OPEN ACCESS
Indonesian Journal of Pedagogy and Teacher Education Vol 4 No 1 (2026) https://doi.org/10.58723/ijopate.v4i1.675
Check for updates
Research Article

Gamification in Public Sector Training: Evidence from Ireland

Received: March 30, 2026	Revised: April 10, 2026	Accepted: April 22, 2026	Published: April 28, 2026

Samuel Ojobo Uwakwe Udeh*

Abstract:
Background: Gamification has gained prominence as an instructional strategy to enhance learner engagement in educational technology. However, its effectiveness in producing measurable learning and performance outcomes remains debated, particularly within public sector training environments where traditional approaches often result in low engagement and limited skill transfer.
Aims: This study aims to evaluate the effectiveness of a simulation-based gamification approach in improving employee engagement, competency development, and task performance within Irish public sector training, based on an integrated framework proposed by Udeh (2025).
Methods: A convergent mixed-methods design was adopted, combining quantitative and qualitative data collected concurrently. The study involved 84 public sector participants who engaged in a gamified simulation intervention. Data collection included engagement surveys, competency assessments, system-generated performance metrics, and semi-structured interviews. Quantitative data were analysed using inferential statistics, while qualitative data were examined through thematic analysis.
Results: The findings reveal statistically significant improvements in learner engagement ($p < .01$), alongside notable gains in task accuracy and efficiency. Competency development, particularly in analytical and decision-making skills, also improved. Qualitative results highlight that contextual alignment, realism of simulation scenarios, and system usability are critical factors influencing learning effectiveness.

Keywords: Educational Technology, Gamification, Instructional Design, Mixed Methods, Public Sector Training, Simulation-Based Learning

1. INTRODUCTION

The rapid evolution of digital learning environments has intensified the search for innovative instructional strategies capable of enhancing both learner engagement and measurable learning outcomes. Traditional training approaches, particularly within large organisations, have often been criticised for their passive delivery formats and limited capacity to foster deep learning or behavioural change (Salas et al., 2017; Noe & Kodwani, 2018). In response, gamification defined as the application of game design elements in non-game contexts has gained increasing attention as a potential solution to these limitations (Deterding et al., 2016; Koivisto & Hamari, 2019). Empirical studies suggest that gamification can improve motivation, participation, and user engagement across educational and organisational settings (Koivisto & Hamari, 2019; Sailer & Homner, 2020; Bai et al., 2020).

However, despite its growing adoption, evidence regarding its effectiveness in improving learning transfer and performance outcomes remains mixed (Landers et al., 2018; Toda et al., 2019; Van Roy & Zaman, 2019). Many implementations prioritise superficial engagement mechanisms, such as points and badges, without adequately linking these elements to instructional objectives or performance metrics.

Within the public sector, these challenges are further compounded by structural and organisational constraints. Training systems are often characterised by compliance-driven frameworks, limited interactivity, and resource constraints, which can result in low learner engagement and suboptimal learning outcomes (OECD, 2020; European Commission, 2021). These characteristics necessitate the exploration of alternative pedagogical approaches that align with both organisational objectives and learner needs.

1.1 Gamification and Learning Outcomes

Gamification has gained significant attention as a mechanism for enhancing learner motivation, engagement, and participation in both educational and organisational environments. It is commonly defined as the incorporation of game design elements such as points, badges, leaderboards, and feedback systems into non-game contexts to influence user behaviour and improve experiential outcomes (Deterding et al., 2016). Empirical evidence supports its positive effects on psychological constructs, with gamified interventions frequently associated with increased intrinsic motivation, enjoyment, and user satisfaction (Sailer & Homner, 2020; Bai et al., 2020).

Despite these benefits, the relationship between gamification and actual learning outcomes remains complex and not always directly proportional. While gamification can successfully increase engagement manifested through higher participation rates and extended time on task this does not necessarily translate into improved knowledge acquisition, skill development, or long-term retention (Clark et al., 2016; van Roy & Zaman, 2019). This distinction highlights an important conceptual separation between engagement as a proximal outcome and learning as a distal, performance-based outcome. To address this gap, Landers et al. (2018) proposes a theoretical framework in which gamification influences learning indirectly through mediating variables such as effort, persistence, and attention. In this view, gamification does not inherently produce learning gains but instead enhances the conditions under which learning is more likely to occur.

Furthermore, the effectiveness of gamification is highly dependent on its design quality and contextual alignment. Superficial implementations that rely heavily on extrinsic rewards may generate only short-term engagement, often diminishing as novelty effects fade (Toda et al., 2019). Additionally, competitive elements such as leaderboards can have differential effects, potentially demotivating certain learners while motivating others. These findings underscore the importance of adopting a more nuanced, learner-centred approach to gamification design.

Recent research advocates for theory-driven and outcome-oriented gamification, where game mechanics are explicitly aligned with pedagogical objectives and measurable performance indicators (Sailer & Homner, 2020; Bai et al., 2020). This shift reflects a broader recognition that gamification should not be treated as a standalone intervention but rather as a complementary component within a holistic instructional framework.

1.2 Simulation-Based Learning

Simulation-based learning is grounded in experiential learning theory, which conceptualises learning as a cyclical process involving concrete experience, reflective observation, abstract conceptualisation, and active experimentation (Kolb, 1984). Contemporary research continues to validate this model within digital and organisational learning environments (Makransky et al., 2021; Makransky & Petersen, 2021; Radianti et al., 2020).

Simulations create immersive and context-rich learning environments that facilitate the application of theoretical knowledge in practice. Evidence suggests that such environments enhance knowledge retention, critical thinking, problem-solving, and decision-making skills by promoting deeper cognitive (Makransky et al., 2021; Radianti et al., 2020). By situating learning within authentic contexts, simulations also improve the transferability of skills, enabling learners to apply acquired competencies effectively in real-world situations.

A key strength of simulation-based learning lies in its capacity to provide a safe and controlled environment for experimentation. Learners can engage in decision-making processes, explore alternative strategies, and learn from errors without real-world risks. This feature is particularly valuable in high-risk sectors such as healthcare and aviation (Radianti et al., 2020).

Advancements in digital technologies including virtual reality (VR), augmented reality (AR), and artificial intelligence (AI) have further strengthened the effectiveness of simulation-based learning. These technologies enable more immersive, adaptive, and scalable learning environments, allowing for personalised and data-driven instructional experiences (Radianti et al., 2020; Makransky et al., 2021).

A critical synthesis of the literature reveals that while gamification and simulation-based learning each offer distinct advantages, their integration presents a more robust approach to achieving both engagement and learning outcomes. Gamification primarily enhances motivation, while simulations provide the experiential depth necessary for meaningful learning (Landers et al., 2018; Sailer & Homner, 2020).

1.3 Toward Integrated Learning Models

Recent scholarship highlights the need to integrate gamification with complementary pedagogical approaches to move beyond surface-level engagement. While gamification enhances motivation and participation, standalone implementations often fail to produce meaningful learning outcomes due to their focus on motivational elements and limited attention to cognitive and skill development (Landers et al., 2018; Toda et al., 2019; van Roy & Zaman, 2019). Consequently, improved engagement does not always translate into better learning transfer or performance.

This has led to calls for more holistic instructional design that integrates motivational, cognitive, and behavioural dimensions of learning. Constructivist and experiential learning theories emphasise active, contextualised, and feedback-rich learning, positioning gamification as one component within a broader learning system rather than a standalone solution.

The framework proposed by Udeh (2025) responds to this need by integrating three components: gamification for motivation and engagement, simulation for experiential and contextual learning, and performance metrics for evaluation and accountability. Together, these form a triadic model linking engagement, learning processes, and measurable outcomes.

This integrated approach addresses a key gap in gamification research the disconnect between engagement-focused design and demonstrable performance outcomes. Simulation enhances learning by enabling realistic problem-solving and applied

practice, while gamification sustains motivation and encourages repeated engagement. This aligns with Landers et al. (2018) view that gamification influences learning indirectly through mediating factors such as effort and persistence.

The inclusion of performance metrics introduces an essential evaluative dimension, enabling organisations to assess competency development rather than relying on engagement indicators alone. This is particularly important in organisational contexts where training impact must be measurable and aligned with strategic goals.

Although aligned with emerging performance-oriented instructional design models (Clark et al., 2016; Sailer & Homner, 2020; Bai et al., 2020), the integration of gamification and simulation remains underexplored empirically, as existing studies tend to treat them separately. Therefore, this study proposes an integrated simulation-based gamification framework that aligns motivation, experiential learning, and performance measurement to better connect learner engagement with demonstrable competency outcomes.

1.4 Public Sector as a Learning Context

Public sector organisations present a distinct and often complex context for instructional design and training innovation. Unlike private sector environments, public institutions operate within rigid administrative frameworks characterised by hierarchical governance structures, bureaucratic procedures, high levels of accountability, and strong regulatory oversight. These structural features often result in risk-averse organisational cultures, where experimentation with innovative learning approaches may be limited due to concerns around compliance, standardisation, and auditability (OECD, 2020; European Commission, 2021; Mergel et al., 2019). Consequently, the adoption of emerging instructional technologies, including gamification and simulation-based learning, tends to be slower and more constrained.

Training within the public sector is frequently compliance-driven, designed primarily to ensure adherence to policies, regulations, and procedural standards rather than to foster deep learning or competency development. Such programmes typically emphasise knowledge transmission through formal, instructor-led or e-learning modules, often lacking interactivity and learner-centred design principles (Noe & Kodwani, 2018). This approach can lead to passive learning experiences, reduced learner engagement, and limited knowledge retention. More critically, it often fails to support the transfer of training to workplace performance, which remains a persistent challenge in organisational learning literature (Blume et al., 2019).

In addition to structural constraints, resource limitations further complicate the effectiveness of public sector training initiatives. Budgetary restrictions, legacy IT systems, and competing organisational priorities can hinder the implementation of advanced learning technologies and innovative pedagogical approaches. Moreover, workforce diversity in terms of age, digital literacy, and professional background introduces additional complexity in designing inclusive and effective training programmes (OECD, 2023). These challenges underscore the need for adaptable, scalable, and cost-effective learning solutions that can operate within existing institutional constraints.

Despite these limitations, the public sector is undergoing significant transformation driven by digitalisation, policy reform, and increasing citizen expectations for efficient and high-quality service delivery. Governments across Europe and globally are investing in digital government strategies, emphasising the development of digital competencies, data-driven decision-making, and continuous professional development (European Commission, 2021; OECD, 2023). This shift has created a growing demand for more dynamic, engaging, and performance-oriented learning approaches that go beyond traditional compliance-based training.

Within this evolving landscape, simulation-based gamification emerges as a particularly promising instructional approach. By integrating experiential learning with motivational design elements, it offers the potential to address both cognitive and behavioural dimensions of learning. Simulation environments enable public sector employees to engage with realistic, context-specific scenarios that mirror the complexity of their roles, thereby enhancing decision-making, problem-solving, and critical thinking skills. At the same time, gamification elements—such as feedback systems, progression mechanics, and goal-oriented challenges—can increase learner motivation, engagement, and persistence (Sailer & Homner, 2020; Bai et al., 2020).

Importantly, simulation-based gamification aligns well with the competency-based frameworks increasingly adopted within public administration. By linking learning activities directly to job-relevant tasks and measurable performance outcomes, it supports not only knowledge acquisition but also the development of practical skills and behavioural competencies. Furthermore, digital simulations can provide real-time performance data and analytics, enabling organisations to track learning progress, identify skill gaps, and make evidence-based decisions regarding workforce development.

However, the successful implementation of such approaches in the public sector requires careful consideration of contextual factors. Issues such as organisational readiness, technological infrastructure, stakeholder buy-in, and alignment with policy objectives play a critical role in determining effectiveness. Without strategic integration, there is a risk that gamification may be reduced to superficial engagement mechanisms, failing to deliver meaningful learning outcomes a limitation widely noted in existing research (Landers et al., 2018; Toda et al., 2019).

Therefore, there is a clear need for context-sensitive, theory-driven frameworks that guide the design and implementation of simulation-based gamification within

public sector environments. Such frameworks must account for institutional constraints while leveraging the affordances of digital technologies to enhance both engagement and performance. Addressing this gap is central to this study, which seeks to develop and evaluate an integrated simulation-based gamification framework tailored to the specific needs and challenges of the Irish public sector.

1.5 Theoretical Framework

This study is grounded in an integrated simulation-based gamification model comprising three interrelated layers: the gamification layer, the simulation layer, and the performance layer. The framework is designed to address a key limitation in existing gamification research namely, the disconnect between learner engagement and measurable performance outcomes (Landers, 2019; Sailer & Homner, 2020; Koivisto & Hamari, 2019). By combining motivational, experiential, and evaluative dimensions, the model provides a holistic approach to instructional design in complex organisational contexts such as the public sector.

1.5.1 Gamification Layer

The gamification layer focuses on the incorporation of motivational design elements intended to enhance learner engagement, sustain participation, and influence behavioural outcomes. Core components of this layer include feedback systems, progression mechanics, and reward structures.

Feedback systems provide learners with immediate and continuous information about their performance, enabling self-regulation and goal adjustment. Contemporary research confirms that timely and adaptive feedback significantly enhances learning effectiveness and engagement in digital and gamified environments (Shute & Rahimi, 2021).

Progression mechanics, such as levels, stages, and milestones, structure the learning experience into manageable and increasingly challenging segments. These mechanics support scaffolding and competence development, contributing to sustained engagement and perceived mastery (Sailer & Homner, 2020; Looyestyn et al., 2017).

Reward structures, including points, badges, and leaderboards, serve as extrinsic motivators that reinforce desired behaviours. However, their effectiveness depends on alignment with intrinsic motivation; poorly designed systems may reduce intrinsic interest (Koivisto & Hamari, 2019).

The theoretical foundation of this layer is rooted in Self-Determination Theory (SDT), which posits that motivation is driven by autonomy, competence, and relatedness (Ryan & Deci, 2020). Recent studies demonstrate that gamification elements designed to satisfy these needs significantly improve engagement and learning outcomes in digital environments (Sailer & Homner, 2020; Bai et al., 2020).

1.5.2 Simulation Layer

The simulation layer provides the experiential foundation of the framework by embedding learning within contextually rich, scenario-based environments. Scenario-based tasks replicate real-world challenges, enabling learners to apply knowledge in authentic contexts. Recent evidence shows that simulation-based learning significantly improves transfer of training, decision-making skills, and workplace readiness (Gegenfurtner et al., 2019; Sitzmann & Weinhardt, 2019).

Experiential learning cycles underpin this layer, drawing on Kolb's experiential learning model. Contemporary research supports the continued relevance of experiential cycles in digital simulations, particularly when combined with reflective feedback and iterative practice (Poore et al., 2022).

Decision-making environments within simulations allow learners to explore consequences in a risk-free setting. This is especially valuable in public sector contexts, where errors can have significant implications. Simulation-based environments enhance adaptive expertise and resilience by enabling safe experimentation (Chernikova et al., 2020). This layer is grounded in experiential learning theory and constructivist learning principles, which emphasise active knowledge construction through interaction and reflection. Recent studies reaffirm that immersive and interactive environments enhance deep learning and cognitive engagement (Radianti et al., 2020).

1.5.3 Performance Layer

The performance layer ensures that learning outcomes are measurable, observable, and aligned with organisational objectives. Competency frameworks provide a structured approach to defining required knowledge, skills, and behaviours. Updated research highlights their importance in aligning training with organisational performance and workforce capability development (Campion et al., 2020). Key performance indicators (KPIs) serve as quantifiable measures of learning outcomes, including accuracy, efficiency, and decision quality. Modern performance measurement approaches emphasise data-driven evaluation and continuous improvement (Marr, 2016; Parmenter, 2020).

Data-driven assessment mechanisms leverage learning analytics to capture and analyse performance in real time. Advances in learning analytics and educational data mining enable personalised learning, predictive insights, and adaptive interventions (Ifenthaler & Yau, 2020; Viberg et al., 2018). The theoretical underpinning of this layer is derived from gamified learning theory, which emphasises the linkage between game elements and performance outcomes (Landers, 2019). Gamification influences performance indirectly through

mediating variables such as motivation, engagement, and behaviour, making alignment with instructional objectives essential (Landers & Marin, 2021).

2. MATERIAL AND METHOD

2.1 Research Design

This study adopted a convergent mixed-methods research design to enable a comprehensive and multidimensional evaluation of the simulation-based gamified intervention. Mixed-methods research has gained increasing prominence in educational technology and organisational learning due to its ability to integrate quantitative performance data with qualitative experiential insights (Creswell & Plano Clark, 2018; Guetterman et al., 2019; Fetters & Molina-Azorin, 2020).

The convergent design involves the simultaneous collection of quantitative and qualitative data, followed by independent analysis and subsequent integration during interpretation. This approach is particularly effective for evaluating complex interventions such as gamified simulations, which generate both measurable behavioural outcomes and subjective user experiences (Guetterman et al., 2019).

By combining datasets, the study achieves methodological triangulation, thereby enhancing validity, reliability, and interpretive depth (Fetters & Molina-Azorin, 2020). Quantitative data provided objective indicators of engagement, competency acquisition, and task performance, while qualitative data offered insights into user perceptions, system usability, and contextual influences. This dual perspective is essential in gamification research, where behavioural metrics alone may not fully capture underlying motivational mechanisms (Sailer & Homner, 2020; Koivisto & Hamari, 2019).

Furthermore, the adoption of a convergent mixed-methods approach aligns with Design Science Research (DSR), which emphasises rigorous artefact evaluation through both empirical performance evidence and user-centred feedback (Johannesson & Perjons, 2021; Gregor & Hevner, 2019). In this study, the simulation-based gamified system represents the artefact, requiring both quantitative validation and qualitative interpretation.

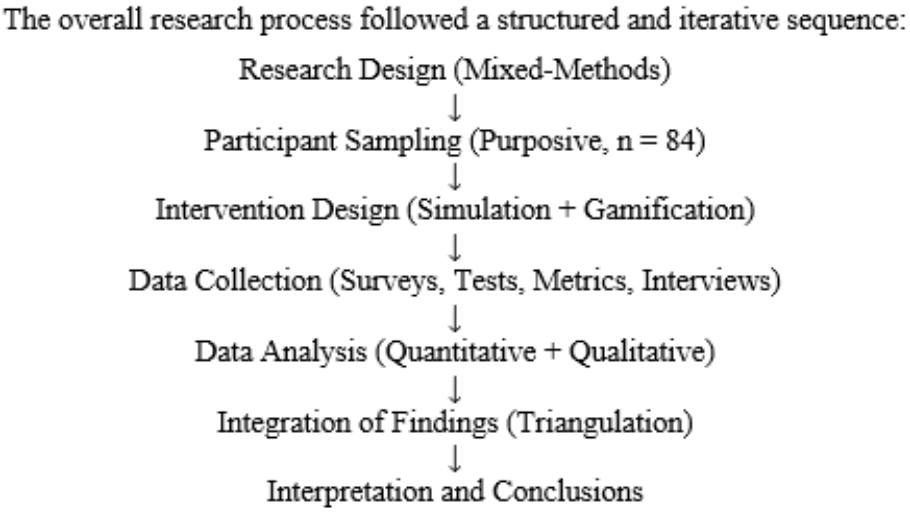

Figure 1. This structured approach enhances transparency, replicability, and methodological rigour in applied research contexts (Creswell & Creswell, 2018).

2.2 Participants and Context

The study involved 84 participants drawn from Irish public sector organisations, including administrative officers, ICT professionals, and training and development personnel. A purposive sampling strategy was employed to ensure participants possessed relevant domain expertise and contextual experience. Such sampling is widely recommended in organisational and applied research where information-rich cases are required (Palinkas et al., 2015; Campbell et al., 2020).

The public sector context is characterised by structured workflows, regulatory compliance, and performance accountability, all of which influence training effectiveness and learning design (OECD, 2020; Lodge & Hood, 2021). This makes it a suitable environment for evaluating simulation-based learning, particularly where decision-making accuracy and procedural adherence are critical. Participants had prior exposure to digital systems and workplace learning platforms, ensuring baseline technological competence. However, familiarity with gamified systems varied, which is beneficial for analysis, as prior experience has been shown to influence engagement and performance outcomes (Koivisto & Hamari, 2019; Bai et al., 2020).

Ethical approval was obtained in accordance with institutional guidelines and GDPR requirements. Participants provided informed consent, and all data

were anonymised to ensure confidentiality and ethical integrity (Saunders et al., 2019; Wiles, 2020).

2.3 Intervention Design

The intervention consisted of a simulation-based gamified training module, developed using principles from instructional design, gamification theory, and experiential learning. A systematic approach based on the ADDIE model was adopted to ensure alignment between learning objectives, instructional strategies, and evaluation mechanisms (Peterson, 2016; Branch, 2016).

Core Components

1. Real-World Administrative and ICT Scenarios

The simulation environment replicated authentic workplace tasks, including administrative workflows, data processing, and ICT decision-making. Scenario-based learning has been shown to significantly enhance transfer of learning and workplace applicability (Gegenfurtner et al., 2019; Sitzmann & Weinhardt, 2019).

2. Progression-Based Challenges

Participants progressed through increasingly complex levels, reflecting scaffolding principles and incremental skill development. This aligns with contemporary interpretations of flow theory, where optimal engagement occurs when task difficulty matches user capability.

3. Immediate Feedback Systems

The system provided real-time feedback on accuracy, efficiency, and decision quality. Immediate and adaptive feedback is widely recognised as a critical determinant of learning effectiveness and self-regulation in digital learning environments (Narciss, 2017; Shute & Rahimi, 2021).

4. Gamification Elements

Gamification elements including points, badges, leaderboards, and progress indicators were integrated to enhance motivation and engagement. These were implemented in a pedagogically meaningful manner to avoid superficial engagement and over-reliance on extrinsic rewards (Koivisto & Hamari, 2019; Landers, 2019). Overall, the intervention adhered to the principle of constructive alignment, ensuring coherence between learning objectives, activities, and assessment outcomes.

2.4 Data Collection

A multi-instrument data collection strategy was adopted to capture both the quantitative and qualitative dimensions of the simulation-based gamification intervention. This integrated approach enhances the robustness of the study through methodological triangulation, enabling convergence and corroboration of findings across multiple data sources (Creswell & Plano Clark, 2018; Fetters & Molina-Azorin, 2020). By combining subjective self-reported measures with objective behavioural data and in-depth qualitative insights, the study provides a comprehensive evaluation of engagement, competency development, and performance outcomes.

Survey Instruments (Engagement Measurement)

Participant engagement was measured using pre- and post-intervention surveys based on a five-point Likert scale. The instrument captured key dimensions of engagement, including motivation, attention, perceived usefulness, and enjoyment, which are widely recognised as core constructs in gamified and technology-enhanced learning environments.

Likert-scale instruments remain a dominant approach for measuring attitudes and perceptions due to their simplicity, reliability, and suitability for statistical analysis (Boone et al., 2017). The use of a pre-post design enabled the study to assess changes in engagement attributable to the intervention, thereby strengthening internal validity and supporting causal inference.

Survey items were adapted from previously validated scales in educational technology and gamification research to ensure construct validity and theoretical alignment. To further strengthen measurement quality, internal consistency reliability was assessed using Cronbach's alpha, which confirmed that the survey items consistently measured the intended constructs across participants (Taber, 2018). In addition, descriptive and inferential statistical analyses were conducted to identify patterns and statistically significant differences in engagement levels before and after the intervention.

Competency Assessment Tests

Participants completed structured competency assessments designed to measure analytical reasoning, problem-solving, and decision-making skills. These competencies are particularly critical in public sector environments, which are often characterised by complex, rule-based, and policy-driven decision-making processes (Campion et al., 2020).

To enhance ecological validity, the assessments were designed using scenario-based and case-driven questions that closely reflected real-world workplace challenges. This approach allows for the evaluation of applied competencies, rather than abstract knowledge recall, thereby providing a more accurate measure of practical capability (Chernikova et al., 2020). All assessments were administered under standardised conditions, including consistent instructions, time allocations, and scoring rubrics. This ensured reliability,

fairness, and comparability across participants, while also minimising potential sources of measurement bias. Pre- and post-intervention comparisons enabled the identification of competency development attributable to the gamified simulation.

Performance Metrics

Objective behavioural data were captured directly from the simulation platform, providing a detailed and continuous record of participant interactions within the gamified environment. Key performance indicators (KPIs) included:

a. Task accuracy (correctness of decisions and actions)
b. Completion time (efficiency in task execution)
c. Error rates (frequency and severity of incorrect actions)

These system-generated analytics offer high-resolution, longitudinal data that enhance the precision of performance measurement. Unlike self-reported data, such metrics reduce the risks of recall bias, social desirability bias, and subjective interpretation (Klarkowski et al., 2016; Landers, 2019).

The integration of learning analytics reflects contemporary trends in data-driven educational assessment, where digital trace data are increasingly used to evaluate engagement, behavioural patterns, and performance progression in real time (Ifenthaler & Yau, 2020; Viberg et al., 2018). Furthermore, these metrics enabled fine-grained analysis of user behaviour, supporting deeper insights into how participants interacted with the gamified system and how such interactions influenced performance outcomes.

Semi-Structured Interviews

A purposive subsample of participants (n = 15) was selected for semi-structured interviews to gain deeper insights into user experiences of the simulation-based gamification system. The sampling approach ensured representation across different levels of engagement and performance, thereby capturing a diverse range of perspectives.

The semi-structured interview format provided a balance between consistency and flexibility, allowing the researcher to explore predefined themes while also accommodating emergent insights (Kallio et al., 2016). Key areas of inquiry included system usability, perceived realism of the simulation, motivational drivers, engagement experiences, feedback effectiveness, and perceived learning outcomes.

All interviews were audio-recorded with participant consent and transcribed verbatim to ensure data accuracy. The data were analysed using reflexive thematic analysis, following the systematic procedures outlined by Braun and Clarke (2021). This approach enabled the identification of recurring patterns, themes, and relationships within the qualitative data.

To enhance credibility and analytical rigour, the study employed careful coding procedures, iterative theme development, and reflexive engagement with the data. Reflexive notes were maintained throughout the analysis process to support transparency and to acknowledge the researcher's interpretive role. This qualitative component provided rich contextual insights that complemented and explained the quantitative findings, thereby strengthening the overall validity of the study.

2.5 Data Analysis

Quantitative Analysis

Quantitative data were analysed using paired-sample t-tests to examine statistically significant differences between pre-intervention and post-intervention scores. This statistical technique is appropriate for within-subject (repeated measures) designs, as it accounts for inter-individual variability while assessing mean changes over time (Field, 2018; Lakens, 2017). The use of paired comparisons strengthens internal validity by ensuring that observed differences can be attributed to the intervention rather than between-group variation.

In addition to hypothesis testing, multiple regression analysis was conducted to examine the predictive relationships between key constructs, including engagement, competency development, and performance outcomes. Regression modelling enabled the estimation of effect sizes and the identification of statistically significant predictors, thereby supporting a more nuanced understanding of how gamification mechanisms influence learning outcomes (Hair et al., 2019). This approach also allowed for the examination of the relative contribution of independent variables while controlling for potential confounding effects.

Prior to conducting inferential analyses, key statistical assumptions were systematically assessed to ensure the validity and robustness of results. These included:

a. Normality, assessed using the Shapiro–Wilk test and inspection of Q–Q plots
b. Linearity, evaluated through scatterplot diagnostics
c. Homoscedasticity (homogeneity of variance), examined using residual plots
d. Independence of observations, ensured through the study design

Where violations of assumptions were identified, appropriate corrective procedures were applied, such as data transformation or the use of non-parametric alternatives (e.g., Wilcoxon signed-rank test), in line with established methodological guidelines (Ghasemi & Zahediasl, 2019).

To complement statistical significance testing, effect sizes (e.g., Cohen's *d* for t-tests and R^2 for regression models) were calculated to determine the practical significance of observed differences (Lakens, 2017).

This dual emphasis on statistical and practical significance enhances the interpretability and applied relevance of findings, particularly in organisational and public sector contexts where the magnitude of effects is critical for decision-making.

All quantitative analyses were conducted using appropriate statistical software (e.g., SPSS/R), ensuring accuracy, reproducibility, and transparency of results.

Qualitative Analysis

Qualitative data were analysed using reflexive thematic analysis, following the six-phase framework proposed by Braun and Clarke (2021). This approach provides a systematic yet flexible method for identifying, analysing, and reporting patterns within qualitative data, making it particularly suitable for exploring complex user experiences in gamified and simulation-based learning environments.

The analysis proceeded through the following iterative phases:

1. Familiarisation with the Data
All interview transcripts, open-ended survey responses, and reflective participant comments were read repeatedly to achieve deep immersion in the dataset. Initial notes were recorded to capture early insights related to engagement, motivation, usability, and learning experience.

2. Generating Initial Codes
Data were systematically coded at a granular level. Meaningful data segments were labelled using concise codes representing key concepts such as autonomy, feedback immediacy, perceived competence, competitive dynamics, and simulation realism. Coding was iterative and reflexive, allowing continuous refinement of interpretations.

3. Searching for Themes
Codes were organised into broader candidate themes representing patterns across the dataset. For example, codes related to rewards, progression, and feedback were grouped under themes such as gamification-driven motivation or engagement mechanisms.

4. Reviewing Themes
Themes were reviewed at two levels:
(a) coherence of coded extracts within each theme, and
(b) alignment with the overall dataset.

Themes were refined, merged, or discarded where necessary to ensure conceptual clarity and analytical robustness.

5. Defining and Naming Themes
Each theme was clearly defined with explicit conceptual boundaries. Themes were named to reflect their analytical contribution to the research questions, ensuring clarity and interpretive precision.

6. Producing the Report
The final phase involved integrating themes into a coherent analytical narrative, supported by illustrative participant quotations. This ensured that findings remained grounded in empirical data while directly addressing the study's research objectives.

Thematic analysis was selected due to its ability to capture rich, nuanced insights into participant experiences, particularly in technology-enhanced learning contexts (Nowell et al., 2017). To enhance trustworthiness, an audit trail was maintained throughout the process, documenting coding decisions, theme development, and analytical iterations. This supports credibility, dependability, and confirmability of findings.

Integration of Quantitative and Qualitative Data

The final stage of analysis involved integrating quantitative and qualitative findings using a convergent parallel mixed-methods approach, in which both datasets were analysed independently and subsequently merged during interpretation (Creswell & Plano Clark, 2018; Fetters & Molina-Azorin, 2020).

This integration focused on identifying three key relationships:

a. Convergence – where quantitative and qualitative findings aligned and reinforced each other
b. Complementarity – where qualitative insights elaborated or explained quantitative trends
c. Divergence – where discrepancies emerged, prompting deeper interpretation

In practice, qualitative findings were used to contextualise and explain statistical results. For example, increases in engagement scores were supported by participant narratives highlighting the motivational impact of real-time feedback, immersive scenarios, and competitive elements. These insights revealed underlying psychological mechanisms not directly observable in quantitative data.

Conversely, instances of divergence such as improved performance accompanied by increased perceived workload were explained through qualitative accounts indicating cognitive load and system complexity during early interaction stages. This highlights the importance of considering user experience alongside performance metrics.

This integrative approach enhances ecological validity by grounding statistical patterns in lived experience, while also strengthening explanatory power by linking outcomes to behavioural and motivational processes (Guetterman et al., 2019). Overall, it provides a holistic

and triangulated understanding of how simulation-based gamification influences both learner engagement and performance in organisational training contexts.

3. RESULTS DISCUSSION

3.1 Result

This section presents the empirical findings derived from both quantitative and qualitative analyses. The results are structured around three core outcome dimensions aligned with the study's conceptual framework: learner engagement, competency development, and performance outcomes. Together, these dimensions provide a holistic evaluation of the effectiveness of the simulation-based gamified learning intervention.

The integration of statistical results with thematic qualitative insights enables a mixed-methods interpretation that goes beyond numerical outcomes to explain how and why the intervention was effective within a real organisational learning context.

3.1.1 Engagement

A statistically significant increase in learner engagement was observed following the intervention. Descriptive and inferential statistics indicate a substantial improvement:

The table below presents the descriptive and inferential statistics for learner engagement before and after the intervention, along with effect size and key analytical outcomes.

Table 1. Summary of Engagement Scores, Statistical Tests, and Regression Results

Measure	Pre-Intervention	Post-Intervention	Statistical Test / Result	Interpretation
Engagement (Mean)	M = 3.10	M = 4.20	$t(83) = 6.45$, $p < .01$	Statistically significant increase in engagement
Standard Deviation	SD = 0.62	SD = 0.55	—	Reduced variability post-intervention
Effect Size	—	—	Cohen's $d \approx 0.70$	Large practical effect
Regression Outcome	—	—	$\beta = .42$, $p < .01$	Engagement significantly predicts performance outcomes

3.1.2 Learner Engagement

A statistically significant improvement in learner engagement was observed following the gamified simulation-based intervention. Paired-sample t-test results indicated a substantial increase in post-intervention engagement scores compared to pre-intervention levels. The magnitude of this change was confirmed by a large effect size (*Cohen's d* ≈ 0.70), indicating strong practical significance and suggesting that the intervention had a meaningful impact on participants' motivation, attention, and perceived value of the training experience (Lakens, 2017).

This improvement reflects enhanced levels of intrinsic and extrinsic motivation, likely driven by the integration of gamification elements such as real-time feedback, progression systems, and reward mechanisms. These findings are consistent with contemporary research demonstrating that gamification can significantly enhance user engagement by leveraging motivational affordances (Koivisto & Hamari, 2019; Sailer & Homner, 2020).

Importantly, unlike studies that report only short-term engagement gains, the present findings suggest that embedding gamification within a simulation-based learning environment contributes to more sustained and meaningful engagement, as learners interact with realistic, task-oriented scenarios rather than abstract or decontextualised activities.

Further analysis using multiple regression revealed that engagement was a statistically significant predictor of performance outcomes ($\beta = .42$, $p < .01$). This finding supports the theoretical proposition that gamification influences learning indirectly through motivational pathways, reinforcing the mediating role of engagement in driving performance (Landers, 2019; Landers & Marin, 2021).

Collectively, these results highlight the importance of instructionally aligned gamification design, where motivational elements are integrated in ways that directly support learning objectives rather than functioning as superficial engagement tools.

3.1.3 Competency Development

Participants demonstrated statistically significant improvements in key competency areas, particularly: analytical skills and decision-making accuracy. Post-intervention assessment scores showed a measurable increase in participants' ability to analyse complex scenarios, identify relevant information, and make informed decisions. These improvements can be attributed to the integration of simulation-based tasks, which required active problem-solving and contextual application of knowledge.

The findings provide strong empirical support for the argument that simulation enhances the cognitive effectiveness of gamification by promoting deeper learning processes. Simulation-based environments facilitate active and experiential learning, which has been shown to significantly improve knowledge retention and skill acquisition compared to passive instructional approaches (Chernikova et al., 2020).

Furthermore, the observed improvements align with more recent meta-analytic evidence indicating that digital simulation-based training enhances the development of higher-order cognitive skills, including critical thinking, problem-solving, and decision-making (Gegenfurtner et al., 2019). situating gamified elements within realistic and context-rich scenarios, the intervention enabled learners to move beyond surface-level engagement toward meaningful competency development.

These findings also reinforce the theoretical foundations of experiential learning, where knowledge is constructed through iterative cycles of action, reflection, and adaptation. The simulation environment provided opportunities for learners to test decisions, receive feedback, and refine their approaches, thereby strengthening both cognitive and practical competencies.

3.1.4 Performance Outcomes

The intervention resulted in statistically significant improvements in objective performance metrics, demonstrating its effectiveness in translating learning into measurable behavioural outcomes. These improvements indicate that the integration of gamification with simulation not only enhances engagement and competency development but also leads to tangible performance gains within task-based environments.

The analysis of system-generated data revealed improvements across key performance indicators, including:

a. Task accuracy (increased correctness of decisions and actions)
b. Completion time (greater efficiency in task execution)
c. Error rates (reduction in incorrect decisions and rule violations)

These findings suggest that participants were able to perform tasks more accurately and efficiently, reflecting improved procedural understanding and decision-making capability.

The observed performance gains are consistent with research highlighting the effectiveness of simulation-based training in improving real-world performance outcomes, particularly in complex and high-stakes environments (Sitzmann & Weinhardt, 2019). Moreover, the integration of gamification elements likely contributed to sustained engagement and effort, further enhancing performance improvements.

The table below summarises changes in objective performance metrics following the gamified simulation-based intervention.

Table 2. Changes in Performance Metrics Following the Intervention

Performance Metric	***Pre/Post Change***	***Result***	***Interpretation***
Task Completion Time	Post-intervention improvement	↓ 18% reduction	Improved procedural fluency and efficiency
Error Rates	Post-intervention improvement	↓ 22% reduction	Enhanced accuracy and decision quality

The intervention produced significant improvements in objective performance outcomes, indicating that participants were able to transfer acquired knowledge and skills effectively into simulated work environments. The reduction in task completion time reflects improved procedural fluency, while the decrease in error rates indicates enhanced accuracy and decision-making quality. These findings are particularly relevant for public sector training, where performance improvements contribute directly to organisational efficiency and service delivery effectiveness (OECD, 2020; OECD, 2023). The results support gamification theory suggesting that performance gains are maximised when gamified systems are aligned with clear learning and performance objectives and embedded within structured instructional design frameworks (Landers, 2019; Sailer & Homner, 2020), and when supported by real-time feedback mechanisms (Ifenthaler & Yau, 2020; Viberg et al., 2018).

These findings indicate increased efficiency and accuracy in task execution, suggesting that participants were able to apply acquired knowledge and skills effectively in simulated work environments. The reduction in completion time reflects improved procedural fluency, while the decrease in error rates indicates enhanced decision quality and attention to detail. These results are particularly important in the context of public sector training, where performance improvements can have direct implications for organisational effectiveness and service delivery (OECD, 2020; OECD, 2023). The findings support the argument that gamification, when integrated with simulation and performance measurement, can produce tangible improvements in workplace performance (Chernikova et al., 2020; Sitzmann & Weinhardt, 2019).

Consistent with gamified learning theory, these outcomes suggest that the effectiveness of gamification depends on its alignment with performance goals and metrics (Landers, 2019; Landers & Marin, 2021). The inclusion of real-time feedback and performance tracking mechanisms likely contributed to these improvements by enabling learners to monitor and adjust their behaviour during the training process (Ifenthaler & Yau, 2020).

3.1.5 Qualitative Insights

1. Authenticity Enhances Learning Transfer
Participants consistently emphasised the importance of realistic, scenario-based tasks in facilitating learning transfer. The authenticity of the simulation environment allowed learners to relate training activities directly to their workplace responsibilities, thereby increasing the perceived relevance and applicability of the training.

This finding aligns with simulation-based learning research demonstrating that authentic task design significantly improves transfer of training to workplace performance (Chernikova et al., 2020; Gegenfurtner et al., 2019). It also supports situated and experiential learning perspectives in contemporary workplace learning literature (Sitzmann & Weinhardt, 2019).

2. Gamification Increases Motivation but Must Be Meaningful
While participants reported increased motivation due to gamification elements, they also highlighted the importance of meaningful integration. Superficial elements, such as points or badges, were perceived as less valuable unless directly linked to performance and learning outcomes.

This finding reinforces meta-analytic evidence that gamification effectiveness is highly dependent on design quality and alignment with learning objectives (Sailer & Homner, 2020; Koivisto & Hamari, 2019). It also aligns with concerns regarding poorly designed extrinsic reward systems that fail to produce sustained motivation (Ryan & Deci, 2020).

3. Technological Usability Affects Adoption
Participants identified system usability as a critical factor influencing engagement and overall experience. Issues such as interface complexity, navigation difficulties, and technical glitches were reported as barriers to effective learning. This finding is consistent with educational technology research demonstrating that usability is a key predictor of engagement, cognitive load, and learning effectiveness in digital environments (Ifenthaler & Yau, 2020; Viberg et al., 2018).

The integration of quantitative and qualitative findings provides strong evidence for the effectiveness of the simulation-based gamification framework. While quantitative results demonstrate significant improvements in engagement, competency, and performance, qualitative insights reveal the underlying mechanisms driving these outcomes.

3.2 Discussion

The findings of this study provide strong empirical support for the integration of simulation-based learning with gamification as a means of achieving performance-oriented learning outcomes in organisational contexts. While prior research has consistently demonstrated the motivational benefits of gamification, its effectiveness in improving learning transfer and workplace performance has remained contested (Sailer & Homner, 2020; Koivisto & Hamari, 2019). The present study contributes to resolving this ambiguity by demonstrating that gamification, when embedded within simulation-based environments, can produce both engagement and measurable performance gains.

A key contribution of this study lies in its demonstration that engagement alone is insufficient for effective learning. Traditional gamification approaches often rely on surface-level mechanics that increase participation but do not necessarily improve cognitive processing or skill acquisition (Hanus & Fox, 2015; (Landers, 2019). In contrast, simulation-based learning enables contextualised, experiential engagement that improves transfer of training (Chernikova et al., 2020; Sitzmann & Weinhardt, 2019).

The observed improvements in competency development and performance outcomes suggest that simulation enhances the cognitive depth of gamified learning environments. This is consistent with meta-analytic evidence demonstrating strong effects of simulation-based training on higher-order cognitive skills (Gegenfurtner et al., 2019; Chernikova et al., 2020).

Furthermore, the study supports gamified learning theory, which argues that gamification influences outcomes indirectly through motivational pathways (Landers, 2019). However, the findings extend this by highlighting simulation as a moderating mechanism that strengthens the translation of engagement into performance.

The qualitative findings reinforce the importance of authenticity, meaningful gamification, and usability, aligning with contemporary learning science research (Ifenthaler & Yau, 2020; Ryan & Deci, 2020).

3.2.1 Implications

Building on the empirical findings of this study, a comprehensive set of evidence-informed design principles is proposed to guide the development of effective simulation-based gamified learning environments. These principles contribute meaningfully to both instructional design theory and applied practice, particularly within the domain of educational technology and workplace learning systems.

Align Gamification with Performance Outcomes

Gamification strategies should be deliberately and systematically aligned with clearly defined learning objectives and measurable performance outcomes. Rather than functioning as superficial or extrinsic motivators, game elements such as points, badges, leaderboards, and progression systems must be purposefully designed to reinforce target competencies and desired behavioural changes. This approach is grounded in the principle of constructive alignment, which emphasises coherence between intended learning outcomes, instructional activities, and assessment methods. By embedding gamification within a structured pedagogical framework, designers can ensure that engagement is not pursued in isolation but serves as a mechanism for enhancing performance and capability development. Consequently, gamification becomes an

enabler of meaningful learning rather than a distraction from it.

Embed Learning in Authentic Simulation Contexts

Effective learning environments should situate knowledge acquisition within realistic, scenario-based simulations that closely mirror real-world tasks and challenges. Such contextualisation enhances the perceived relevance of learning activities and supports experiential learning processes, enabling learners to actively construct knowledge through practice and reflection. Simulation-based environments facilitate the development of higher-order cognitive skills, including problem-solving, decision-making, and critical thinking. Furthermore, by replicating workplace conditions, these environments promote the transferability of acquired knowledge and skills, thereby bridging the gap between theory and practice. This is particularly valuable in professional and organisational settings where applied competence is essential.

Provide Immediate and Meaningful Feedback

Timely and informative feedback is a critical component of effective gamified learning systems. Feedback mechanisms should go beyond simple correctness indicators to provide actionable insights that guide learner improvement. This includes diagnostic feedback that highlights strengths and weaknesses, as well as prescriptive feedback that suggests pathways for enhancement. Immediate feedback supports self-regulated learning by enabling learners to monitor their progress, adjust strategies, and correct errors in real time. In gamified environments, feedback can be delivered through multiple channels, including visual cues, performance dashboards, and narrative elements, thereby enriching the overall learning experience and sustaining engagement.

Ensure System Usability and Accessibility

System usability plays a pivotal role in determining both learner engagement and instructional effectiveness. Gamified learning platforms should be designed with a strong emphasis on intuitive navigation, clarity of interface, and ease of interaction. A user-centred design approach is essential to minimise cognitive load and prevent usability barriers from detracting from the learning process. Accessibility considerations are equally important, ensuring that systems are inclusive and usable by individuals with diverse abilities, technological proficiencies, and learning preferences. This includes adherence to accessibility standards, responsive design for multiple devices, and the provision of alternative interaction modalities where necessary. Poor usability not only diminishes user satisfaction but can also significantly impair learning outcomes.

Adapt Design to Organisational Context

Instructional design does not occur in a vacuum; it must be responsive to the specific organisational environment in which it is implemented. This includes aligning gamified learning systems with organisational culture, strategic objectives, operational workflows, and technological infrastructure. In the context of the public sector, additional considerations include compliance with policy frameworks, accountability structures, and resource constraints. Training interventions must therefore be tailored to support institutional goals, such as service delivery improvement, regulatory adherence, and workforce capability development. Context-sensitive design enhances both the relevance and sustainability of gamified learning initiatives.

Collectively, these design principles advocate for a holistic, performance-oriented approach to gamification. They move beyond engagement-centric models toward integrated learning ecosystems that combine pedagogical rigour, technological sophistication, and organisational alignment. This shift is essential for realising the full potential of gamification as a transformative tool in education and professional development.

3.2.2 Research Contribution

This study makes several important contributions to the literature on gamification and simulation-based learning. First, it provides empirical evidence that gamification, when integrated with simulation-based environments, can lead to both increased learner engagement and measurable improvements in performance outcomes. This finding helps address ongoing debates regarding the limited effectiveness of gamification in facilitating learning transfer and workplace performance.

Second, the study extends existing gamified learning theory by demonstrating that engagement alone is insufficient to ensure meaningful learning. By identifying simulation as a critical moderating mechanism, this research offers a more nuanced understanding of how motivational affordances can be translated into cognitive and performance gains.

Third, the findings contribute to the growing body of research on simulation-based learning by confirming its role in enhancing higher-order cognitive skills and supporting the transfer of training. In doing so, the study bridges the gap between engagement-focused and performance-oriented learning approaches, offering an integrated perspective that is both theoretically and practically relevant.

3.2.3 Limitations

While this study makes significant theoretical and practical contributions, several limitations should be acknowledged when interpreting the findings.

Limited Sample Size

The study was conducted with a sample of 84 participants. Although this size is adequate for statistical analysis and hypothesis testing, it may constrain the generalisability of the results. Larger and more diverse samples would enhance the robustness of the findings and enable more nuanced subgroup analyses.

Single-Country Context (Ireland)

The research was situated within the Irish public sector, which possesses unique organisational, cultural, and policy characteristics. These contextual factors may influence both the implementation and effectiveness of gamified learning systems. As a result, caution should be exercised when extrapolating the findings to different national or sectoral contexts, particularly those with differing governance structures or workforce dynamics.

Short-Term Evaluation Horizon

The study focused primarily on immediate post-intervention outcomes, such as engagement levels and short-term performance improvements. This temporal limitation restricts the ability to assess long-term knowledge retention, behavioural change, and sustained organisational impact. Existing literature suggests that the effects of gamification may diminish over time if not reinforced through continuous engagement strategies.

3.2.4 Suggestions

Considering these limitations, several avenues for future investigation are proposed to extend and deepen understanding in this field. First, Longitudinal Studies: Future research should adopt longitudinal designs to examine the durability of learning outcomes associated with simulation-based gamification. Such studies would provide valuable insights into long-term knowledge retention, behavioural transformation, and the sustained impact on organisational performance. Tracking learners over extended periods would also help identify factors that influence the persistence or decline of gamification effects. Second, Cross-Cultural and Cross-Sector Validation: Replicating this study across different countries, industries, and organisational settings would enhance the external validity of the proposed framework. Comparative analyses could reveal how cultural dimensions, institutional structures, and workforce characteristics shape the effectiveness of gamified learning systems. This would support the development of more universally applicable design principles while also highlighting the need for contextual adaptation. Third, AI-Driven Adaptive Gamification Systems: Emerging technologies, particularly artificial intelligence and learning analytics, present significant opportunities for advancing gamified learning environments. Future research should explore the design and implementation of adaptive systems that personalise learning experiences based on individual performance, preferences, and progression patterns.

Such systems can dynamically adjust difficulty levels, content sequencing, and feedback mechanisms, thereby optimising learner engagement and effectiveness. Investigating the integration of AI-driven personalisation with simulation-based environments represents a promising frontier for both research and practice. Fourth, Comparative Effectiveness Studies: Further studies should compare simulation-based gamification with alternative instructional approaches, including traditional e-learning, instructor-led training, and blended learning models. These comparative analyses would help establish the relative advantages and limitations of gamification, providing clearer guidance for practitioners on when and how to deploy such interventions effectively.

By addressing these limitations and pursuing the outlined research directions, future work can build on the foundation established in this study. This will contribute to a more comprehensive and nuanced understanding of simulation-based gamification, ultimately enhancing its effectiveness as a tool for learning, performance improvement, and organisational development.

4. CONCLUSION

This study demonstrates that simulation-based gamification is a viable and effective approach to enhancing public sector training, addressing challenges related to learner engagement, knowledge transfer, and performance measurement. By integrating motivational design elements with experiential learning processes and data-driven assessment, the framework provides a comprehensive and theoretically grounded model for outcome-oriented learning.

The findings contribute to educational technology research in several ways. First, the study extends gamification theory by showing how simulation acts as a mediating mechanism that transforms engagement into measurable performance outcomes, addressing concerns that gamification often prioritises motivation over learning effectiveness. Second, it provides empirical support for integrated learning models that combine motivational, cognitive, and behavioural dimensions. Third, it proposes practical, evidence-based design principles for developing learning systems in complex organisational contexts.

From a policy and practice perspective, the study highlights the potential of simulation-based gamification to support capacity building, skills development, and performance improvement in the public sector. The framework offers a scalable and adaptable solution aligned with real-world tasks and organisational objectives.

Furthermore, the study emphasises the importance of aligning instructional innovation with institutional realities. In public sector environments, integrating performance metrics within gamified simulations enables effective monitoring, evaluation, and continuous improvement.

In conclusion, integrating gamification, simulation, and performance measurement provides a structured pathway toward more effective, measurable, and sustainable learning outcomes.

5. ACKNOWLEDGEMENT

The author would like to express sincere gratitude to his employer, the Department of Agriculture, Food and the Marine (DAFM), Ireland, for granting study leave and providing institutional support during the development of this article. This support was instrumental in enabling the time and focus required for the preparation of this work

6. AUTHOR CONTRIBUTION STATEMENT

Samuel Ojobo Uwakwe Udeh is the sole author of this work. He was responsible for all aspects of the research and manuscript preparation, including the conceptualisation of the study, development of the research framework, literature review, methodology design using Design Science Research (DSR), data analysis, interpretation of findings, and drafting, reviewing, and finalising the manuscript for submission.

No other individuals contributed to the intellectual content or writing of this article.

AUTHOR INFORMATION

Corresponding Authors

Samuel Ojobo Uwakwe Udeh, Technological University Dublin, Ireland.

https://orcid.org/0009-0003-6926-3220

Email: D22125450@mytudublin.ie

REFFERENCE

Bai, S., Hew, K. F., & Huang, B. (2020). Does gamification improve student learning outcome? Evidence from a meta-analysis and synthesis of qualitative data in educational contexts. *Educational Research Review*, *30*, 100322. https://doi.org/10.1016/j.edurev.2020.100322

Boone, H. N., Boone, A, D., & Boone. (2017). Analyzing Likert Data. *Journal of Extension*, *50*(2), 1–6. https://doi.org/10.34068/joe.50.02.48

Branch, R. M. (2016). *Instructional Design: The ADDIE Approach*. Spinger New York. https://doi.org/10.1007/978-0-387-09506-6

Campion, M. A., FINK, A. A., RUGGEBERG, B. J., CARR, L., PHILLIPS, G. M., & ODMAN, R. B. (2020). Doing competencies well: Best practices in competency modeling. *Personnel Psychology*, *64*(1), 225–262. https://doi.org/10.1111/j.17446570.2010.01207.x

Chernikova, O., Heitzmann, N., Stadler, M., Holzberger, D., Seidel, T., & Fischer, F. (2020). Simulation-Based Learning in Higher Education : A Meta-Analysis. *Review of Educational Research*, *90*(4), 499–541. https://doi.org/10.3102/0034654320933544

Clark, Douglas B, Tanner-Smith, Emily E, & Killingsworth, Stephen S. (2016). Digital Games, Design, and Learning: A Systematic Review and Meta-Analysis. *Review of Educational Research*, *86*(1), 79–122. https://doi.org/10.3102/0034654315582065

Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). Sage.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2016). From game design elements to gamefulness: defining "gamification." *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments*, 9–15. https://doi.org/10.1145/2181037.2181040

European Commission. (2021). *Digital Education Action Plan (2021–2027)*. https://education.ec.europa.eu

Fetters, Michael D, & Molina-Azorin, José F. (2020). Utilizing a Mixed Methods Approach for Conducting Interventional Evaluations. *Journal of Mixed Methods Research*, *14*(2), 131–144. https://doi.org/10.1177/1558689820912856

Field, A. (2018). *Discovering Statistics Using IBM SPSS Statistics* (5th ed.). Sage.

Gegenfurtner, A., Quesada-Pallarès, C., & Knogler, M. (2019). Digital simulation-based training: A meta-analysis. *Br. J. Educ. Technol.*, *45*, 1097–1114. https://doi.org/10.1111/BJET.12188

Ghasemi, A., & Zahediasl, S. (2019). Normality tests for statistical analysis: a guide for non-statisticians. *International Journal of Endocrinology and Metabolism*, *10*(2), 486–489. https://doi.org/10.5812/ijem.3505

Gregor, S., & Hevner, A. R. (2019). Positioning and presenting design science research for maximum impact. *MIS Quarterly*, *43*(2), 337–355. https://doi.org/10.25300/MISQ/2019/14163

Guetterman, T. C., Fetters, M. D., & Creswell, J. W. (2019). Integrating quantitative and qualitative results in health science mixed methods research. *American Behavioural Scientist*, *63*(1), 54–74. https://doi.org/10.1177/0002764218772673

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis* (8 ed.). Cengage Learning.

Ifenthaler, D., & Yau, J. Y. K. (2020). Utilising learning analytics for study success: Reflections on current empirical findings. *Research and Practice in Technology Enhanced Learning*, *15*(1), 1–17. https://doi.org/10.1186/s41039-020-00134-x

Johannesson, P., & Perjons, E. (2021). *An introduction to design science* (2 ed.). Springer. https://doi.org/10.1007/978-3-030-78132-8

Kallio, H., Pietila, A. M., Johnson, M., & Kangasniemi, M. (2016). Systematic methodological review: Developing a framework for a qualitative semi-structured interview guide. *Journal of Advanced Nursing*, *72*(12), 2954–2965. https://doi.org/10.1111/jan.13031

Klarkowski, M., Johnson, D., Wyeth, P., Smith, S., & Phillips, C. (2016). Operationalising and evaluating sub-optimal and optimal play experiences through challenge-skill manipulation. *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, 5583–5594. https://doi.org/10.1145/2858036.2858563

Koivisto, J., & Hamari, J. (2019). The rise of motivational information systems: A review of gamification research. *International Journal of Information Management*, *45*, 191–210. https://doi.org/10.1016/j.ijinfomgt.2018.10.013

Lakens, Daniël. (2017). Equivalence Tests: A Practical Primer for t Tests, Correlations, and Meta-Analyses. *Social Psychological and Personality Science*, *8*(4), 355–362. https://doi.org/10.1177/1948550617697177

Landers, R. N. (2019). Gamification misunderstood: How badly executed and rhetorical gamification obscures its transformative potential. *Journal of Management Inquiry*, *28*(2), 137–140. https://doi.org/10.1177/1056492618790913

Landers, R. N., Auer, E. M., Collmus, A. B., & Armstrong, M. B. (2018). Gamification science, its history and future: Definitions and a research agenda. *Simulation & Gaming*, *49*(3), 315–337. https://doi.org/10.1177/1046878118774385

Landers, R. N., & Marin, S. (2021). Theory and practice of gamification in education. *Simulation & Gaming*, *52*(6), 1–18. https://doi.org/10.1177/10468781211010694

Lodge, M., & Hood, C. (2021). The politics of public service reform. *Public Administration*, *99*(1), 1–17. https://doi.org/10.1111/padm.12703

Makransky, G., & Petersen, G. B. (2021). The Cognitive Affective Model of Immersive Learning (CAMIL): a Theoretical Research-Based Model of Learning in Immersive Virtual Reality. *Educational Psychology Review*, *33*(3), 937–958. https://doi.org/10.1007/s10648-020-09586-2

Makransky, Petersen, G. B., & Klingenberg, S. (2021). Immersive virtual reality and learning: A meta-analysis. *Educational Psychology Review*, *33*, 937–958. https://doi.org/10.1007/s10648-020-09586-2

Mergel, I., Edelmann, N., & Haug, N. (2019). Defining digital transformation in the public sector. *Government Information Quarterly*, *36*(4), 101385.https://doi.org/10.1016/j.giq.2019.06.002

Narciss, S. (2017). Conditions and effects of feedback viewed through the lens of the interactive tutoring feedback model. In D. H. Jonassen (Ed.), *Handbook of research on educational communications and technology* (4 ed., hal. 131–153). Springer. https://doi.org/10.1007/978-3-319-17727-4_9

Noe, R. A., & Kodwani, A. D. (2018). *Employee training and development* (7 ed.). McGraw-Hill.

Nowell, Lorelli S, Norris, Jill M, White, Deborah E, & Moules, Nancy J. (2017). Thematic Analysis: Striving to Meet the Trustworthiness Criteria. *International Journal of Qualitative Methods*, *16*(1), 1609406917733847. https://doi.org/10.1177/1609406917733847

OECD. (2020). *The OECD Digital Government Policy Framework*. https://www.oecd.org

OECD. (2023). *Public service leadership and capability: Strengthening public sector performance*. OECD Publishing. https://doi.org/10.1787/2b87c6a0-en

Peterson, C. (2016). Bringing ADDIE to life: Instructional design at its best. *Journal of Educational Multimedia and Hypermedia*, *25*(3), 227–241. https://doi.org/10.54443/morfai.v5i4.4223

Radianti, J., Majchrzak, T. A., Fromm, J., & Wohlgenannt, I. (2020). A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. *Computers & Education*, *147*, 103778. https://doi.org/https://doi.org/10.1016/j.compedu.2019.103778

Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective. In *Contemporary educational psychology*. Springer. https://doi.org/10.1007/978-3-030-32034-2

Sailer, M., & Homner, L. (2020). The Gamification of Learning: a Meta-analysis. *Educational Psychology Review*, *32*(1), 77–112. https://doi.org/10.1007/s10648-019-09498-w

Salas, S. I., Kraiger, K., Smith-Jentsch, K. A., & Tannenbaum, E. (2017). The science of training and development in organizations: What matters in practice. *Psychological Science in the Public Interest*, *13*(2), 74–101. https://doi.org/10.2307/23484697

Saunders, M., Lewis, P., & Thornhill, A. (2019). *Research methods for business students* (8 ed.). Pearson.

Shute, V. J., & Rahimi, S. (2021). Review of computer-based assessment for learning in elementary and secondary education. *Educational Measurement: Issues and Practice*, *40*(1), 16–28.

https://doi.org/10.1111/emip.12386

Sitzmann, T., & Weinhardt, J. M. (2019). Training engagement theory: A multilevel perspective on the effectiveness of work-related training. *Journal of Applied Psychology*, *104*(6), 732–756. https://doi.org/10.1037/apl0000400

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments. *Research in Science Education*, *48*(6), 1273–1296. https://doi.org/10.1007/s11165-016-9602-2

Toda, A. M., Valle, P. H. D., & Isotani, S. (2019). The dark side of gamification: An overview of negative effects of gamification in education. *Educational Technology & Society*, *22*(2), 1–15. https://doi.org/10.1007/978-3-319-97934-2_9

Udeh, S. U. (2025). *An integrated simulation-based gamification framework for business competency and performance management*. Technological University Dublin.

Van Roy, R., & Zaman, B. (2019). Unravelling the Ambivalent Motivational Power of Gamification: A Systematic Literature Review. *Computers & Education*, *127*, 1–21. https://doi.org/10.1016/j.compedu.2018.08.009

Viberg, O., Hatakka, M., Balter, O., & Mavroudi, A. (2018). The current landscape of learning analytics. *Computers in Human Behavior*, *89*, 98–110. https://doi.org/10.1016/j.chb.2018.07.027

Wiles, R. (2020). *What are qualitative research ethics?* Bloomsbury Academic.