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Leveling up in corporate training: Unveiling the power of gamification to enhance knowledge retention, knowledge sharing, and job performance

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ABSTRACT

This paper extends the fast-growing research stream on gamification in corporate training by examining the impact of gamification on employees' knowledge retention, knowledge sharing, and job performance. A mixed-methods approach was employed. Quantitative data from surveys and qualitative insights from experimental research were combined to ascertain the effectiveness of gamification techniques in corporate training. The sample consisted of 110 employees and business owners who attended gamified training sessions powered by the Discovery-Innovation-Growth platform. Participants were aged 18 to 64 years and had diverse educational backgrounds and job positions. They were also based in different European countries (Spain, France, Germany, United Kingdom, Italy, Finland, and Romania). The sample characteristics thus ensured comprehensive coverage of different employee profiles. Gamification significantly enhanced knowledge retention and job performance. Gamification techniques such as points, badges, and leaderboards positively influenced employee engagement, which in turn boosted the ability to retain and apply knowledge effectively at work. Social interaction mediated the relationship between gamification techniques and knowledge sharing, highlighting the role of collaborative learning environments. These insights offer valuable guidance for corporate instructors and human resource (HR) professionals aiming to develop engaging and personalized training programs that meet diverse employee needs and learning preferences. This study contributes to the theoretical framework of gamification in adult learning and organizational development, paving the way for future research in this dynamic field.

Introduction

Gamification has become a powerful tool in various fields, including education and corporate training. Gamification is an innovative approach that uses elements such as points, badges, leaderboards, and interactive challenges to enhance user engagement and motivation. In corporate training, gamification aims to make traditional learning experiences more engaging and dynamic, thereby improving employee learning outcomes and job performance (Schöbel et al., 2020). The growing interest in gamification is due to its potential to address common training challenges such as low engagement and retention rates. By incorporating game mechanics, organizations can create a more enjoyable and effective learning environment that fosters continuous improvement and knowledge sharing among employees (Kraus et al., 2023).

Studies provide justification for the use of gamification platforms in training applications because of their positive impact on learning outcomes. For example, Hamari et al. (2016) investigated the impact of flow, engagement, and immersion on learning in game-based environments. Engagement was observed to affect learning positively, while immersion was not. Other studies have shown that gamification offers companies seeking to improve their training programs a systematic approach to boost engagement and competition through captivating game-like mechanics and incentives (Kumar & Raghavendran, 2015; Larson, 2020). Companies use gamification as part of their training framework to increase employee engagement and inspire them to perform better at work (Gupta & Gomathi, 2017).

Many studies have focused on the effectiveness of gamification in enhancing engagement and knowledge outcomes. However, there is a gap in the understanding of how different gamification techniques are aligned with or affect cognitive load, self-determination, and social exchange in corporate training environments. Cognitive load theory suggests that learning effectiveness is influenced by how

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information is presented and by the mental effort required to process it. For example, gamification elements such as points and badges can streamline information processing and reduce cognitive overload, thus enhancing learning and retention (Turan et al., 2016). Self-determination theory can help explain how autonomy, competence, and relatedness enhance performance in gamified training. For instance, giving employees choices in their learning paths and immediate feedback through gamified elements can increase their intrinsic motivation and sense of competence, leading to better performance (Luarn et al., 2023). Social exchange theory helps explain the reciprocal nature of knowledge sharing in gamified environments. Gamification fosters a collaborative learning atmosphere, where employees feel more inclined to share knowledge and skills in exchange for recognition and social rewards (Dikcius et al., 2021). These theoretical frameworks can offer deeper insight into the impact of gamification on corporate training outcomes.

The present study employed a mixed-methods approach. An experimental phase based on eye-tracking technology was combined with a correlational survey based on partial least squares structural equation modeling (PLS-SEM). In the experimental phase, eye tracking was used to observe and analyze the visual engagement of participants with different elements of the gamified training platform. The correlational survey phase examined data from learners who attended gamified training sessions powered by the Discovery-Innovation-Growth platform. Participants completed an online questionnaire to measure gamification techniques, knowledge retention, knowledge sharing, job performance, engagement, individual learning style, social interaction, and prior knowledge. The survey data were analyzed using PLS-SEM to examine the complex relationships between these latent constructs and test the proposed hypotheses. The combination of these methods gives a comprehensive understanding of how gamification can be strategically implemented to enhance learning outcomes. This understanding supports both theoretical development and practical applications in corporate training environments. The research questions addressed by this study are as follows:

RQ1: How does engagement mediate the relationship between gamification techniques and knowledge retention?
RQ2: How does social interaction mediate the relationship between gamification techniques and knowledge sharing?
RQ3: How does prior knowledge mediate the relationship between gamification techniques and job performance?
RQ4: Does individual learning style moderate the impact of gamification on cognitive load and subsequent learning outcomes?

The main aim of this research was to explore how gamification techniques influence knowledge retention and sharing, which are pivotal factors in knowledge dynamics. The study also aimed to evaluate the extent to which gamification techniques contribute to enhancing overall job performance.

The mixed-methods approach used in the present research not only contributes to the understanding of how gamification affects learning and performance but also provides insights into designing more effective gamified training programs by considering the principles of cognitive load. It bridges the gap between gamification research and cognitive load theory, providing a nuanced understanding of how to optimize gamified learning environments for a range of learners.

The paper is structured as follows. The next section describes the theoretical background and presents the hypotheses. The methodology is then explained. The following section examines the findings from the experimental eye-tracking study and the PLS-SEM survey-based study. A discussion follows. The final sections of the article discuss the implications, conclusions, limitations, and further research directions.

Theoretical background

The literature consistently highlights the effectiveness of gamification techniques in enhancing corporate training outcomes. During the COVID-19 pandemic, gamification platforms emerged as attractive tools for communication and collaboration, fostering efficiency, coopetition, and team productivity, while minimizing cost (Dragan et al., 2023; López-Cabarcos et al., 2020). Gamification promotes inherent motivation, enhances learner engagement, and improves knowledge retention (Putz et al., 2020). It encourages repetitive task engagement, allowing individuals to experience failure and make repeated attempts, which is crucial for learning (Larson, 2020). The design and implementation of training programs should consider various factors, including the learning styles and preferences of employees, the use of innovative training methods (such as gamification), and the provision of continuous feedback and support (Palmquist, 2023). Overall, the literature underscores the transformative potential of gamification in corporate training, supporting research into its effects on knowledge retention, knowledge sharing, and job performance, as well as the roles of engagement, social interaction, and individual learning styles in these processes.

Theoretical frameworks

Cognitive load theory

Cognitive load theory is crucial for understanding how gamification can optimize learning outcomes by managing the mental effort required to process information. This theory posits that the human cognitive system has a limited capacity for processing new information. When this capacity is exceeded, learning capacity is affected (Sweller, 1988). In the context of gamified training, cognitive load theory suggests that well-designed gamification elements reduce cognitive load, thus enhancing learners' ability to absorb and retain information (Turan et al., 2016). By integrating game-like mechanics that simplify complex information and provide immediate feedback, gamified training makes the learning process more efficient and enjoyable, thereby improving knowledge retention and performance.

In the context of gamified training, well-designed gamification elements such as points, badges, and leaderboards reduce cognitive load by making information presentation more intuitive and engaging. For example, interactive challenges and immediate feedback mechanisms facilitate information processing by providing learners with clear and concise goals, thus preventing cognitive overload. Furthermore, the use of narrative elements and contextualized scenarios within gamified platforms enhances intrinsic cognitive load, making the learning process more meaningful and relevant to learners' real-world experiences.

Self-determination theory

Self-determination theory was developed by Deci and Ryan (1985). It emphasizes the role of intrinsic motivation in driving human behavior. According to self-determination theory, intrinsic motivation is fostered when individuals' needs for autonomy, competence, and relatedness are satisfied. In a gamified training environment, gamification elements such as points, badges, and leaderboards enhance learners' sense of competence by providing continuous feedback and rewards for achievements. The autonomy of choosing different paths or challenges within the game satisfies the need for self-direction. Furthermore, features that promote social interaction and collaboration such as team-based challenges can fulfill the need for relatedness, thereby increasing engagement and motivation to learn (Luarn et al., 2023). Competence is stimulated through continuous feedback, recognition, and rewards such as earning points and badges for completing tasks. These rewards reaffirm learners' capabilities and progress. Relatedness is promoted through social features such as team-based challenges and leaderboards that

encourage interaction, cooperation, and a sense of community among participants.

Social exchange theory

Social exchange theory was introduced by Homans (1958). It is fundamental for understanding knowledge sharing within gamified environments. This theory posits that social behavior is the result of an exchange process where individuals seek to maximize benefits and minimize costs in their interactions. In the context of gamified training, social exchange theory explains how gamification elements promote knowledge sharing among employees. Features such as leaderboards and badges create a competitive yet collaborative environment where employees are motivated to share their knowledge and skills to gain social rewards and recognition from peers (Dikcius et al., 2021). By fostering a culture of reciprocity and mutual support, gamified training enhances both individual and collective learning outcomes. For example, employees who share valuable knowledge or assist colleagues in solving problems may earn badges or rise up the leaderboard. These rewards reinforce their willingness to contribute to their teams' success. This reciprocal exchange fosters a collaborative culture, where knowledge sharing is strongly incentivized.

Knowledge retention empowered by gamified training

The gamification techniques integrated in corporate training reflect individuals' needs for recognition and enjoyment of challenges and competition. They purposefully transform the learning experience from a passive to an active process, making it more engaging and enjoyable, in turn leading to better knowledge retention. Gamified training is used in organizations for learning purposes to empower brand performance and speed up the knowledge retention process (Kaoud & ElBolok, 2023). Buckley and Doyle (2017) empirically showed that gamification has a beneficial effect on knowledge retention when individual learning demands and personality features are adequately considered. Implementing gamification in corporate training enhances employees' ability to retain knowledge, particularly by increasing confidence, improving recall, and fostering long-term retention.

Gamification fosters a more relaxed and captivating learning environment. Engaged and satisfied employees tend to experience greater confidence in their knowledge and skills during the training process (Hammedi et al., 2021). This self-assurance motivates people to disseminate their acquired knowledge among peers, fostering a culture of collective learning and cooperation. Using gamification approaches involves active engagement, which can result in enhanced recall. For example, using deep learning algorithms in simulated training settings or challenging situations encourages more efficient storage of information (Munteanu et al., 2022). This active involvement implies that employees are more inclined to retain the information they have learnt and can easily disseminate this knowledge to others. A recent study showed that gamification and game-based learning significantly improved training performance, engagement, retention, and motivation among learners, highlighting the need for further research to optimize these strategies (Dahalan et al., 2024). Based on these insights, the following hypothesis is proposed:

H1. The use of gamification techniques in corporate training positively affects employees' knowledge retention.

Knowledge sharing empowered by gamified training

Gamification incorporates play and competition, thereby enhancing training outcomes by making it more captivating. The enjoyable nature of gamified training might encourage employees to engage actively in knowledge sharing with peers (Sharma et al., 2024). When incorporating game mechanics into a learning environment, various elements should be considered. For example, it is important to be aware of each learner's profile, the specific context in which gamification is applied, and the activities carried out before the game mechanics start. The level of cooperation within a collaborative learning setting significantly affects the individual and collective achievements of group members (Uz Bilgin & Gul, 2020).

Leaderboards, points, and badges create a sense of competition that motivate employees to engage more actively in learning activities. This competitive spirit can encourage learners to collaborate and share knowledge to improve their team's standing or their own. Accumulating points or badges as a reward for sharing knowledge can be highly gratifying. These features are concrete signs of accomplishment and acknowledgement, inspiring employees to give more to obtain further incentives. Points and badges frequently serve as indicators of learners' advancement and acquisition of knowledge within a training program (Robson et al., 2016). By disseminating knowledge, learners not only help others but also visibly enhance their own standing within the instructional setting, fostering a feeling of achievement. Leaderboards establish a competitive environment. Observing a rise in rankings is a powerful incentive, compelling learners to share more knowledge to protect or improve their ranking (McHenry & Makarius, 2023). The results of a study of employees of a multinational corporation that used a gamified business collaboration system specifically created to facilitate knowledge sharing showed that three aspects of gamification (rewardability, competitiveness, and visibility of performance) collectively influenced employees' perceptions of knowledge sharing value, thereby increasing knowledge contribution (Suh & Wagner, 2017). Therefore, the following hypothesis is proposed:

H2. The use of gamification techniques in corporate training positively affects employees' knowledge sharing.

Gamified training and job performance

Implementing gamified training methods frequently enhances engagement and enjoyment in the learning process. Learners who find the learning process engaging are more inclined to assimilate and retain information, resulting in more effective implementation of the training contents in their professional duties. Gamified training programs can be specifically created to replicate real-life situations, enabling learners to acquire practical skills in a safe and controlled setting. Engaging in practical activities is a precursor for employees to develop competencies in effectively managing comparable responsibilities in their job positions (Georgiou et al., 2019). Chen et al. (2023) enriched the research on digital game-based learning using the Octalysis gamification framework to create a highly efficient game-based system for teaching a foreign language to employees. It also showed the interconnections between the use of game learning functions and the enhanced efficiency of learning outcomes.

Studies indicate that gamification techniques such as points, badges, leaderboards, and challenges are extrinsic motivators that significantly boost employee satisfaction, knowledge acquisition, and information recall (Armstrong & Landers, 2018; Baxter et al., 2016). Points act as a quantifiable measure of progress, providing immediate feedback and encouraging ongoing engagement with the training content (Jayalath & Esichaikul, 2022). Badges reflect specific achievements, fostering a sense of accomplishment and motivating further learning (Domínguez et al., 2013; Kyewski & Kramer, 2018). Leaderboards introduce competitive elements that enhance motivation and foster a sense of community and performance improvement (Larson, 2020; Miri & Macke, 2022).

Challenges in gamified training make learning interactive and relevant by including real-life scenarios, which enhance understanding and retention (Kapp, 2012). When tailored to individual or team strengths, these challenges boost self-efficacy and confidence in

navigating learning journeys (Park et al., 2019; Saura et al., 2021). The interactive nature of gamified learning, coupled with competition and rewards, leads to enhanced long-term retention of information, as reflected by higher satisfaction and engagement levels (Alsawaier, 2018; Krause et al., 2015). Gamification also uses internal motivators such as accomplishment and proficiency, which encourage knowledge sharing among employees (Feng et al., 2018). Gamified environments promote teamwork and social interaction, fostering a collaborative culture where knowledge is shared more freely (Dragolea et al., 2023; Van Roy & Zaman, 2019). Organizations can use badges to monitor accomplishments and foster a knowledge-driven culture, enhancing overall knowledge sharing (Spanellis et al., 2020). The primary goal of serious games in training settings is to facilitate the dissemination of knowledge. The game enhances the career advancement of learners, whether they are supported from within the game or externally. The best-performing learners within a company can increase their job performance and thus become qualified for internal promotion (Allal-Chérif & Bidan, 2017).

Training that involves gamification frequently requires innovative problem-solving and the ability to think creatively. This type of involvement enhances creativity, motivating learners to tackle issues with an innovative mindset (Landers & Armstrong, 2017). Gamification improves cognitive flexibility, enabling individuals to approach challenges from several perspectives and apply a range of techniques. Universities and companies are tending toward the design and development of training approaches that foster learners' immersion and active participation in their quest to achieve superior academic and job performance (Leal-Rodriguez & Albort-Morant, 2019). The ability to adapt and be flexible is crucial for fostering creativity because it enables the creation of distinctive and original ideas (Gimenez-Fernandez et al., 2021).

Training that uses gamification frequently presents a diverse range of barriers that require innovative thinking and the ability to solve problems (AlSaad & Durugbo, 2021). The range of scenarios in gamification platforms promotes a highly flexible and inventive approach to job-related obstacles. The interactive element of gamified instruction fosters active engagement. This type of engagement is essential for profound comprehension and the development of innovative analytical abilities, leading to higher performance at work (Dragan et al., 2020). In a gamified context, learners tend to experience design thinking principles because the environment fosters an exploratory setting. This approach promotes experimentation and the acquisition of knowledge from errors, cultivating a more creativity-oriented mindset (Patrício et al., 2021). Therefore, the following hypothesis emerges:

H3. The use of gamification techniques in corporate training positively affects employees' job performance.

Learners' engagement in gamified training

By making the learning process more enjoyable, rewards such as points, badges, and levels motivate employees to engage more deeply with gamification platforms and to advance along their training journey. Instructors should assess and comprehend the game aspects that are appropriate for each training program. Likewise, team leaders should frequently interact with peers to achieve the desired impact on training outcomes. It is also important for the chosen game features to be aligned with the user profiles and the overall training concept of the program to ensure high engagement (Kulkarni et al., 2022).

An enjoyable user experience enhances internal motivation and positively influences knowledge management processes, including training. Adding components of gamification to the training process enhances learners' engagement and incentivizes them to participate in challenges. It thus improves their focus and enjoyment of learning (Wang et al., 2022). Learners are motivated by emotions such as the enjoyment and satisfaction of being immersed in gamified scenarios (Darejeh & Salim, 2016). However, crucially, an incentive system on a gamification platform is not an effective standalone motivational tool. Instead, it needs to be seamlessly integrated into the corporate strategy (Friedrich et al., 2020).

According to Bartle (1996), the four player types in serious games provide a comprehensive framework for understanding learners' enjoyment. The first type, Killers, have a need for and gain satisfaction from challenging others. The second and third types, Explorers and Achievers, have a desire to collect more clues and stimulate curiosity, potentially leading to the discovery of flaws in the experience. The final type, Socializers, become engaged in the experience through storytelling, encouraging players to share information about their success. These behaviors are expected to enhance learners' engagement (Iacono et al., 2020).

A successful gamification strategy should first focus on elements that effectively motivate participants. The appropriate game design features to enhance their engagement should then be adopted. Intrinsic motivational components such as challenges, competition, success, and reward are essential to ensure user satisfaction with their chosen behaviors and drive motivation. Additionally, game components such as quests, levels, rankings, and points enhance knowledge retention and learner engagement (Kim, 2021).

Eye-tracking technology is a valuable tool for evaluating the effectiveness of gamified features in maintaining learner attention and involvement in training. The analysis of gaze patterns can show instructors whether learners consistently interact with gamified aspects or whether their attention deviates from essential topics (Gu et al., 2022). This insight can be particularly useful for comprehending the effectiveness of different game systems for knowledge retention. A recent study by Bitrián et al. (2024) empirically showed that gamification positively affects training content quality and learners' enjoyment, which increase perceived usefulness and engagement. Therefore, the following hypothesis is proposed:

H4. Employee engagement mediates the relationship between gamification techniques and knowledge retention.

Social interaction

Game elements foster a sense of community and encourage interactions among participants. When learners feel part of a team, they may be more inclined to share knowledge and contribute to collective learning (Oprescu et al., 2014). Gamification fosters a competitive atmosphere. However, the social element of this competition in the form of the opportunity to measure oneself against others and seek acknowledgement from peers is often what drives individuals to increase their participation, including by sharing their knowledge and insights.

During gameplay situations, the process of knowledge sharing is essential for a team to succeed. Hence, it fosters a culture that prioritizes and actively engages in knowledge sharing (Gupta et al., 2022). Social learning theory posits that individuals acquire knowledge and skills by seeing and imitating others (Bakhanova et al., 2020). In a gamified setting, individuals are more inclined to imitate the behavior of peers when they witness these peers sharing knowledge and being rewarded through gamification mechanisms or social recognition.

Stanculescu et al. (2016) outlined an experiment conducted at IBM to investigate the effectiveness of different game mechanics in promoting social interaction and learning. The experiment yielded valuable insights. Learners interacted with the gamification platform by responding to quiz questions, inviting others to try the application, and sharing news. A high level of engagement was attained through the game mechanics. The use of gamification has been

effective in encouraging knowledge acquisition and sharing. Results for online social behavior are similarly promising, showing that gamification can effectively stimulate specific types of social interactions.

Personal concerns might lead to poor outcomes from teamwork because of disagreements and training group dynamics. Individual concerns and subsequent actions sometimes remain at an unconscious level, leading to a disorderly process. Collaboration among team members must be enhanced to ensure optimal outcomes. Gamification can make it possible to synchronize individual objectives with the overall goals of training (Vegt et al., 2015). Gamification techniques help develop professional networks within an organization. These networks can become useful communities of practice, facilitating knowledge sharing (Wanick & Bui, 2019). Therefore, the following hypothesis emerges:

H5. Social interaction mediates the relationship between gamification techniques and knowledge sharing.

Prior knowledge

Prior knowledge is the foundation for learners to develop and acquire new abilities and knowledge during gamified training. Employees with a strong knowledge base in a specific field can benefit more from gamification techniques because they can leverage their existing expertise to improve their performance (Putz et al., 2020). Employees with prior knowledge are more inclined to participate actively in gamified learning at a deeper level because they rapidly discover whether their training content is aligned with their preexisting knowledge. This alignment can result in enhanced learning and superior work proficiency (Bai et al., 2021).

By adapting to employees' prior knowledge, gamification techniques can be customized to meet the unique learning requirements of each individual. This personalization ensures that learning is relevant and sufficiently demanding to lead to performance enhancements. The cognitive perspective of game-based learning focuses on the mental representations that players develop during games and the way players integrate these representations with their existing knowledge (Davis et al., 2018). Learners with prior expertise in a specific topic may find gamified learning more gratifying because they may quickly add new insights to their own knowledge framework (Behl et al., 2022). Thus, prior knowledge can enhance motivation and engagement, ultimately resulting in improved job performance. Therefore, the following hypothesis is proposed:

H6. Prior knowledge mediates the relationship between gamification techniques and job performance.

Individual learning style

An individual's learning style relates to the individual's preferred method of processing, comprehending, and retaining knowledge. Frequently debated learning styles include visual, reading/writing, and kinesthetic. Customizing training to align it with an individual's unique learning style increases comprehension and memory retention.

Individual learning styles have four dimensions. The first dimension (Sensing or Intuitive) refers to how learners perceive the scenarios of a gamification platform based on their ability to manage abstract concepts. The second dimension pertains to the optimal perception of information by learners (Visual or Verbal). The third dimension refers to the cognitive processing of information (Active or Reflective). The fourth dimension (Sequential or Global) relates to whether learners choose a sequential approach, focusing on step-by-step progression, or a global learning style, focusing on the big picture before the details (Buckley & Doyle, 2017).

Various fundamental educational and psychological principles justify the importance of synchronizing gamified elements of training with individual learning preferences. Customizing gamification to match individual learning styles greatly enhances engagement. For example, people who learn best through visual stimuli may find themselves more interested in components that are visually stimulating. In contrast, those who learn best through physical movement may favor activities that include interactive and physical engagement (Hassan et al., 2021). Customized gamification can tap into inherent motivations, enhancing the learning process by making it more pleasurable and fulfilling. Learners are more likely to experience motivation when the learning process matches their preferences. For learners, this motivation is driven by not only external rewards such as points or badges but also the inherent satisfaction of learning in a way that suits their needs (Tsay et al., 2018). Matching learning materials to a learner's preferred style decreases cognitive load, making it easier to process and assimilate information. The reason is that the information is provided in a manner that corresponds with the learner's innate cognitive processing (Chen & Wu, 2015). Therefore, the following hypothesis emerges:

H7. Individual learning style moderates the relationship between gamification techniques and knowledge retention.

Conceptual model

The conceptual model captures relationships between eight latent variables: gamification techniques (GT), knowledge retention (KR), knowledge sharing (KS), engagement (ENG), individual learning style (ILS), social interaction (SI), prior knowledge (PK), and job performance (JP). Social interaction and prior knowledge are mediators. Individual learning style is a moderator. Each latent construct is measured using different items following a reflective approach (Fig. 1).

A reflective measurement model is relevant for gamified training contexts. The reason is that, in such contexts, constructs such as motivation and engagement are thought to influence specific indicators such as time spent on tasks, understanding of scenarios and challenges, decision making, and the effects of leaderboard position.

Methods

This study combined an experimental method based on eye tracking with a PLS-SEM survey-based study. This mixed method was applied to examine the impact of gamified training on knowledge acquisition and sharing. Such an approach can offers several valuable insights, and this combination of methods enhances the reliability and validity of the research findings.

First, PLS-SEM is effective when analyzing complex relationships between latent constructs. In this study, PLS-SEM was adopted to shed light on how gamification techniques such as points, badges, leaderboards, and challenges influence knowledge retention, knowledge sharing, and job performance. Furthermore, this study investigated the mediating effects of engagement, social interaction, and prior knowledge, as well as the moderating role of individual learning styles. PLS-SEM is suitable for examining these mediation and moderation effects. This method has been used in similar research to evaluate gamification frameworks based on user engagement in e-learning environments (Jaffar & Baharum, 2023).

Second, eye tracking provides objective, real-time data on where learners are focusing their attention during gamified training. This method can shed light on learners' engagement and interest. Similar studies have examined how eye tracking can provide real-time feedback on users' visual engagement in gamified training (Vasiljevas et al., 2019). Eye tracking can mitigate social desirability bias, which is a common issue in self-reported data. Eye tracking identifies which areas of interest reflecting gamification elements (e.g., scenarios, badges, leaderboards, and narratives) are most engaging and effective in retaining attention. In gamified training, eye-tracking technology

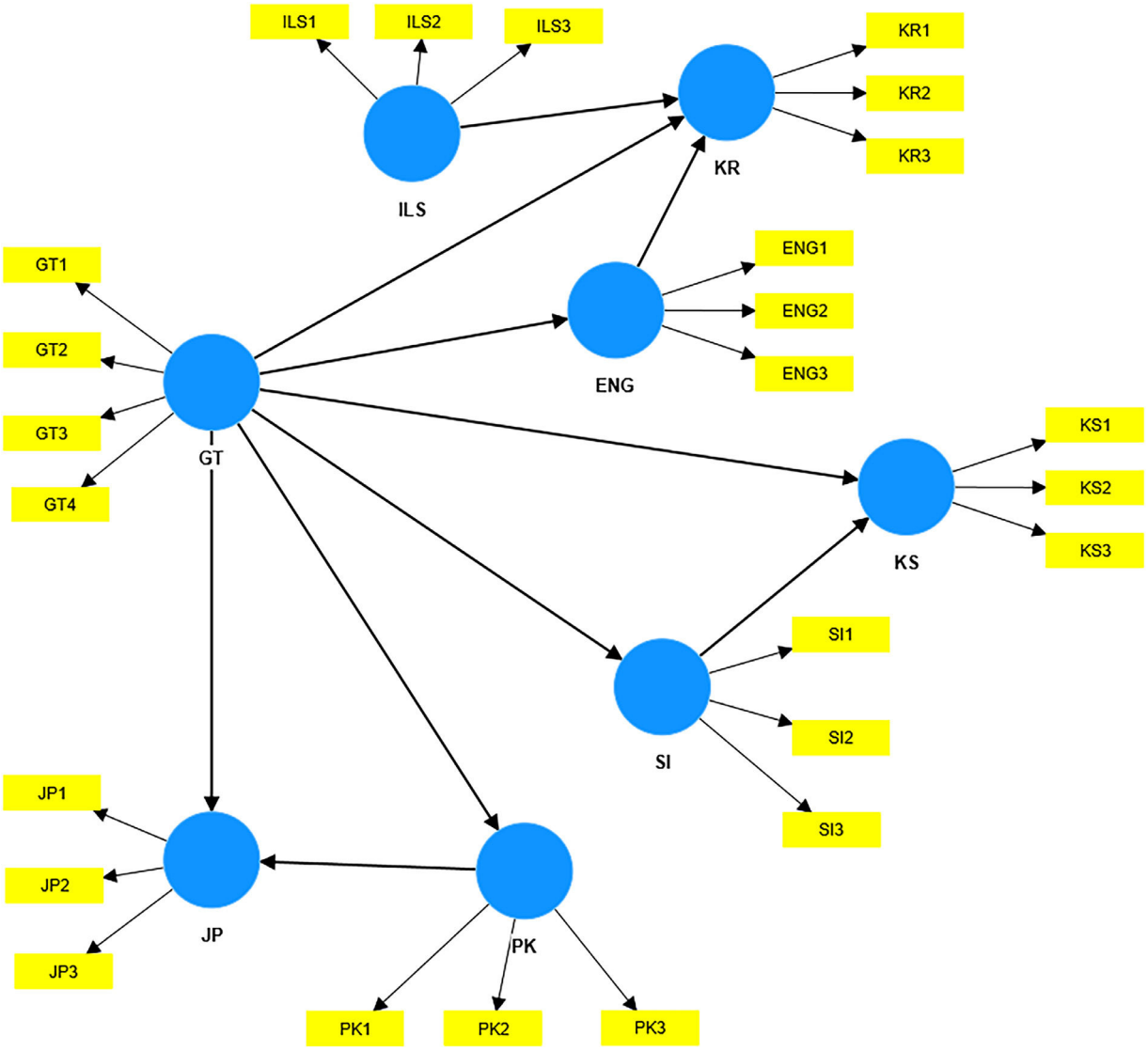

Fig. 1. Conceptual model Notes: ENG = engagement, GT = gamification techniques, ILS = individual learning style, JP = job performance, KR = knowledge retention, KS = knowledge sharing, PK = prior knowledge, and SI = social interaction.Source: Authors.

can precisely identify the location and duration of a learner's focus on particular aspects of the training material. Thus, eye tracking can discern the specific gamification elements that attract and retain attention. The objective of eye tracking in this study was to determine the levels of attraction and visual attention of a sample of learners toward a given gamification platform.

Survey instrument

A questionnaire was created to capture all constructs derived from prior studies and adapted to fit the current research on gamified training. The variable gamification techniques (GT) was measured with four items capturing respondents' perceptions on points, badges, leaderboards, and challenges. The variable knowledge retention (KR) was measured with three items capturing respondents' perceptions on confidence, recall enhancement, and long-term retention. The variable knowledge sharing (KS) was measured with three items capturing respondents' perceptions on willingness to share, collaborative learning, and encouragement of sharing. The variable engagement (ENG) was measured with three items capturing respondents' perceptions on enjoyment, motivation, and attention. The variable individual learning style (ILS) was measured with three items capturing respondents' perceptions on matching, personalization, and flexibility. The variable social interaction (SI) was measured with three items capturing respondents' perceptions on peer support, teamwork, and sense of community. The variable prior knowledge (PK) was measured with three items capturing respondents' perceptions on usefulness, confidence, and ease of understanding. Finally, the variable job performance (JP) was measured with three items capturing respondents' perceptions on enhanced efficiency, innovative thinking, and creative thinking. All items were present in the statistical analysis using PLS-SEM. The control variables were respondents' age, gender, education level, job position, and job tenure. They were considered to influence how learners engage in gamified training.

Sample and data collection

The sampling strategy involved contacting employees and business owners who attended gamified training sessions powered by the Discovery-Innovation-Growth platform and agreed to complete the online questionnaire (Appendix A). Selection was not random. Instead, participants were chosen based on their willingness to complete the online questionnaire and their availability during the data

collection period. This approach ensured that responses were relevant and reflected the recent training experience. Participants completed the questionnaire after the gamified training sessions to report their immediate reactions and insights.

In total, 110 responses were collected from November 2023 to January 2024. The sample included a wide range of participants in terms of age. The largest age group comprised individuals aged 25 to 34 years (49 participants), which represented a large portion of the sample. The next largest age group was 35 to 44 years, consisting of 35 participants. Eight younger participants belonged to the age group of 18 to 24 years. The 45 to 54 years age group comprised 14 participants. The smallest group was 55 to 64 years, with four participants. This diverse age distribution ensured a broad perspective of the effects of gamification at different stages of career development.

Gender distribution in the sample was relatively balanced. There were 52 male participants and 58 female participants. This almost equal representation of genders was helpful for gaining an understanding of the impact of gamification techniques in corporate training without a substantial gender bias. It thus enabled more generalizable findings across the workforce.

The educational background of the participants varied. Most had a bachelor's degree or equivalent (74 participants). Many also had a master's degree or equivalent (24 participants). A smaller proportion of the sample had not continued their studies after completing high school (eight participants). Only four participants had a doctoral or professional degree. This variety in educational attainment meant that the study provided insights into how gamification affects employees with different levels of education.

Current job positions ranged across various organizational levels. The largest group was professional/technical (non-management) positions, with 44 participants. Entry-level/trainee positions accounted for 33 participants, whereas 13 participants were in team leader/supervisor roles. Middle management accounted for 12 participants, senior management four participants, executives one participant, and owners/managing partners three participants. This distribution captured a wide array of perspectives on gamification from different levels of the organizational hierarchy.

In this study, job tenure referred to the time participants had spent in their current job position, not their overall career. Within the sample, there was a range of job tenures. In total, 24 participants had less than one year of experience in their current role, indicating recent hires or job changes. The group with one to three years of tenure comprised 31 participants, whereas the group of those with four to 10 years of tenure consisted of 35 participants, indicating substantial experience within their role. Finally, 20 participants had more than 10 years of tenure. Therefore, the questionnaire also captured insights from seasoned employees. This focus on current job tenure provided specific insights into how long participants had been engaged in their current roles. This insight was relevant for understanding their experience and performance in the context of the gamified training they received.

The participants worked at companies of varying sizes. Most worked at small and medium-sized enterprises (SMEs). Specifically, 51 participants were from companies with 11 to 50 employees, and 40 participants were from companies with 51 to 500 employees. Smaller companies with one to 10 employees accounted for 11 participants, whereas larger organizations with more than 501 employees accounted for eight participants. This diversity in company size provided a comprehensive view of how gamification affects training across different organizational contexts.

Data on respondents' age, gender, education level, job position, and job tenure were collected and used for control variables in the statistical analysis. These variables were considered influential in determining how learners engage with gamified training. Specifically, the analysis examined how these demographic factors influence the effectiveness of gamification techniques for knowledge retention, knowledge sharing, and job performance.

Survey pre-testing was performed with 15 learners (seven men and eight women) who used the gamification platform Discovery-Innovation-Growth (https://dig.demedicis.fr/) and participated voluntarily in the eye-tracking study. All items were measured using a five-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*).

The experimental research phase was performed using the eye-tracker model Gazepoint GP3HD, with a 150 Hz sampling rate. For data collection, Gazepoint Analysis UX Edition v.6.11.0 software was used. The statistical analysis of the data was performed with R software, v.3.6.3. Participants were exposed to one stimulus, with a time limit of 10 s, to prioritize the areas of interest that captured the most attention. The eye-tracking study consisted of 15 participants, who were exposed to the gamified platform for 10 s per stimulus. This method provided objective real-time data on where learners focused their attention, helping identify which gamification elements were most engaging. The correlational study phase was performed with SmartPLS software version 4.0.9.6 to determine path coefficients in the structural model and test the research hypotheses.

Findings

Results from the experimental phase through eye tracking

The Discovery-Innovation-Growth gamification platform was developed under the coordination of Professor Jean Claude Larreche to illustrate the concepts of discovery, innovation, and growth described in the book *The Momentum Effect* (Larreche, 2008). Learners' main goal is to maximize value creation, measured by earnings growth. The game scenario focuses on two phases. In the conception phase, the purpose is to generate customer-based innovations that create optimal conditions for sustainable growth. In the execution phase, the purpose is to achieve the most effective deployment of the innovative product through learners' decisions on pricing, interactive communications, mass communications, and access (distribution and e-commerce). The product is Magic Pen, a gadget sold to virtual customers via a subscription model.

Five areas of interest (AOIs) were identified to analyze learners' focus on the gamification platform features (Fig. 2). AOI 1 was the top left menu. It displayed the actions to be performed by learners in the conception phase (discovery of insights to improve the offer, the testing and inclusion of these insights in the offer, and boosters to enhance growth) and the execution phase (pricing and marketing strategy deployment). AOI 2 was the top middle part of the screen. It displayed the player dashboard, specifically achievements in terms of resource allocation, customer impact, and value sharing in each round of the game. AOI 3 was the bottom left menu. It displayed valuable information on growth drivers and past dashboards to support learners' decision making for future rounds of the game. AOI 4 was the bottom middle-left part of the screen. It displayed the insights discovered by each team in their quest to improve the offer. AOI 5 was the bottom middle-right part of the screen. It displayed the leaderboard, based on key performance indicators such as cover, engagement, acquisition of customers, and earnings.

All participants were exposed to at least 10 s of the stimulus and consequently the five AOIs. Fig. 3 displays the heat map. A range of colors from blue (less exposure time) to red (more exposure time) graphically represents the visual attention that the participants devoted to the stimulus.

The data on participants' engagement and visual attention dedicated to each AOI of the stimulus appear in Table 1.

Only AOIs 2 and 4 were viewed by all users. AOI 1 was viewed by 12 users, and AOI 3 was viewed by 10 users. The AOI viewed by the fewest users was AOI 5, with 9 users. The AOI that attracted the most

Fig. 2. Distribution of areas of interest (AOIs).Source: Authors based on a screenshot from the platform https://dig.demedicis.fr/.

Fig. 3. Heatmap of participants' visualization.Source: Authors.

Table 1
Eye-tracking metrics for each area of interest (AOI).

AOI	Viewers	Total viewers	Avg. time to 1st view (sec) *	Avg. time viewed (sec)	Avg. time viewed (%)	Avg. fixations	Revisitors	Average revisits
AOI 1	12	15	3.1	0.8	7.5 %	2.6	6	2.0
AOI 2	15	15	0.3	3.0	29.8 %	11.3	14	4.0
AOI 3	10	15	4.5	1.1	10.7 %	2.9	6	1.4
AOI 4	15	15	1.7	1.4	13.7 %	5.2	13	1.8
AOI 5	9	15	3.7	2.1	21.2 %	5.1	5	1.0

Notes: "–1.0" means not viewed.
Source: Authors.

visual attention (i.e., first to be seen on average for the group) was AOI 2, after 0.3 s. The next was AOI 4 (1.7 s), followed by AOI 1 (3.1 s), AOI 5 (3.7 s), and finally AOI 3 (4.5 s). Regarding visual attention (time dedicated to viewing), AOI 2 received the most visual attention (3 s, equivalent to 29.8 % of total time). AOI 2 was followed by AOI 5 (21.2 %), AOI 4 (13.7 %), AOI 3 (10.7 %), and AOI 1 (7.5 %). The highest number of fixations (average number of times each AOI was viewed by participants) belonged to AOI 2 (11.3 times), followed by AOI 4 and AOI 5 (5.2 and 5.1 times, respectively), AOI 3 (2.9 times), and finally AOI 1 (2.6 times). Regarding the number of users who revisited a given AOI, AOI 2 received the most revisitors (14 revisitors), followed by AOI 4 (13 revisitors), AOI 1 and AOI 3 (6 revisitors), and lastly AOI 5 (5 revisitors). A related measure is the average number of revisits (the number of times users revisited each AOI). AOI 2 had the

Table 2
Description of the reflective measurement model.

Construct reliability and convergent validity	Item outer loading	Source(s)
Gamification techniques (α = 0.797, CR = 0.801, AVE = 0.624)		
GT1: Earning **points** during the gamified corporate training makes me feel more motivated to learn.	.864	Armstrong & Landers, 2018; Baxter et al., 2016
GT2: Receiving **badges** upon completing training modules makes the organizational learning experience more rewarding for me.	.784	Jayalath & Esichaikul, 2022, Kyewski & Kramer, 2018
GT3: Seeing my name or my team in leading positions on the gamification platform **leaderboard** encourages me to engage more with the corporate training content.	.753	
GT4: Participating in gamified **challenges** during corporate training helps me understand and retain the information better than traditional training formats.	.752	
Knowledge retention (α = 0.756, CR = 0.759, AVE = 0.692)		
KR1: I am confident in applying the knowledge gained from gamified training effectively in my job. (**confidence**)	.805	Buckley & Doyle, 2017, Dahalan et al., 2024, Hammedi et al., 2021
KR2: Since participating in gamified training, I find it easier to recall important information when I need it in my tasks. (**recall enhancement**)	.758	
KR3: The knowledge gained from the gamified training remains clear in my mind even after a long period. (**long-term retention**)	.744	
Knowledge sharing (α = 0.768, CR = 0.771, AVE = 0.684)		
KS1: The gamified concepts in the corporate training program make me more willing to share useful knowledge with my colleagues at their request. (**willingness to share**)	.859	McHenry & Makarius, 2023, Suh & Wagner, 2017, Uz Bilgin & Gul, 2020
KS2: Through the gamified training, I feel more engaged in collaborative learning with my colleagues. (**collaborative learning**)	.770	
KS3: The gamified elements (like points, badges, and leaderboards) in the corporate training program encourage me to share knowledge with my colleagues. (**encouragement of sharing**)	.849	
Job performance (α = 0.761, CR = 0.768, AVE = 0.676)		
JP1: Since participating in the gamified corporate training, I complete my professional tasks more efficiently. (**enhanced efficiency**)	.812	Domínguez et al., 2013, Jayalath & Esichaikul, 2022, Krause et al., 2015, Spanellis et al., 2020
JP2: I am coming up with innovative solutions to my tasks since completing the gamified training. (**innovative thinking**)	.836	
JP3: Gamified training has enhanced my skills to solve job-related challenges creatively. (**creative thinking**)	.819	
Engagement (α = 0.750, CR = 0.753, AVE = 0.667)		
ENG1: The gamified elements in the corporate training make the learning process more enjoyable. (**enjoyment**)	.839	Kim, 2021, Kulkarni et al., 2022, Wang et al., 2022
ENG2: I feel more motivated to complete the training modules due to the gamification features. (**motivation**)	.826	
ENG3: The gamified elements in corporate training keep me focused throughout the sessions. (**attention**)	.785	
Social interaction (α = 0.822, CR = 0.825, AVE = 0.737)		
SI1: Gamification encourages me to help and share knowledge with my colleagues during the training sessions. (**peer support**)	.878	Gupta et al., 2022, Stanculescu et al., 2016, Vegt et al., 2015
SI2: The gamified techniques encourage me to work as a team with my peers during training activities. (**teamwork**)	.836	
SI3: The gamification of training leads to a stronger sense of community among colleagues. (**sense of community**)	.861	
Prior knowledge (α = 0.869, CR = 0.882, AVE = 0.792)		
PK1: My prior knowledge was useful in engaging with the gamified training activities. (**usefulness**)	.904	Behl et al., 2022, Davis et al., 2018, Putz et al., 2020
PK2: Having prior knowledge made me more confident when attending the gamified training activities. (**confidence**)	.880	
PK3: My prior knowledge helped me understand the gamified training content more easily. (**ease of understanding**)	.886	
Individual learning style (α = 0.824, CR = 0.825, AVE = 0.739)		
ILS1: The gamified aspects of the training matched my personal learning preferences. (**matching**)	.838	Buckley & Doyle, 2017, Hassan et al., 2021, Tsay et al., 2018
ILS2: I better appreciate the value of the gamified training content when it is presented in a way that suits my learning style. (**personalization**)	.870	
ILS3: The gamified training is flexible enough to meet my unique learning needs and preferences. (**flexibility**)	.871	

Notes: α = Cronbach's alpha; CR = composite reliability; AVE = average variance extracted.
Source: Values provided by SmartPLS software.

most revisits (4), followed by AOI 1 (2), AOI 4 (1.8), AOI 3 (1.4), and finally AOI 5 (1). All AOIs were viewed by the users. AOIs 2, 4, and 5 received the most visual attention due to their more central location. The menus (AOIs 1 and 3) attracted similar visual attention. However, it was less than the attention dedicated to the other elements. A likely explanation is that the graphical part is more appealing than the text part.

The eye-tracking results revealed distinct patterns of visual attention among participants. AOI 2, which displayed the player dashboard, attracted the most attention. It was viewed first by all participants within an average of 0.3 s and attracted the highest average viewing time of 3 s, representing 29.8 % of total time. This finding indicates that participants were highly engaged with monitoring their progress and resource allocation. Conversely, AOI 5, the leaderboard, received less initial attention (viewed by nine participants within 3.7 s on average). However, it still attracted substantial attention, reflecting its role in fostering competition. The heatmap and opacity map analyses visually confirmed these patterns, showing that central elements of the platform attracted the most sustained attention. These findings underscore the importance of dashboard and leaderboard features in maintaining engagement and guiding user behavior in gamified learning environments. This detailed examination of AOIs through eye tracking provides a thorough understanding of which elements are most engaging to users. It thus offers practical insights for optimizing the design of gamified training platforms to maximize user engagement and effectiveness.

Results of correlational survey-based analysis using PLS-SEM

Table 2 reflects the reliability and validity measurements of the latent variables in the structural model. Cronbach's alpha and composite reliability (CR) values were above the recommended threshold of 0.70. All item loadings were above the threshold of 0.70, so all items were kept for further statistical analysis. All average variance

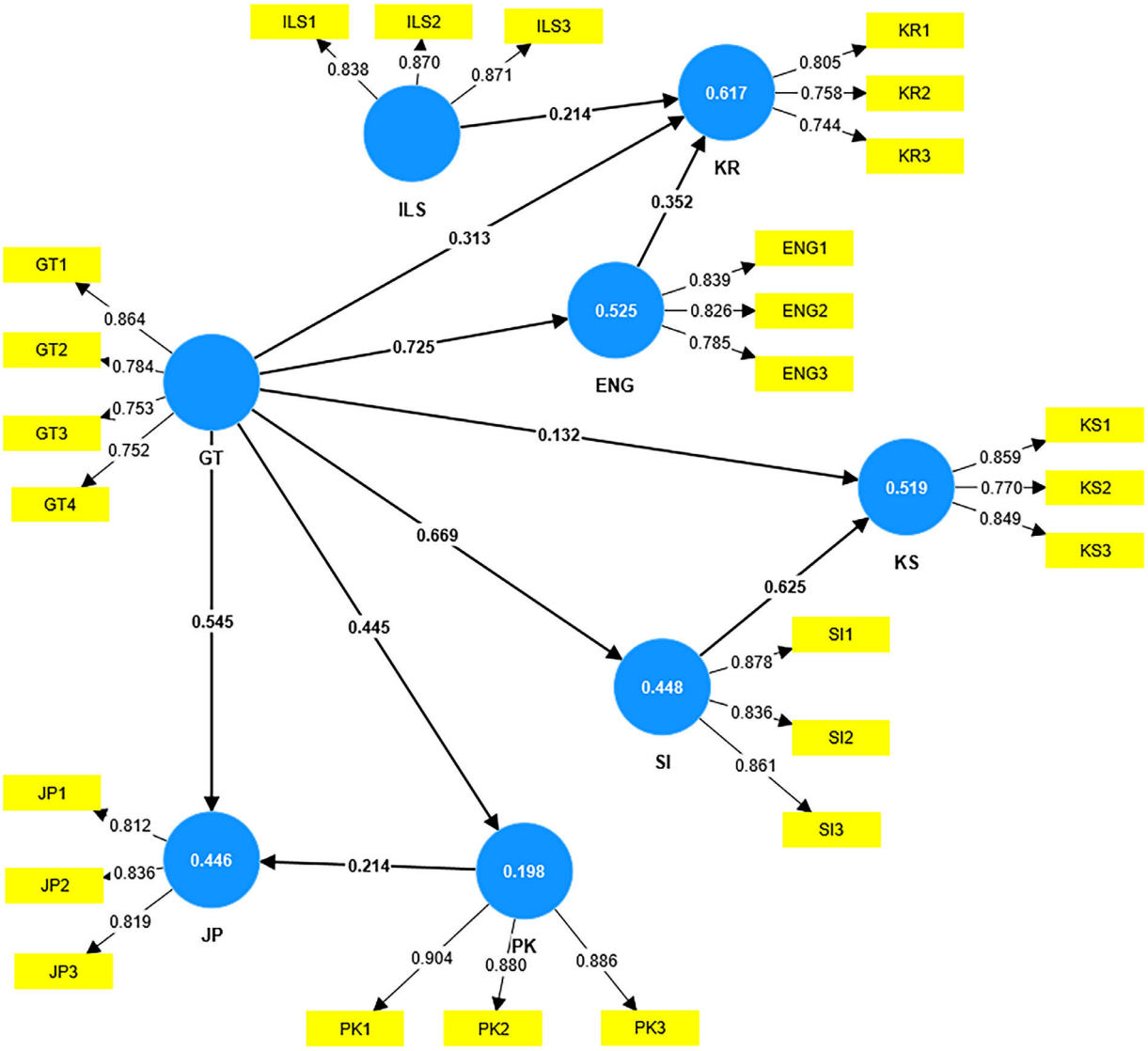

Fig. 4. Path coefficients in the structural model Notes: ENG = engagement, GT = gamification techniques, ILS = individual learning style, JP = job performance, KR = knowledge retention, KS = knowledge sharing, PK = prior knowledge, and SI = social interaction.Source: SmartPLS software output.

extracted (AVE) values were situated above the recommended threshold of 0.50.

Considering the values of outer loadings for the items in each latent construct, the item with the highest contribution to each construct was motivation based on points earned during the training (GT1) for gamification techniques (GT); confidence (KR1) for knowledge retention (KR); willingness to share (KS1) for knowledge sharing (KS); innovative thinking (JP2) for job performance (JP); enjoyment (ENG1) for engagement (ENG); peer support (SI1) for social interaction (SI); usefulness (PK1) for prior knowledge (PK); and flexibility (ILS3) for individual learning style (ILS).

The structural model indicated that gamification techniques (GT) had the strongest impact on engagement (ENG; path coefficient = 0.725), followed by the impact of gamification techniques (GT) on social interaction (SI; path coefficient = 0.669). Gamification techniques (GT) had the lowest impact on knowledge sharing (KS; path coefficient = 0.132). These data appear in Fig. 4.

The constructs individual learning style, gamification techniques, and engagement explained 61.7 % of the variance of knowledge retention (R squared = 0.617). The construct gamification techniques alone explained 52.5 % of the variance of engagement (R squared = 0.525), 44.8 % of the variance of social interaction (R squared = 0.448), and only 19.8 % of the variance of prior knowledge (R squared = 0.198). Gamification techniques and social interaction explained 51.9 % of the variance of knowledge sharing (R squared = 0.519). Gamification techniques and prior knowledge explained 44.6 % of the variance of job performance (R squared = 0.446).

The square root of each construct's average variance extracted (AVE) was greater than its highest correlation with the other constructs (shown below the main diagonal). These results confirmed the discriminant validity of the latent variables based on the Fornell-Larcker criterion (Table 3).

Discriminant validity was further supported by the heterotrait-monotrait ratio of correlations (HTMT), with all pairings of latent variables having correlations below the threshold of 0.90 (Table 4). The HTMT is a recently developed and more reliable technique for evaluating discriminant validity than conventional methods such as the Fornell-Larcker criterion and cross-loadings. The HTMT compares the correlations of indicators across different constructs with the correlations of indicators within the same construct (Sarstedt et al., 2022).

PLS-SEM methodology uses a nonparametric bootstrapping process to assess the statistical significance of the predicted coefficients in the structural model. For the bootstrapping technique, 5000 subsamples were generated by randomly selecting observations from the original data set, with replacement. Table 5 presents the results

Table 3
Fornell-Larcker criterion for assessing discriminant validity.

Construct	ENG	GT	ILS	JP	KR	KS	PK	SI
ENG	.817							
GT	.725	.79						
ILS	.667	.67	.86					
JP	.688	.64	.69	.822				
KR	.721	.711	.658	.697	.77			
KS	.654	.551	.658	.725	.667	.827		
PK	.423	.445	.611	.457	.476	.541	.89	
SI	.721	.669	.716	.704	.647	.713	.648	.858

Notes: ENG = engagement, GT = gamification techniques, ILS = individual learning style, JP = job performance, KR = knowledge retention, KS = knowledge sharing, PK = prior knowledge, and SI = social interaction.
Source: SmartPLS software output.

Table 4
HTMT criterion for assessing discriminant validity.

Construct	ENG	GT	ILS	JP	KR	KS	PK	SI
ENG								
GT	.835							
ILS	.847	.827						
JP	.815	.815	.868					
KR	.826	.88	.892	.884				
KS	.867	.705	.823	.846	.844			
PK	.521	.534	.72	.548	.618	.653		
SI	.819	.821	.868	.883	.878	.898	.763	

Source: SmartPLS software output.
Notes: ENG = engagement, GT = gamification techniques, ILS = individual learning style, JP = job performance, KR = knowledge retention, KS = knowledge sharing, PK = prior knowledge, and SI = social interaction.

Table 5
Results of hypothesis testing.

Hypothesis	Standard deviation (STDEV)	t-statistics (|O/STDEV|)	*p* values
ENG -> KR	.127	2.784	.005
GT -> ENG	.09	8.012	0
GT -> JP	.103	5.313	0
GT -> KR	.106	2.944	.003
GT -> KS	.125	1.062	.288
GT -> PK	.145	3.073	.002
GT -> SI	.092	7.242	0
ILS -> KR	.124	1.721	.085
PK -> JP	.102	2.096	.036
SI -> KS	.114	5.483	0

Notes: ENG = engagement, GT = gamification techniques, ILS = individual learning style, JP = job performance, KR = knowledge retention, KS = knowledge sharing, PK = prior knowledge, and SI = social interaction.
Source: SmartPLS software output.

of the hypothesis testing based on the *p* values and t-statistics of the associations between the latent variables in the model.

The first hypothesis (H1) proposed that the use of gamification techniques in corporate training positively affects employees' knowledge retention. This hypothesis was supported (GT -> KR: *p* value = 0.003). The second hypothesis (H2) proposed that the use of gamification techniques in corporate training positively affects employees' knowledge sharing. This hypothesis was rejected (GT -> KS: *p* value = 0.288). The third hypothesis (H3) proposed that the use of gamification techniques in corporate training positively affects employees' job performance. This hypothesis was supported (GT -> JP: *p* value = 0). The fourth hypothesis (H4) proposed that employees' engagement mediates the relationship between gamification techniques and knowledge retention. This hypothesis was supported (GT -> ENG: *p* value = 0; ENG -> KR: *p* value = 0.005). The fifth hypothesis (H5) proposed that social interaction mediates the relationship between gamification techniques and knowledge sharing. This hypothesis was supported (GT -> SI: *p* value = 0; SI -> KS: *p* value = 0). The sixth hypothesis (H6) proposed that prior knowledge mediates the relationship between gamification techniques and job performance. This hypothesis was supported (GT -> PK: *p* value = 0.002; PK -> JP: *p* value = 0.036). Finally, the seventh hypothesis (H7) proposed that individual learning style moderates the relationship between gamification techniques and knowledge retention. This hypothesis was rejected (ILS -> KR: *p* value = 0.085; GT -> KR: *p* value = 0.003).

The t-statistics quantified the magnitude of the relationship between constructs. The highest correlation was between gamification techniques and engagement (t-value = 8.012), and the weakest correlation was between gamification techniques and knowledge sharing (t-value = 1.062). The mediating role of social interaction between gamification techniques and knowledge sharing is highly relevant for the discussion of findings.

The significant positive effect of gamification on knowledge retention (H1) reflects the benefits of engaging and interactive learning environments. The mediating role of engagement (H4) underscores the importance of keeping employees actively involved to maximize knowledge retention. This finding suggests that the elements of gamification should be designed to maintain high levels of engagement in an attempt to enhance knowledge retention. The lack of a direct significant effect of gamification on knowledge sharing (H2) indicates that gamification alone might not be sufficient to encourage employees to share knowledge. However, the significant mediating role of social interaction (H5) suggests that gamified training programs should have features that promote social engagement and collaboration among employees to facilitate knowledge sharing. The positive impact of gamification on job performance (H3) and the mediating role of prior knowledge (H6) suggest that gamification techniques can effectively enhance job performance, particularly when they build on employees' existing knowledge. This finding implies that training programs should be tailored to leverage the prior knowledge of employees to maximize the effectiveness of gamification. The nonsignificant moderating effect of individual learning styles (H7) suggests that, although gamification is generally effective, its impact on knowledge retention is not significantly influenced by employees' individual learning preferences. This finding indicates that gamification techniques can be broadly applied across different learning styles without the need for extensive customization.

Discussion

The effectiveness of gamification strategies in enhancing employees' knowledge retention in corporate training depends on psychological, pedagogical, and engagement-related variables. Gamification uses components such as points, badges, leaderboards, and challenges to enhance the engagement and enjoyment of players in the learning process. Enhanced involvement is essential for promoting successful learning and knowledge retention. Gamification promotes active engagement rather than passive consumption of information. Engaging actively in the learning process facilitates a deeper assimilation of information, which is crucial for the long-term retention of knowledge. This idea is consistent with the research of Saleem et al. (2022). They reported that gamification is a valuable tool for learners to gain knowledge and helps them assess their existing knowledge to identify areas that require attention. It thus enables learners to make fast improvements to their learning practices, thereby enhancing knowledge retention.

The findings should be interpreted in light of the fact that this study primarily investigated correlations rather than causal relationships. With this idea in mind, the results of the testing of the first hypothesis are aligned with the idea that interactive components of gamification such as simulations enable employees to use their knowledge in common and practical real-life situations, hence

improving their knowledge retention (Reiners et al., 2015). Knowledge sharing within a corporate environment is influenced by factors other than gamification. Such factors include a collaborative work environment, rewards, and acknowledgement. The rejection of the second hypothesis indicates that, although gamification is potentially beneficial for engagement and learning, it does not necessarily lead to increased knowledge sharing among employees. This finding could be explained by the fact that gamification may not adequately cater to these motivations. This finding is inconsistent with those of Cai et al. (2023), who reported that gamification provides an effective toolkit for incentivizing and promoting knowledge sharing.

Although the findings do not indicate a direct relationship between gamification techniques and knowledge sharing, the analysis confirms the fifth hypothesis that social interaction mediates the relationship between gamification techniques and knowledge sharing. Thus, gamification is perceived as promoting an organizational environment in which employees are more inclined to engage in social interactions, thereby increasing knowledge sharing. This finding is consistent with those of Van Toorn et al. (2022), who reported the importance of designing gamification strategies that specifically aim to boost social interactions, rather than just focusing on individual achievements. The analysis shows that the use of gamification techniques in corporate training positively affects employees' job performance. This finding is in line with those of Kossyva et al. (2023), who reported that enhanced employee engagement with training content is associated with greater knowledge retention, resulting in enhanced work performance. The mediating role of engagement suggests that the effectiveness of gamification in improving knowledge retention is not direct. Instead, it would seem to occur through the pathway of increased engagement. This idea has also been noted by Putz et al. (2020). Understanding this mediating relationship provides firms with insights into how to propose more efficient training programs. It implies that merely adding components of gamification may not be enough. The crucial factor is to create these components in a manner that captivates employees.

The findings reveal that employees' level of prior knowledge significantly influences the effectiveness of gamification in improving job performance. This mediation suggests that, for gamification to be most effective, training programs should be tailored to the varying knowledge levels of employees. This finding is in line with those of Friedrich et al. (2020), who reported that training programs might need to include adaptive learning paths, where the components of gamification are adjusted based on learners' existing knowledge and skills.

The observation that individual learning style does not moderate the relationship between gamification techniques and knowledge retention could be influenced by the one-size-fits-all approach of many gamified platforms. Although gamification techniques can be engaging for a wide range of learners, they might not address the unique ways in which different individuals process and retain information. This finding is consistent with the idea that the effectiveness of gamification might be more related to its ability to make learning enjoyable and rewarding rather than its capacity to adapt to different learning styles (Buckley & Doyle, 2017).

The experimental phase of the study used eye-tracking technology to perform objective measurement of engagement with and attention toward gamified training elements. This phase shows that the gamified elements of leaderboards and interactive scenarios capture and retain participants' attention most effectively. These findings support the self-reported data from the PLS-SEM analysis, suggesting that engaging gamification elements enhance the learning experience.

Conclusions

Gamified corporate training programs offer major competitive advantages for organizations. By equipping employees with the latest skills and knowledge, companies enhance their ability to innovate and adapt to changing market conditions. Trained employees are more likely to contribute to the development of a company, creating a culture of continuous improvement and innovation. Moreover, gamified training programs lead to higher employee engagement and retention, reducing recruitment costs and ensuring a highly skilled workforce.

The combination of eye tracking and PLS-SEM to study the impact of gamification techniques on training, knowledge acquisition, and knowledge sharing provides a multifaceted understanding of the behavioral and psychological aspects of training. This approach not only enhances the reliability and validity of the research findings but also offers practical insights for optimizing learners' engagement and learning outcomes. Combining the experimental results with the PLS-SEM analysis shows that attention-capturing elements identified through eye tracking are associated with higher engagement levels reported by participants. This combination of objective and subjective data provides a more robust understanding of how gamification affects training outcomes.

The mixed-methods approach provides valuable solutions for academic research and practical applications for educational and corporate training settings. It can guide the design of more effective gamified learning environments and contribute to knowledge on gamification-based training and human-computer interaction. Using both methods cross-validates the findings. Observations from eye tracking can be further explored and explained through the constructs of the PLS-SEM survey-based analysis, providing robustness to the research findings.

Theoretical implications

The mixed-methods research approach combining experimental and correlational studies gives a more comprehensive understanding of the impact of gamification on training outcomes. It also offers a comprehensive overview of cognitive load, combining objective measurements with subjective perceptions and performance outcomes. The study provides new theoretical perspectives for balancing cognitive load through gamification. Cognitive load theory relates to the limitations of attentional resources. Therefore, this research contributes to knowledge by explaining how gamification captures and maintains learners' attention, thereby optimizing cognitive resources for better knowledge retention and sharing. By including job performance in the analysis, this research extends the application of cognitive load theory from educational settings to the workplace.

Gamification includes elements of choice, an example of which is allowing learners to make decisions. This paper investigates how these elements foster a sense of autonomy and how this sense of autonomy then affects knowledge retention and job performance. Moreover, gamified environments typically provide immediate feedback, which enhances learners' sense of competence. The study offers new perspectives on how this sense of competence contributes to motivation and learning outcomes. It is thus aligned with the principles of self-determination theory. Furthermore, because most gamified platforms involve collaborative and competitive elements, this study reveals how the social interaction aspects of gamification influence feelings of relatedness among peers. This paper explores how gamification affects trust among colleagues, building on social interactions to influence job performance and knowledge exchange. It emphasizes the importance of trust and social interaction in facilitating knowledge sharing, thereby contributing to the development of social exchange theory.

Practical implications

The findings provide valuable insights for designing more effective corporate training and educational programs. By understanding the gamification approaches that best target attention and

engagement, instructors can develop programs that maximize learning outcomes and enhance knowledge retention.

Organizations seeking to enhance employees' efficiency can benefit from understanding the impact of gamification on job performance. Companies can include efficient gamification techniques in their standard training programs to improve staff competencies. The study's emphasis on different learner profiles provides valuable insights for creating tailored learning experiences. These insights might result in the development of customized training programs adapted to the varied learning styles and preferences of employees.

These findings can be further used by information technology (IT) companies specialized in gamification software to enhance their products. Novel gamification strategies and resources can be created to engage users in an efficient way. The study's findings also provide valuable insights for corporate training policymakers, supporting the development of policies and strategies that promote the adoption of impactful gamification approaches in corporate learning and development settings.

Limitations and future research

The experimental and correlational studies were both based on a specific gamification platform. This feature of the research limits the generalizability of the findings to other platforms. The self-reported measures for knowledge retention, sharing, and job performance may be subjective and prone to biases such as social desirability and recall.

In the experimental setting, a challenge was being able to monitor all variables in the conceptual model that might influence attention and engagement with gamification techniques. Participants' prior exposure to gamification platforms and personal preferences may also have influenced their engagement and attention levels, perhaps introducing bias. Further research should use stratified sampling based on prior exposure to gamification to allow comparison between groups and thus understand how previous exposure affects engagement and attention.

Because the correlational study was cross-sectional, it limits the scope for causal inferences. Further research should use longitudinal data to provide a more robust understanding of the impact of gamification techniques on knowledge retention, knowledge sharing, and job performance over time. Alternatively, future research could use a configurational framework to identify causal conditions that affect gamified training learning outcomes.

CRediT authorship contribution statement

Alexandru Capatina: Writing – original draft, Methodology, Formal analysis, Conceptualization. **David Juarez-Varon:** Writing – review & editing, Software, Investigation, Funding acquisition. **Adrian Micu:** Validation, Supervision, Project administration, Data curation. **Angela Eliza Micu:** Writing – review & editing, Investigation, Formal analysis.

Appendix A. Questionnaire items

Questionnaire items, measured on 5-point Likert scale	Sources
Gamification techniques	
GT1: Earning **points** during the gamified corporate training makes me feel more motivated to learn.	Armstrong & Landers, 2018, Jayalath & Esichaikul, 2022; Kyewski & Kramer, 2018; Miri & Macke, 2022; Saura et al., 2021
GT2: Receiving **badges** upon completing training modules makes the organizational learning experience more rewarding for me.	
GT3: Seeing my name or my team in leading positions on the gamification platform **leaderboard** encourages me to engage more with the corporate training content.	
GT4: Participating in gamified **challenges** during corporate training helps me understand and retain the information better than traditional training formats.	
Knowledge retention	
KR1: I am confident in applying the knowledge gained from gamified training effectively in my job. (**confidence**)	Buckley & Doyle, 2017 Hammedi et al., 2021 Kaoud & ElBolok, 2023
KR2: Since participating in gamified training, I find it easier to recall important information when I need it in my tasks. (**recall enhancement**)	
KR3: The knowledge gained from the gamified training remains clear in my mind even after a long period. (**long-term retention**)	
Knowledge sharing	
KS1: The gamified concepts in the corporate training program make me more willing to share useful knowledge with my colleagues at their request. (**willingness to share**)	McHenry & Makarius, 2023, Sharma et al., 2024; Uz Bilgin & Gul, 2020
KS2: Through the gamified training, I feel more engaged in collaborative learning with my colleagues. (**collaborative learning**)	
KS3: The gamified elements (like points, badges, and leaderboards) in the corporate training program encourage me to share knowledge with my colleagues. (**encouragement of sharing**)	
Job performance	
JP1: Since participating in the gamified corporate training, I complete my professional tasks more efficiently. (**enhanced efficiency**)	Allal-Chérif & Bidan, 2017, Chen et al., 2023; Leal-Rodriguez & Albort-Morant, 2019
JP2: I am coming up with innovative solutions to my tasks since completing the gamified training. (**innovative thinking**)	
JP3: Gamified training has enhanced my skills to solve job-related challenges creatively. (**creative thinking**)	
Engagement	
ENG1: The gamified elements in the corporate training make the learning process more enjoyable. (**enjoyment**)	Friedrich et al., 2020, Kulkarni et al., 2022; Wang et al., 2022
ENG2: I feel more motivated to complete the training modules due to the gamification features. (**motivation**)	
ENG3: The gamified elements in corporate training keep me focused throughout the sessions. (**attention**)	
Social interaction	
SI1: Gamification encourages me to help and share knowledge with my colleagues during the training sessions. (**peer support**)	Bakhanova et al., 2020, Gupta et al., 2022; Wanick & Bui, 2019
SI2: The gamified techniques encourage me to work as a team with my peers during training activities. (**teamwork**)	
SI3: The gamification of training leads to a stronger sense of community among colleagues. (**sense of community**)	
Prior knowledge	
PK1: My prior knowledge was useful in engaging with the gamified training activities. (**usefulness**)	Bai et al., 2021, Behl et al., 2022; Putz et al., 2020
PK2: Having prior knowledge made me more confident when attending the gamified training activities. (**confidence**)	
PK3: My prior knowledge helped me understand the gamified training content more easily. (**ease of understanding**)	
Individual learning style	
ILS1: The gamified aspects of the training matched my personal learning preferences. (**matching**)	Buckley & Doyle, 2017, Hassan et al., 2021; Tsay et al., 2018
ILS2: I better appreciate the value of the gamified training content when it is presented in a way that suits my learning style. (**personalization**)	
ILS3: The gamified training is flexible enough to meet my unique learning needs and preferences. (**flexibility**)	

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