodologies.

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