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The power of play: gamification in virtual workplace training

Vera Maria Eger[a], Eleni Georganta[b], Paul-David Joshua Zuercher[c], Felix Mueller[c], Thomas Bohné[c] and Sarah Diefenbach[d]

[a]TUM Entrepreneurship Research Institute, Technical University of Munich, Munich, Germany; [b]Faculty of Social and Behavioural Sciences, University of Amsterdam, Amsterdam, The Netherlands; [c]Cyber-Human Lab, University of Cambridge, Cambridge, UK; [d]Department of Psychology, Ludwig-Maximilians-Universitaet, Munich, Germany

ABSTRACT

Organizations face growing pressure to upskill their employees and provide effective and engaging training, leading to significant investments in virtual workplace training (VWT). However, the effectiveness of VWT, particularly when incorporating game elements, remains unclear. To address this, this study examined the impact of gamification intensity on perceived autonomy and its effect on training outcomes. Additionally, it explored whether self-efficacy played a moderating role in these relationships. Using a between-subjects design, we manipulated gamification intensity (low, medium and high levels) and asked 355 employees to complete a VWT and a retention test. In contrast to our expectations, gamification intensity negatively affected perceived autonomy. Furthermore, perceived autonomy had a positive impact only on affective but not on performance-related training outcomes. Also, we found no evidence of the mediating role of perceived autonomy or the moderating role of self-efficacy in these relationships. Regarding the retention test, gamification intensity negatively affected perceived autonomy and both affective and performance-related training outcomes. Our findings challenge the belief that gamification intensity enhances satisfaction and training success and underscore the importance of autonomy in VWT. We discuss how our findings can guide researchers and practitioners to promote sustainable training success in organizations.

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Investments in workplace training have long been recognized as a crucial strategy for improving employee performance, productivity and overall organizational success (Wef, 2023). This is why organizations across industries are spending billions yearly implementing comprehensive training programs aimed at equipping their workforce with the tools and skills needed to continually learn and adapt to new challenges (Glaveski, 2019). Meeting the training needs of employees is essential for organizations to survive in today's business landscape (Kauffeld & Maier, 2020; Kauffeld et al., 2022). This becomes even more evident when looking into recent reports predicting that half of the global workforce will require either upskilling or reskilling by 2025 (Wef, 2023). Workplace training reflects the process of acquiring knowledge or skills in a certain amount of time and using one or multiple training methods at work (Arthur et al., 2003). When effective, it facilitates learning, "a relatively permanent change in knowledge or skill produced by experience" (Weiss, 1990, p. 172), and learning transfer, the extent to which the knowledge and skills acquired in training are applied across settings and situations over time (Blume et al., 2010). However, about 40% of employees seem to be unsatisfied with their workplace training (Bingham, 2022).

To remain competitive and offer a satisfying learning experience to their employees, organizations increasingly offer virtual workplace training (VWT), which we define as a three-dimensional (3D) computer program that includes interactive and multimedia features, such as computer animations, audio and video, or 3D graphics to teach the training participant specific skills at work (Jia et al., 2013). VWT are intentionally designed learning environments that primarily support formal learning, defined as highly structured learning in terms of what to learn (Kyndt & Baert, 2013), guided often by instructors with predefined goals and structured pathways. These learning contexts are particularly useful for acquiring technical or motor skills where a predefined sequence of operations or steps is given to achieve a goal (Rodríguez et al., 2012); this delivers real-time content and prioritizes learning as the central objective of the training (Clark et al., 2018).

Gamification, the use of game design elements in nongame contexts (Deterding et al., 2011), reflects a popular way to design VWTs in an effort to promote the effectiveness of workplace training. Gamification enables employees the flexibility to explore and master the training content by incorporating gamification features, such as points, levels, badges, leader boards and challenges (Palmas et al., 2019). Depending on the level of gamification, it can encourage active participation and self-regulated learning (Sailer, Hense, Mandl, et al., 2017; Sailer, Hense, Mayr, et al., 2017; Sailer & Homner, 2020). During VWT, trainees receive immediate feedback, have the ability to make independent decisions (e.g., trying things out and seeking feedback) and gain control over one's own learning process (Sheldon & Filak, 2008). These self-regulating learning behaviours are characterized by the learner setting their own learning goals and independently

CONTACT Vera Maria Eger vera.eger@tum.de

observing and monitoring the learning process (Sitzmann & Ely, 2011). This creates a feeling of having ownership of one's own learning (Cerasoli et al., 2014, 2016, 2018), boosting problem-solving skills and reflecting on the task (Cerasoli et al., 2018; Tannenbaum et al., 2010). This perceived autonomy supports training outcomes, such as performance during and satisfaction with the training (H.-M. Huang et al., 2010; Y. C. Huang et al., 2019). Still, there is limited evidence about the impact of VWT and its gamified design on perceived autonomy and training outcomes (Sailer, 2016; Sailer, Hense, et al., 2017). For instance, badges have been found to support the learner's sense of accomplishment (Nicholson, 2015), while providing choice and interaction has been shown to promote intrinsic motivation (Aparicio et al., 2012). Despite its widespread popularity in designing training, it remains unclear how gamification impacts perceptions and outcomes during increasingly implemented VWTs (Sitzmann, 2011; Sitzmann & Ely, 2011). At the same time, little is known about whether all employees can profit the same from gamification in VWT (Kraiger & Ford, 2021).

The goal of the present study is to shed some light on the influence of gamification on training outcomes in VWT and to explore why and for whom gamification during training at work might be more effective. To do that and given that gamification can differ in intensity depending on the game elements implemented, we investigate the indirect impact of gamification intensity (i.e., low, medium and high) on training outcomes, both performance-related and affective, as suggested by Sitzmann and Weinhardt (2018) and Watson et al. (2018). Furthermore, we explore whether perceived autonomy mediates the relationship between gamification intensity and training outcomes. Thereby, we recognize the importance of autonomy for informal learning behaviours (Cerasoli et al., 2018) and online training (Eberle & Hobrecht, 2021), responding to calls for more evidence on autonomy in VWT (Sailer, Hense, Mandl, et al., 2017). Finally, as individual characteristics can shape the effectiveness of training elements (Klock et al., 2020; Koivisto & Hamari, 2014), we investigate whether the relationships between gamification intensity, perceived autonomy and training outcomes change depending on self-efficacy. Self-efficacy, an individual's belief in their ability to successfully perform a specific task or achieve a particular goal (Bandura, 1977), can shape the impact of a new learning environment on an employee's learning (Cherian & Jacob, 2013).

In our work, we aim to move beyond previous studies that have examined the general relevance of gamification for training outcomes (Bai et al., 2020) by testing the impact of different levels of gamification in VWT on perceived autonomy and, in turn, on performance-related and affective training outcomes. In doing so, we also attempt to gain a more complete picture of the impact of advanced technologies, such as gamification and virtual reality, on workplace training, as recently called for (Cascio & Montealegre, 2016; Gegenfurtner et al., 2020; Radianti et al., 2020). As organizations continue to invest billions in gamified VWT without a clear understanding of their effectiveness, we hope that our findings can help make more informed decisions about training strategies considering employees' autonomy needs and personal characteristics.

Theoretical background

The role of autonomy in VWT

Within workplace training, autonomy plays a crucial role in shaping learners' satisfaction and engagement (Niessen & Volmer, 2010; Strauss & Parker, 2014). Autonomy refers to the need for individuals to experience a sense of volition, choice and control over their desired actions and decisions (Sheldon & Filak, 2008). Therefore, meeting the need for autonomy in training involves more than simply offering choices (Katz & Assor, 2007). It also emphasizes the importance of opportunities for self-realization and self-determination by engaging in tasks that are in line with personal goals (Y. C. Huang et al., 2019; Sailer, Hense, Mayr, et al., 2017). According to self-determination theory (SDT; Deci & Ryan, 2000), when the psychological need for autonomy is satisfied, individuals are more likely to experience intrinsic motivation and learn. Furthermore, when individuals feel autonomous in their training environment, they are more likely to experience higher levels of engagement and satisfaction (Gagné & Deci, 2005). Autonomy in training allows learners to have control over their learning process, make choices and set their own learning goals, which can lead to increased intrinsic motivation and a sense of ownership over the learning experience (Su & Reeve, 2011).

Research has suggested that autonomy in training has a positive impact on various training outcomes. Autonomy facilitates performance-related outcomes (van den Broeck et al., 2016), as learners are more likely to persist in challenging tasks and take responsibility for their training outcomes. Autonomy is also associated with higher levels of cognitive engagement, critical thinking skills and creativity, as learners are encouraged to explore, experiment and take ownership of their learning (Cerasoli et al., 2014). Additionally, autonomy promotes affective training outcomes, such as satisfaction within the learning process, as learners feel empowered and fulfilled when they have a sense of control and choice in their training experience (Ebner & Gegenfurtner, 2019; Vansteenkiste & Ryan, 2013; Vansteenkiste et al., 2004, 2009). Related evidence in virtual training environments has shown that perceived autonomy is positively related to satisfaction and performance (Y. Jung, 2011; Lee et al., 2010) as well as to positive experience (Y. C. Huang et al., 2019). Building on these previous findings, we argue that perceived autonomy in VWT promotes both performance-related and affective training outcomes. Specifically, we propose the following:

Hypothesis 1: Perceived autonomy is positively associated with training outcomes (performance-related and affective).

The effect of gamification on autonomy

Gamification in training encourages active participation and organized informal learning (R. Landers & Reddock, 2017; Sitzmann & Ely, 2011), as learners are motivated to explore and master the training content to earn rewards and progress through different training levels. Gamification can tap into the inherent human desire for competition, achievement and rewards and thereby increase the learning motivation and engagement of employees. Indeed, gamification has been shown to simplify complex processes, create an intuitive learning environment and enhance self-efficacy and motivation (Banfield & Wilkerson, 2014; Kettler & Kauffeld, 2019). Furthermore, gamification has been found to support autonomy in online training (Ryan et al., 2006). Different gamification elements can be integrated into workplace training and can provide instant feedback to learners and performance metrics, allowing learners to track their progress and identify areas for improvement (Bai et al., 2020; Khaldi et al., 2023). Nevertheless, a clear understanding of their impact and the resulting gamification intensity in VWT is missing.

The most basic gamification elements (i.e., low gamification intensity) that reflect prerequisites for non-immersive (i.e., control over characters and activities) virtual training environments are the freedom to investigate and discover task features (i.e., exploration, Dalgarno & Lee, 2010; Noe et al., 2014) and receive *feedback* during task execution (Den den et al., 2017; Miranda & Palmer, 2014). Research has shown that receiving feedback can promote learning by supporting the learner's autonomy to use the learned content (Decius et al., 2019; Welk et al., 2022). The most common gamification elements, in addition to the basic ones (i.e., medium gamification intensity), are presenting goals (i.e., *goal setting*; Chiaburu & Marinova, 2005), implementing signs to guide the trainees (i.e., *signposting*; Lavoué et al., 2018) and having a *virtual instructor* (Sheldon & Filak, 2008). Having clear goals and cues that support reaching those goals allows trainees to locate their own strengths and weaknesses by urging them to think about what they need to do next (Harris, 1997). Thereby, trainees are given the autonomy to become responsible for their own progress. At the same time, having a virtual instructor who communicates the purpose or goal of the training helps convince trainees of the importance of performing a task. Perceiving a task as meaningful increases the feeling of autonomy during training (Su & Reeve, 2011).

In VWT, additional gamification elements can be implemented that create a more playful, rich and engaging training environment (Subhash & Cudney, 2018). Specifically, one powerful gamification element to support autonomy and engagement in training is *choice*. Choice(s) can be given and control how trainees engage with the content and progress through their training (Sailer, Hense, et al., 2017), fostering a sense of autonomy and, in turn, increasing their motivation and engagement. Prior work has shown that freedom in regard to avatar customization (Peng et al., 2012), the order and colour of displayed grids (Sheldon & Filak, 2008) or at least one aspect of the virtual training environment (Sanli et al., 2013; Wulf & Lewthwaite, 2016) increased perceived autonomy. Similarly, *narratives*, the implementation of a storyline (Armstrong & Landers, 2017), instead of only providing dry instruction, can set the task in a meaningful context by artificially increasing its importance (Nicholson, 2015) and thereby the perceived autonomy. The training can also be visually adapted to the story, enabling trainees to better imagine themselves in the described situation. In this way, trainees perceive the training activities as self-chosen rather than externally controlled and thereby feel more autonomous (Gagné & Deci, 2005).

In line with prior work that has shown that different gamification elements can foster autonomy during virtual tasks (Sailer, 2016; Sailer, Hense, et al., 2017) and given the fact that the stronger the gamification intensity and thereby training experience, the more trainees perceive the task and training as self-determined, we propose the following:

Hypothesis 2: Gamification intensity is positively associated with perceived autonomy.

Autonomy as a mediator in the relationship between gamification intensity and training outcomes

In line with SDT (Deci & Ryan, 2000) and previous evidence, we also propose that gamification intensity can enhance trainees' perceived autonomy and thereby promote training outcomes, both performance-related and affective. Along this line of thinking, gamified learning theory (R. N. Landers, 2014) similarly suggests that gamification intensity can indirectly impact training outcomes by enhancing trainees' perceived autonomy and self-control (Buckley & Doyle, 2016; Leftheriotis et al., 2017). Sailer, Hense, et al. (2017) showed that autonomy is the underlying mechanism of the positive relationship between gamification intensity and performance in a VWT task. It seems that gamification intensity can make trainees aware of their choices and help them set their own goals and make autonomous decisions on how to progress through training (Sailer & Homner, 2020). For instance, Kern et al. (2019) showed that immersive virtual reality training led to higher decision freedom compared to traditional training, due to storytelling and the autonomy to stop or continue the training. Gamification intensity empowers trainees and makes them feel autonomous, perceptions that improve not only performance-related outcomes, such as increased retention of information and better application of learned skills in real-world contexts (Blume et al., 2010), but also affective outcomes, such as increased enjoyment and satisfaction (R. Landers & Reddock, 2017). Taking this together, we argue that gamification intensity in VWT promotes perceived autonomy and, in turn, supports both performance-related and affective training outcomes. Specifically, we propose the following:

Hypothesis 3: Perceived autonomy mediates the positive relationship between gamification intensity and training outcomes (performance-related and affective).

The moderating role of self-efficacy

Research on trainee characteristics has shown that self-efficacy is one of the most influential individual characteristics shaping motivation to learn (Colquitt et al., 2000), as well as positive attitudes towards learning (Tsai et al., 2011) and the training environment (Theelen et al., 2019). This is because self-efficacy can activate self-regulating learning strategies, such as self-monitoring, self-evaluation, goal-setting and planning (Zimmerman et al., 1992). These factors influence the effectiveness of the training and how it is evaluated (Gegenfurtner et al., 2014; Sitzmann & Weinhardt, 2019). Indeed, evidence has found that self-efficacy can shape the impact of training on training outcomes, both affective, such as motivation to learn (Colquitt et al., 2000) and satisfaction with the training (Jia et al., 2009), and performance-related outcomes (Rosenqvist & Skans, 2015; Wulf & Lewthwaite, 2016).

Building on this line of thinking, we propose that self-efficacy will also shape the impact that gamification intensity has on training outcomes during VWT. Indeed, self-efficacy has been shown to influence how learners perceive and engage with gamification elements in virtual training and, thereby, how these affect their perceptions and training outcomes (Banfield & Wilkerson, 2014; Ortiz-Rojas et al., 2017; Polo-Peña et al., 2021). Specifically, the level of self-efficacy has been found to impact how individuals use and perceive new learning technologies (Huffman et al., 2013; Lin & Wang, 2021; Polo-Peña et al., 2021) as well as their willingness and motivation to try out new learning methods in virtual training environments (Lin & Wang, 2021; Tsai et al., 2011).

In particular, we argue that individuals with low levels of self-efficacy will profit more from gamification intensity in terms of their training outcomes, both performance-related and affective, compared to individuals with high levels of self-efficacy. This is because instant feedback mechanisms inherent in rich gamified training environments reduce anxiety and increase confidence in task execution (J. Jung et al., 2010). For those unaccustomed to such training systems, gamification is a significant aid in their learning journey (Strmecki et al., 2015). On the contrary, individuals with high self-efficacy find less benefit from gamification initiatives compared to those with low self-efficacy. High self-efficacy individuals typically exhibit a proactive approach to challenges, readily engaging in self-regulating learning strategies, such as self-monitoring, self-evaluation and goal-setting (S. Rigby & Ryan, 2011; Sitzmann & Ely, 2011). Research supports this notion, suggesting that individuals with high self-efficacy are more inclined to employ effective self-regulatory processes in their learning endeavours (Locke & Latham, 2002; Seijts & Latham, 2001; Van Roy & Zaman, 2017). Therefore, the additional motivational boost provided by gamification may be redundant for these individuals, as they are already highly driven by their confidence in their abilities. Evidence shows that people who are already confident in their skills cannot profit as much from gamified training as those who have shown positive changes in their motivation and cognitive benefits (Makransky et al., 2019). As the within-person change in self-efficacy has been shown to be a major predictor of learning in training (Sitzmann & Weinhardt, 2018, 2019), and this change is higher for people benefitting more from the training (Makransky et al., 2019), we assume that also in our VWT, people with already high perceived self-efficacy will benefit less.

Additionally, individuals with high self-efficacy may not benefit as much from gamified training as those with lower self-efficacy, due to the nature of training as a preparatory context. According to control and self-efficacy theories (Bandura, 1977; Vancouver & Kendall, 2006), high self-efficacy can potentially impair performance in preparatory contexts. This is because individuals tend to rely on their self-efficacy to gauge the level of resources needed to achieve satisfactory performance. When individuals are highly confident in their ability to succeed, they may reduce the allocation of resources towards knowledge acquisition and skill development (Vancouver & Kendall, 2006) or even feel bored or restricted by a gamified training context (Loderer et al., 2020). However, if this confidence is unwarranted or the gamified context thwarts self-regulating strategies, it can lead to a shortfall in perceived autonomy (Cerasoli et al., 2016), resulting in inadequate preparation and, ultimately, poorer performance.

In contrast, individuals with low self-efficacy may lack the intrinsic motivation and confidence to engage in self-regulating learning strategies independently (Colquitt et al., 2000). For them, gamification can serve as a powerful external motivator, providing a structured framework and tangible rewards that incentivize progress (Loughrey & Broin, 2018). Locke and Latham (2002) highlighted how individuals with low self-efficacy tend to rely heavily on external sources of motivation to initiate and sustain their efforts. Thus, gamification interventions have the potential to bridge the gap between their perceived capabilities and desired outcomes by offering clear milestones and immediate feedback, thereby enhancing their perceived autonomy and efficacy in task completion (Loughrey & Broin, 2018). Evidence from medical training shows that patients with low self-efficacy compared to high self-efficacy could benefit more from web-based training because gamified support is tailored to their exercise needs (Robinson et al., 2019).

Building on this prior work, we expect self-efficacy to shape the impact of gamification intensity on perceptions of autonomy and training outcomes in VWT. Specifically, we argue that individuals who do not believe in themselves benefit more from gamification intensity, leading to higher autonomy and, consequently, higher training outcomes, both performance-related and affective, than individuals with high self-efficacy. Specifically, we propose the following:

Hypothesis 4: Self-efficacy moderates the positive relationship between gamification intensity and perceived autonomy so that the relationship will be stronger for trainees with low self-efficacy than for trainees with high self-efficacy.

Hypothesis 5: Self-efficacy moderates the positive indirect relationship between gamification intensity and training outcomes (performance-related and affective) through perceived autonomy so that the indirect relationship will be stronger for trainees with low self-efficacy than for trainees with high self-efficacy.

Method

Sample

To determine the required sample size for investigating the proposed relationships, a power analysis using the software *G*Power* (Version 3.1.9.6) was conducted (Lakens, 2013; Verma & Verma, 2020). For the power analysis, a small effect size of $\eta^2 = 0.03$, in line with previous work on gamified learning (Sailer & Homner, 2020), a 0.05 alpha error probability and a power of 0.80 were used. The analyses revealed a minimum sample size of 325 individuals. To reach the required sample size, individuals older than 18 years and working at least 10 hours per week were recruited via private and social networks (LinkedIn, Xing, Facebook and Instagram), as well as via the recruiting platform *Amazon Mechanical Turk* (MTurk).[1]

Overall, 423 individuals participated in the study. Thirty-one participants were excluded because they failed one or more of the six bogus items (see Measures), and 37 participants were excluded after reporting application errors. The final sample consisted of 355 participants.[2] The average age of the final sample was 31.23 (*SD* = 9.32), with 27.3% female and 0.8% non-binary. Forty-one per cent were from Germany, 36.6% from the United States of America, 8.7% from the United Kingdom and 6.2% from India. Seventy-three per cent of participants reported using the computer for more than six hours per day. Sixty-five of the participants were full-time workers, whereas the remaining participants worked part-time. Eighty per cent of the participants reported gaming for less than three hours per day. Seventy-three per cent reported having at least some experience with virtual reality. Seventy-five per cent reported having some experience with assembly tasks, and 13 per cent had already completed a virtual assembly task, the type of task executed during the present study. All participants were compensated for their participation either by receiving an Amazon voucher (7€/£ experiment; 3€/£ retention test) or via payment (6.50$ experiment; 2.50$ retention test in Mturk[3]).

Design and learning environment

To investigate the hypothesized relationships, we conducted an online experimental study in which participants completed a VWT. Using a between-subjects design, we manipulated gamification intensity and built three conditions (low gamification, medium gamification and high gamification). Participants were randomly assigned to one of three conditions (low gamification: *n* = 127; medium gamification: *n* = 126; high gamification: *n* = 102). The conditions differed in the number of gamification elements implemented. In the low gamification condition, there were two elements implemented; in the medium gamification condition, four elements were implemented and in the high gamification condition, 13 elements were implemented (for details see Selection of Game elements & Experimental Conditions and Appendix B, Figure C1-C3). The different conditions were created using *Unity* (https://unity.com/de), which is a cross-platform game engine that can be used to create 3D and two-dimensional games, as well as interactive simulations and other experiences. The learning environment for the online experiment was web-based and reflected the industrial context.

Selection of game elements and experimental conditions

zTo systematically select the game elements for the VWT environment, we used three criteria: (1) their positive impact on training outcomes in terms of the majority of previous studies showing that they support such training outcomes; (2) their suitability and compatibility to the learning context in terms of supporting procedural knowledge acquisition in the industrial context and (3) the interplay between game elements in terms of redundancy or counterworking (see Bohné et al., 2022). Table 2 summarizes the 13 game elements that we selected.

The three experimental conditions (low, medium and high gamification intensities) differed in the number of game elements implemented in the virtual learning environment (Table 1). The low gamification condition incorporated two basic game elements (i.e., exploration and feedback), which are prerequisites for non-immersive VWT environments. The medium gamification condition incorporated the two basic game elements and three additional game elements (e.g., virtual instructor), as those were three of the most often used game elements in learning contexts. Finally, the high gamification condition incorporated the game elements of the medium condition and eight additional game elements based on their richness, as well as the importance and impact shown in prior studies (see Table 1).

Table 1. List of selected game elements and their implementation.

Gamification Element	Gamification intensity	Description	Implementation
Exploration	Low, Medium, High	Option to investigate and discover features of the task (Dalgarno & Lee, 2010; Noe et al., 2014)	Navigation inside the training environment and interaction with objects
Feedback	Low, Medium, High	Returns relevant information about the task to the participant (Den den et al., 2017; Miranda & Palmer, 2014)	Visual and auditory feedback on each step
Virtual Instructor	Medium, High	Virtual (often human-like) persona (Sheldon & Filak, 2008)	Human-like appearance of a neutral-looking industrial worker
Goal Setting	Medium, High	Clear goals presented (Chiaburu & Marinova, 2005)	Clear goal definition at the beginning of the virtual training
Signposting	Medium, High	Guiding signs to support the participant (Lavoué et al., 2018)	Visual cues marking the objects needed for each step
Prize	High	A reward that the participant can receive (Sailer, Hense, et al., 2017; Werbach & Hunter, 2012)	Golden coins for placing objects correctly
Badge	High	Visual representation of the participant's accomplishments (Den den et al., 2017)	Beginner, Professional and Expert badge
Choice	High	Having the freedom to decide among possibilities (Wulf & Lewthwaite, 2016)	Fictional choice of the level of difficulty during the training
Meaning	High	Auto-identification with the task via common intention (Holmes et al., 2016)	Participants are informed that they assemble a frequency converter for human safety in car tunnels
Narratives	High	Implementing storylines (Armstrong & Landers, 2017)	Text and audio information about context of the training and participant's role
Progress	High	Milestones and target demonstrating the participant's progress (Miranda & Palmer, 2014)	Orange-coloured progress bar providing in per centage the participant's progress
Reward Schedule	High	Schedule item that strengthens the behaviour in expecting new rewards (Butler, 2014)	Badges are visible at all times
Roles	High	Role-playing elements of characters (Nicholson, 2015)	Assigning participant the role of an industrial worker

Table 2. Means, standard deviations, correlations and reliabilities.

Var.	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11
1. Gamification intensity	1.93	0.80											
2. Autonomy (t1)	4.59	1.30	−0.15**	(0.88)									
3. Age (t0)	31.23	9.32	−0.04	0.01									
4. Gaming experience (t0)	1.85	1.04	0.05	0.15**	0.04								
5. Gender (t0)	1.29	0.47	0.01	−0.14*	0.04	−0.17**							
6. TTC[a]	382.19	253.76	0.00	0.08	0.23**	−0.10	0.21**						
7. Error rate[b]	4.01	1.79	0.11*	0.07	0.12*	0.16**	0.08	0.45**					
8. Self-rated performance [c]	31.21	28.06	−0.06	−0.17**	0.11*	−0.09	0.20**	0.35**	0.29**				
9. Satisfaction (t2)	5.20	1.52	−0.09	0.71**	0.08	0.18**	−0.11*	0.04	0.01	−0.22**			
10. Self-efficacy (t1)	5.01	1.48	−0.12*	0.52**	0.08	0.20**	−0.23**	−0.04	−0.01	−0.30**	0.54**		
11. Performance retention[d] (t3)	7.66	3.25	−0.19*	0.20**	0.02	−0.01	−0.11	−0.17*	−0.21**	0.18*	0.19**	0.14	
12. Satisfaction retention (t3)	5.32	1.28	0.04	0.59**	0.05	0.23**	−0.29**	−0.07	−0.09	0.51**	0.65**	0.50**	0.10

N = 355 main experiment; $N_{retention}$ = 187; The internal reliability (Cronbach's α) for the total constructs is shown in brackets on the diagonal. Pearson correlations are given for the intercorrelations (two sided); [a]Time to completion (TTC) shown in minutes; [b]Error rate as the number of mistakes ranged from 0 to 10. [c]Self-rated performance rated from 1 (good) to 100 (poor); [d]Performance as the number of correct answers from 0 to 14. $*p < 0.05$; $**p < 0.01$; $***p < 0.00$.

Task

Across conditions, the participants were first trained and then assessed to execute an assembly task that described a process of changing and joining different parts to create a whole (Boud et al., 1999). To accomplish this kind of task successfully, one must learn certain assembly steps in a predefined order and develop manual skills (Vélaz et al., 2014). In the present online experiment, the assembly task was similar to a typical medical or industrial task. The participants were required to remember a certain order of steps and execute them accordingly. Specifically, in 10 steps, the participants could select, rotate or combine objects to assemble a frequency converter. The frequency converter was designed close to reality,[4] an essential aspect for providing a realistic training task with sufficient complexity (Hoedt et al., 2017; Samy & ElMaraghy, 2010). The working station, the parts and the tools to assemble the frequency converter were shown from a first-person perspective to the participants. The participants were able to move around in the virtual room, use the objects (drag and drop them) and change their perspective by moving the cursor. After selecting and placing an object, the participants had to rotate it in the right position using the 3D rotation *Gizmo*. This rotation tool is commonly used in product development applications, such as computer-aided design. When executing the assembly task (for both training and assessment), the participants were instructed to try their best.

Procedure

We ran the online experiment for two months. To participate in the online experiment, a link was sent. After clicking on the link, the participants were informed about the length of the study and the requirements to participate and ensured that their participation was anonymous and voluntary.[5] After agreeing to participate, the online experiment began. Across all conditions, the online experiment consisted of three phases: (1) the familiarisation phase, (2) the training phase and (3) the assessment phase of the VWT. The average duration of completing the online experiment across the conditions was 55 minutes.

Before and after each phase of the online experiment, the participants completed a short questionnaire. Specifically, before the familiarization phase (t0), we assessed demographics (age, gender, nationality, occupation and education) and control variables (i.e., gaming experience). After the training phase (t1), we assessed perceived autonomy and self-efficacy. After the assessment phase (t2), we assessed both performance-related and affective training outcomes (self-rated performance and satisfaction) and whether interfering circumstances were present while completing the assessment phase. During the assessment phase, we also assessed additional performance-related training outcomes (time to completion [TTC] and error rate).

Familiarisation phase

The familiarization phase of the VWT started with brief training accompanied by audio and textual instructions that explained step by step how to use the arrow keys of the computer keyboard and the mouse (i.e., controls) for completing the steps needed (select, rotate or combine objects) and move inside the virtual environment. Each step of the assembly task had to be carried out according to the instructions in order to continue with the next step; this also ensured that the participants could learn how to use the controls for the training. We did not set a time limit for the familiarization phase, in line with work highlighting that a substantial amount of time should be devoted to navigational training (R. N. Landers & Callan, 2012).

Training phase

Across all conditions, participants in the training phase of the VWT assembled a frequency converter with step-by-step instructions. The training phase differed between the three conditions (low, medium and high gamification) in the number of game elements implemented (see Table 1 for differences between conditions). Across conditions, the training phase had no time limit.

Assessment phase

In the assessment phase of the VWT, for each condition, the virtual room, the learning environment and the task were the same as in the training phase. The only difference from the training phase was that the participants did not receive instructions on the information board. However, the participants could use a help function to receive instructions if they wanted (i.e., pressing "H" to check the instructions for the next step and pressing "C" to check the controls). In addition, the participants received the following feedback: "You dropped something, please put it back where it came from" when an object was dropped; "There has been a mistake. Incorrect item was picked" when not following the correct step order and "You can't place it there" when an object was placed incorrectly. In the case of inactivity for more than 30 seconds, a short message appeared suggesting that the participants press "H" in order to receive instructions for the next step. The assessment phase had no time limits across all conditions.

Four weeks after completing the online experiment, we asked the participants to complete a retention test (t3).[6] It was designed to explore learning transfer, specifically the extent to which the procedural knowledge and skills acquired for completing the assembly task during the online experiment could be applied to similar assembly tasks (Blume et al., 2010). The goal of the retention test was not to investigate our hypotheses but to explore additional relationships (e.g., the impact of autonomy during the training on training outcomes during the retention test). The retention test consisted of 14 multiple-choice items that were the same across all conditions (Makransky et al., 2019). The participants had to select the right objects and bring them in the correct order. During the retention test, we assessed performance-related training outcomes (number of correct answers). After completing the retention test, we also measured affective training outcome satisfaction via a short questionnaire. The average duration to complete the retention test was 32 minutes. The procedure of the complete online experiment and the retention test are illustrated in Figure 1.

Measures

All scales were assessed using a 7-point Likert scale ranging from 1 = *strongly disagree* to 7 = *strongly agree*, unless stated otherwise.

Autonomy

Autonomy was measured using six items by Sailer, Hense, et al. (2017) based on the *Intrinsic Motivation Inventory* (Tsigilis & Theodosiou, 2003), the *Situational Motivation Scale* (Guay et al., 2000) and the *Activity-Feeling States Scale* (Reeve & Sickenius, 1994), capturing both components of decision freedom and task meaningfulness. Example items are "I could make my own decisions in the virtual training" (decision freedom; three items) and "It was a rewarding experience for me" (task meaningfulness; three items). The internal reliability was α = 0.88.

Training outcomes

In line with suggestions by Sitzmann and Weinhardt (2019), we assessed both performance-related and affective training outcomes. In the online experiment, we objectively assessed two performance-related training outcomes. We assessed the TTC from the beginning of the assessment phase until the participants accomplished all steps of the assembly task, including the time someone used the help function, was inactive or took a break. Furthermore, we assessed the error rate made during the assessment phase (i.e., selection of wrong objects, incorrect placement of objects and use of wrong tools). After the assessment phase, we also assessed self-rated performance, asking, "How successful do you think you were in accomplishing the goals of the task?", rated on a scale from 1 (good) to 100 (poor). In the retention test, we objectively assessed performance-related training outcomes based on the number of correct answers given during the multiple-choice task. The affective training outcome satisfaction was assessed subjectively (in both the online experiment and retention test) using one item by Chou and Liu (2005): "I feel very happy about the training method".

Self-efficacy

Self-efficacy was measured with one self-developed item based on the self-efficacy scale by Jia et al. (2014) and the single item on self-efficacy by Williams and Smith (2016) in the work context: "I believe I have the ability to accomplish the assembly task effectively (in the time given and without errors)", similar to previous studies (Williams & Smith, 2016).

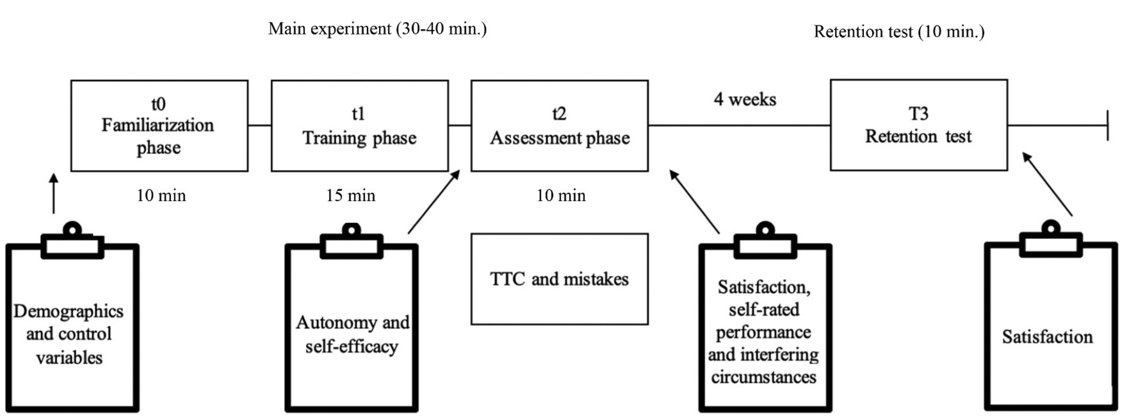

Figure 1. Procedure for the complete online experiment and the retention test.

Control variables

We also measured gender (Ausburn et al., 2009; Den den et al., 2017; Park et al., 2019), age (Polo-Peña et al., 2021) and gaming experience (hours per day) (Gkorezis et al., 2021; Sagnier et al., 2020) as control variables, due to their impact on training outcomes in virtual training (see Appendix A, Table A1). Furthermore, we assessed the extent to which circumstances, under which the online experiment was completed, were interfering with executing the task using the question "How did you perceive the application performance?" and the following answering options (multiple choice): "The application barely runs", "It is difficult to carry out some tasks due to severe lagging", "Lagging is noticeable but does not hinder my performance", "The application only lags at times" and "I have not experienced any performance issues". To further ensure that the participants could focus on the training in their remote environment, we included five control items using a 7-point Likert scale ranging from 1 = *strongly disagree* to 7 = *strongly agree*: "My environment was noisy", "I could not fully pay attention to the task", "The text I read was difficult to understand", "The audio I heard was difficult to understand" and "The interaction controls were difficult to use".

Bogus items

In total, six additional items were used to control the participants' attention during the online experiment and if the audio was working ("Have you ever used a computer?", "Please listen to the audio file and select what you have heard", "Select the correct answer: one day has X hours", "What do you usually use to take pictures?", "Please select the middle option, which is number 4" and "What kind of training did you receive in this experiment?"). These bogus items were added between the items of the other scales used in the present study.

Data analyses

In total, 423 participants completed the online experiment. Out of these, we excluded 35 participants who answered one of the bogus items incorrectly. Additionally, we excluded 36 participants who had technical difficulties ("The application barely runs", "It's difficult to carry out some tasks due to severe lagging"). Furthermore, we excluded one more participant due to experiencing interfering circumstances while completing the assessment phase (sum score higher than 30).

We tested our hypotheses with a final sample of 355 participants using R (version 2022.02.2). To establish the potential causal sequence of our constructs and investigate the proposed relationships, we tested our hypotheses using gamification intensity as manipulated at t1 (during training phase of online experiment), perceived autonomy and self-efficacy as assessed after t1 (after training phase of online experiment) and training outcomes as objectively captured during t2 and subjectively assessed after t2 (assessment phase of online experiment). The control variables age, gender and gaming experience were assessed before the training phase of the online experiment.

To investigate the influence of perceived autonomy on training outcomes (performance-related and affective), we conducted multiple linear regressions (with gender, age and gaming experience as control variables). To investigate differences in perceived autonomy between the three levels of gamification intensity, we conducted an ANCOVA (with gender, age and gaming experience as control variables) and post-hoc analysis to further explore the differences between each pair of gamification intensity levels. To test the indirect effects of gamification intensity on training outcomes (affective and performance-related) through autonomy, we ran our mediation analysis using *pacman* (Rinker et al., 2019) and *mediation packages* (Tingley et al., 2014) and interpreted our findings based on formal significance tests of the indirect effect and on bootstrapped confidence intervals (CIs) to avoid power problems introduced by asymmetric and other non-normal sampling distributions of an indirect effect (MacKinnon et al., 2004). To test the moderation effect of self-efficacy on the relationship between gamification intensity and perceived autonomy, we ran a moderation analysis using *interactions* package (Long, 2022). Finally, to assess whether self-efficacy moderates the indirect effect of gamification intensity on training outcomes (performance-related and affective) through perceived autonomy, we conducted a moderated mediation analysis. Descriptive measures and correlations of all variables are displayed in Table 2.

Results

Hypothesis testing

With regard to the positive impact of perceived autonomy on training outcomes (Hypothesis 1), the results partially support our expectations. Specifically, with respect to performance-related outcomes, we found that the higher the perceived autonomy, the higher the self-rated performance (ß = 3.18, $p = 0.005$).[7] However, in contrast to our assumptions, the higher the perceived autonomy, the more TTC (ß = 22.44, $p = 0.029$); perceived autonomy also did not impact the error rate during the assessment phase (ß = 0.08, $p = 0.267$). With regard to the positive impact of perceived autonomy on affective training outcomes, the findings showed a positive impact of perceived autonomy on satisfaction (ß = 0.57, $p < 0.001$).

With regard to the positive impact of gamification intensity on perceived autonomy (Hypothesis 2), the results did not support our expectations. Specifically, the findings showed that gamification intensity had a negative impact on perceived autonomy (ß = −0.25, $p = 0.004$), with significant differences in perceived autonomy [$F(4, 350) = 5.626$, $p < 0.001$] between the three levels of gamification intensity while controlling for gender, age and gaming experience. Multiple pairwise comparisons revealed statistically significant differences in perceived autonomy only between the low and high gamification conditions ($t(352) = 2.76$, $p = 0.006$) (see Table 3). The highest levels of perceived autonomy were shown in the low gamification condition ($M = 4.83$, $SD = 1.28$), followed by the medium-level ($M = 4.54$, $SD = 1.16$) and high-level gamification conditions ($M = 4.35$, $SD = 1.46$). No differences were found in perceived autonomy between medium and high gamification intensities ($t(352) = 1.07$, $p = 0.285$) or between medium and low gamification intensities ($t(352) = 1.79$, $p = 0.074$).

Table 3. Results of ANCOVA investigating differences in perceived autonomy.

	Low gamification (n = 127)		Medium gamification (n = 126)		High gamification (n = 102)		
Variables	*M*	*SD*	*M*	*SD*	*M*	*SD*	$F(1, 350)$
Perceived Autonomy	4.83	1.28	4.54	1.16	4.35	1.46	8.34**

N = 355.
*p < 0.05; **p < 0.0;1 ***p < 0.001.

Regarding the mediating role of perceived autonomy in the positive relationship between gamification intensity and training outcomes (Hypothesis 3), the results did not support our expectations. With respect to performance-related outcomes, the results showed that perceived autonomy did not mediate the indirect relationship between gamification intensity and TTC (β = −4.44, CI [−14.73, 2.16]), self-rated performance (β = 1.16, CI [−0.02, 2.82]) and error rate during the assessment phase (β = −0.04, CI [−0.10, 0.01]). Regarding the mediating role of perceived autonomy in the positive relationship between gamification intensity and affective training outcomes, the results did not support our assumptions. We found that perceived autonomy did not mediate the indirect relationship between gamification intensity and satisfaction (β = −0.17, CI [−0.37, 0.02]).

With regard to the moderating role of self-efficacy in the relationship between gamification intensity and perceived autonomy (Hypothesis 4), the results did not support our assumptions. The analysis revealed that self-efficacy did not moderate the effect of gamification intensity on perceived autonomy ($t(349) = 0.66$, $p = 0.512$).

With regard to the moderating role of self-efficacy in the indirect relationship between gamification intensity and training outcomes through perceived autonomy (Hypothesis 5), the results did not support our assumptions. The moderated mediation model was not supported for TTC (β = 0.68, CI [−3.64, 6.48]), error rate (β = 0.00, CI [−02, 0.04]), self-rated performance (β = 0.08, CI [−0.38, 0.70]) and satisfaction (β = 0.01, CI [−0.04, 0.06]).

Exploratory analysis – retention test

We explored whether gamification intensity had a direct effect on training outcomes during training (performance-related and affective). We found no significant differences in the TTC [F(1, 353) = 0.003, $p = 0.956$], self-rated performance [F(1, 353) = 1.224, $p = 0.269$] and satisfaction [F(1, 353) = 2.311, $p = 0.129$] between the three levels of gamification intensity. However, we found significant differences in the error rate during the assessment phase [F(1, 353) = 4.047, $p < 0.045$] between the three levels of gamification intensity. However, no differences between the levels of gamification intensity were found with regard to the error rate.

To further investigate the long-term influence of perceived autonomy on training outcomes, we conducted additional analyses and explored the impact of perceived autonomy during training on training outcomes during the retention test. The results revealed a positive influence of perceived autonomy on satisfaction (ß = 0.53, $p < 0.001$) and performance (number of correct answers) (ß = 0.50, $p = 0.007$) in the retention test.

To further explore the direct impact of gamification intensity on learning transfer, we investigated the effect of gamification intensity on training outcomes (performance-related and affective) in the retention test. We found significant differences in the number of correct answers [F(1, 185) = 6.580, $p = 0.011$] between the three levels of gamification intensity; multiple pairwise comparisons revealed significant differences only between low and high levels of gamification intensity ($t(184) = 2.55$, $p = 0.012$), with better performance in the low gamification condition ($M = 8.36$, $SD = 3.38$) than in the high gamification condition ($M = 6.89$, $SD = 3.13$). Although the overall model was significant ($t(184) = 2.55$, $p = 0.012$), no differences between the levels of gamification intensity were found with regard to satisfaction.

Discussion

In today's changing work environment, employees need to continuously improve or expand their skills to master new tasks and adapt to modified work processes (Cerasoli et al., 2018). Thus, the pressure on organizations to provide effective and motivating training is increasing, with huge investments being undertaken in VWTs (Oztemel & Gursev, 2020). Through gamification, VWTs can be quickly adapted to changing demands and individual needs and designed to be intuitively understandable (Wang et al., 2018). Nevertheless, it remains unclear which level of gamification intensity is needed to foster motivation and learning success in the workplace (R. Landers & Reddock, 2017) and whether it is more beneficial for some individuals than for others. To provide some answers, the goal of our study was to investigate the impact of gamification intensity on perceived autonomy and, consequently, training outcomes and to explore whether self-efficacy can shape these relationships.

In contrast to our expectations, gamification intensity had a negative impact on perceived autonomy, with autonomy being higher in the low gamification condition than in the high gamification condition. Exploratory analysis similarly revealed that individuals in the low gamification condition performed better with regard to some of their performance-related outcomes (i.e., error rate and number of correct answers during the training and the retention test, respectively) than individuals in the high gamification condition. Thus, using rich gamification elements to make the formal learning setting more effective did not lead to either a more satisfying experience or better performance in the short term.

Although our findings confirmed that perceived autonomy supported both performance-related and affective training outcomes (i.e., self-rated performance and satisfaction), perceived autonomy had no impact on objective performance-related training outcomes during the assessment phase of the VWT (i.e., TTC and error rate). Nevertheless, exploratory analyses showed that perceived autonomy promoted objective performance-related (i.e., number of correct answers) and affective training outcomes (i.e., satisfaction) during the retention test. These findings imply that VWT can foster formal learning experiences that subsequently stimulate informal learning, thus reconciling the perceived dichotomy between informal and formal learning (see S. Richter et al., 2020). Still, we found no support for perceived autonomy being the underlying mechanism in the relationship between gamification intensity and training outcomes. Finally, our findings did not support the notion that self-efficacy moderates the impact of gamification intensity on autonomy and training outcomes.

The present findings challenge the common assumption that game elements in VWT are always effective in enhancing motivation and success (Chittaro & Buttussi, 2015; Feng et al., 2020; Kazimoglu, 2020). Specifically, our findings suggest that low gamification intensity leads to higher perceived autonomy and better performance compared to high gamification intensity. It is possible that high levels of gamification intensity, due to the number of game elements, create overstimulation and feeling overwhelmed (Diefenbach & Ullrich, 2018; Mollick & Rothbard, 2014) or distracted (Mayer et al., 2022), hindering autonomy and thereby resulting in poorer performance. Hanus and Fox (2015) showed that experiencing a gamified course led to worse exam performance and motivation in an educational longitudinal study. Similarly, Mekler et al. (2017) showed that game elements did not support autonomy in training when perceived as external incentives (for an overview, see Deci et al., 1999).

Another possible explanation for our findings is that some of the game elements implemented might have been more supportive of autonomy and training outcomes, but when combined with others, their influence might have weakened (see Mazarakis & Bräuer, 2023). For instance, prior studies investigating game elements distinctively have shown that badges increase user activity over time (Hamari, 2017), leader boards promote performance (R. Landers & Reddock, 2017) and narratives support satisfaction with the training (Armstrong & Landers, 2017). Similar work has also demonstrated the importance of avatars for promoting freedom of choice (Annetta, 2010; Peng et al., 2012) and the role of stories in task meaningfulness (Gupta & Goyal, 2022; S. Rigby & Ryan, 2011). To provide more insight into the impact of gamification beyond its intensity (R. N. Landers, 2014; Sailer, Hense, et al., 2017), we propose future research to investigate the impact of various game elements distinctively before combining them into the same training and without them necessarily reflecting the same richness and to identify whether a specific number of game elements or combination of those are more effective for workplace training than others.

Furthermore, our results confirmed that perceived autonomy during VWT reflects a crucial factor for both subjective performance-related and affective training outcomes. Specifically, we found that perceived autonomy led to higher self-rated performance. Our results are in line with the SDT (Deci & Ryan, 2000; Katz & Assor, 2007), postulating that when individuals feel autonomous in their work, they feel a greater sense of ownership and are more likely to attribute their success to their efforts rather than external factors. This positive attributional style enhances overall satisfaction with performance (Loderer et al., 2020). Previous studies have shown that people who perceive higher decision freedom and meaningfulness in virtual training rate their performance higher (Baceviciute et al., 2022; Kern et al., 2019). Moreover, we found that perceived autonomy supported satisfaction with the VWT. It seems that individuals who perceived autonomy were able to tailor their training to their specific needs and interests, increasing their motivation to learn and, thereby, being more satisfied with the virtual training. Prior work has similarly shown that autonomy predicts overall training satisfaction in face-to-face (Dember et al., 1992) and virtual training (Lee et al., 2010).

Our findings demonstrate the significance of perceived autonomy for training in tasks that are typically perceived as having a fixed structure and goals. While autonomy has traditionally been linked to creative and open tasks (Baldwin et al., 2009; Blume et al., 2010), our results indicate that perceived autonomy is equally advantageous for training tasks with predetermined structures and objectives. Future studies could further explore whether different mechanisms support autonomy during creative training compared to predetermined tasks and, in turn, how these mechanisms promote training outcomes.

Interestingly, our findings did not confirm that perceived autonomy supported objective training outcomes during virtual training. Instead, our exploratory analysis showed that perceived autonomy during the training promoted training outcomes at a later point in time, namely performance (i.e., number of correct answers) during the retention test. Related studies have similarly shown that supporting intrinsic needs in training facilitates deeper and more internalized learning, with effects becoming more visible in the long run (C. S. Rigby & Przybylski, 2009). It seems that feeling autonomous in VWT led to believing that the training was satisfactory and effective, without actually being more effective. It is possible that, first, a positive belief in oneself and confidence in the training are needed to demonstrate positive objective training outcomes. Possibly, for learning transfer to be successful, first, believing in one's abilities and satisfaction with the training are required to internalize the trained skills and activities and then executing them effectively. Related evidence has shown that believing in oneself in virtual training has a positive effect on learning (Makransky & Petersen, 2019). Another possible explanation is that perceived autonomy during training might result in individuals being overconfident in their abilities without actually developing the necessary skills or knowledge, especially if these are not recalled at a later point in time (i.e., retention test). Individuals might believe that they benefited from the training, even though the training is not effective yet (also see Makransky et al., 2021). Our findings imply that retention tests or complementary training are needed for perceived autonomy to promote objective training outcomes. Similar studies have shown that no differences in affective and performance-related outcomes were found between virtual and traditional training right after the training but instead in the retention test (Makransky et al., 2019). As Lee et al. (2010) similarly showed in their experiment, short exposure to virtual training might not be sufficient to impact learning. To provide more insight into the impact of autonomy, we propose that future research investigate whether perceived autonomy has different short-term and long-term effects on VWT and explore whether receiving immediate feedback or correction during training can shape the impact of autonomy on immediate subjective and objective training outcomes.

Finally, our results did not demonstrate differences between individuals with low and high self-efficacy in terms of the impact of gamification intensity on perceived autonomy and training outcomes, in contrast to our expectations. It is possible that the level of self-efficacy does not change the effect of gamification intensity; instead, some game elements, independent of their intensity and richness, might be more supportive than others, depending on the level of self-efficacy. On the one hand, game elements that provide immediate feedback and a sense of progress might be more beneficial for individuals with low self-efficacy in terms of reaching high training outcomes. On the other hand, game elements that make the learning experience more challenging, such as badges and leader boards, might be more promoting for individuals with high self-efficacy regarding their performance and learning. Koivisto and Hamari (2014) and G. Richter et al. (2015) proposed that gamification should be adapted to the user's needs and personal characteristics. We propose future research to investigate whether specific game elements are more suitable for people with low versus high self-efficacy and thus gain better insight into the role of gamification fit instead of intensity to individual characteristics and needs.

Overall, our study indicates that gamification in VWT is a complex design effort that requires further empirical work and more careful consideration of various individual (Deterding et al., 2011; Koivisto & Hamari, 2014), task (Seaborn & Fels, 2015) and contextual factors (Majuri et al., 2018). At the same time, our work confirms the importance of perceived autonomy during virtual training for both short-term and long-term training outcomes. However, more research is needed to understand the factors that promote perceived autonomy in gamified VWT and how these, in turn, empower individuals and enhance their performance and learning transfer. Finally, our work implies that there is no one-fits-all approach for gamified VWT and that more empirical work is required to gain a more complete picture of how we can maximize the effectiveness of VWT and improve training outcomes.

Practical implications

The findings of our study also have practical implications for organizations seeking to implement gamification in their VWT programs. First and foremost, organizations should be cautious about implementing game elements only depending on their intensity and richness and should carefully select the most important ones for their training purposes. While gamification can be a powerful tool for tailoring the learning environment to personal characteristics and needs (Decius et al., 2024; Klock et al., 2020), our findings imply that it is essential to design or select game elements with a greater focus on adaptability and fit to the learning goal than on intensity.

Given our findings demonstrating the importance of perceived autonomy during training for performance-related and affective outcomes, organizations should also ensure that their employees perceive autonomy when training for both creative and structured tasks. Providing employees with decision-making freedom can facilitate their learning process (Kraiger et al., 2007; R. Landers & Reddock, 2017), even in tasks that have predetermined structure and objectives. This is crucial, as autonomy can increase employees' motivation, engagement and sense of ownership when learning new skills and tasks, which ultimately results in higher performance and job satisfaction.

Furthermore, we propose that organizations avoid offering one-time VWT but instead accompany it with retention tests or complementary training. As our findings suggest, perceived autonomy might result in individuals believing that they have learned from VWT, even though the training might not yet be effective. Thus, we also recommend providing feedback during training to inform employees about their actual performance. This will ensure that individuals are not becoming overconfident in their abilities without actually developing the necessary skills or knowledge. Additionally, trainees could benefit from gamification that adapts to their skill levels and learning style (Hallifax et al., 2019; Lavoué et al., 2018). Following the first training and skill assessment, several small exercises, such as quizzes to recall learning, could support trainees in deepening their understanding of the task and their learning success.

In summary, organizations should carefully select and design game elements, promote perceived autonomy, provide retention tests and feedback and adopt a multi-level approach (considering individual, task and contextual characteristics) to foster motivation and learning in VWT. By doing so, organizations can improve the effectiveness of their training programs and ultimately improve employee performance and job satisfaction.

Limitations and future outlook

The current study aimed to serve as a starting point for investigating the impact of gamification intensity on employees' performance-related and affective training outcomes in VWT. Our experimental design allowed us to create different levels of gamification intensity and explore their causal influence on perceived autonomy and training outcomes while minimizing extraneous effects. Nevertheless, some limitations should be considered when interpreting and building on our findings.

One important limitation is that we investigated the impact of different game elements grouped together based on their richness and intensity, without differentiating between all of them. Consequently, we cannot conclude which game elements had a stronger impact on employees' perceived autonomy and training outcomes. At the same time, we cannot evaluate whether specific game elements were, due to their design, more beneficial for feeling autonomous than others. Instead, we can only draw conclusions about the overall intensity of gamification – the main purpose of our work. We propose future studies to extend our findings and investigate the effects of different game elements first distinctively and then together to understand whether specific game elements or combinations enhance autonomy and training outcomes. To better understand the underlying process, future research should measure intrinsic motivation, as according to SDT this is the key component between autonomy and training outcomes.

Another limitation of our study is that the training task might not have been equally relevant to all participants. In particular, the participants in the retention test might have had more motivation to complete the second training because they were more interested in the skills taught or because they initially (thought they had) performed better. Studies have shown that training motivation (Tharenou, 2001) and past achievements (Sitzmann & Weinhardt, 2018) play a crucial role in predicting future training participation and development. Future research should control for training motivation in both cross-sectional and longitudinal study designs. Furthermore, selecting the appropriate training task is essential for acceptance and perception of the training. Workplace training is often the result of intrinsic motivation and is frequently related to personal development. These factors impact an individual's approach and mindset towards the training and might have been missing from the present study. In future studies, researchers should consider including multiple training tasks that cater to the diverse needs of employees or conduct studies with relevant tasks for specific target groups (e.g., giving feedback tasks for leaders) to ensure that the training and skills developed during the VWT are relevant and beneficial for all participants.

Regarding methodological decisions, although we controlled for different demographics and experiential variables in our data analysis, additional factors could have potentially influenced the participants' perceptions and training outcomes during the training (see meta-analyses by Merchant et al., 2014 or Hoblitz, 2015 or the summary by Kettler and Kauffeld 2019), which we did not assess. Moreover, although used in previous studies (Williams & Smith, 2016), we assessed satisfaction and self-efficacy using one-item measurements, which can often negatively impact scale reliability. Furthermore, we focused only on performance-related and affective training outcomes. However, physical measurements, such as skin conductance and cognitive components, are also informative about the training's effectiveness. We propose to consider these issues when planning similar studies. Additionally, we measured autonomy with two facets: freedom of choice and task meaningfulness as key components to predict affective and performance-related training outcomes. While decision freedom is clearly related to autonomy, task meaningfulness is an independent construct in theories of work design and various measurement instruments, including the intrinsic motivation scale. Prior research on gamification (e.g., Sailer, Hense, et al., 2017) has used these constructs as independent scales, demonstrating differential effects. This suggests that self-efficacy might influence the relationship between gamification conditions and decision freedom and task meaningfulness differently. We propose that future studies should take these issues into account.

In addition, a limitation of our study is its reliance on voluntary participation in retention tests. While our analysis yielded valuable insights, it is essential to recognize that the retention test participants were self-selected, potentially introducing bias towards highly motivated learners. This voluntary nature of participation may not accurately represent the entire spectrum of trainees within the organization. Future research endeavours should aim to replicate our findings using mandatory retention tests for all trainees, ensuring a more comprehensive and representative sample.

A final limitation of our study is that the sample was mixed, consisting of both full-time and part-time employees from different fields and thus may reflect very different training needs. At the same time, it consisted only of participants from our private network and MTurk, who showed some group differences. These points, together with the experimental nature of our work, may limit the generalizability of our findings and question the external validity of our work. Future research should investigate the effects of gamification in the field and with different working populations and thereby test the replicability of the present evidence.

Conclusion

Our study examined the impact of gamification intensity on perceived autonomy and training outcomes and whether self-efficacy moderated these relationships. Contrary to our expectations, our findings showed that low gamification intensity resulted in higher perceived autonomy and better performance-related outcomes at a later point in time compared to high gamification intensity. Furthermore, we found that perceived autonomy is a crucial factor for both subjective performance-related and affective training outcomes during training and for objective performance-related and affective training outcomes during the retention test. Our study challenges the common assumption that game elements in VWT are always effective in enhancing motivation and success. Future research could investigate the impact of various game elements distinctively and identify whether a specific number or combination of those – no matter their intensity – are more effective for VWT than others. Our findings also highlight the importance of perceived autonomy in virtual training, indicating that perceived autonomy is equally advantageous for training tasks that are typically perceived as having a fixed structure and goals.

Notes

1. In total, 187 participants were recruited from Mturk. In line with R. N. Landers and Behrend (2015) and Walter et al. (2019), we believe that with this mixed sample we expand our insights of working population globally without restricting it to our personal network.
2. One hundred and eighty-seven participants of the final sample also completed a retention test.
3. At the time of the study, the average hourly earnings for *Human Intelligence Tasks* at the platform were $5–$10 per hour. As we estimated based on our trial runs, the experiment duration was set to be about 30–40 min for the main experiment and 12 min for the retention test; thus, we set the hourly payment to 10$.
4. The frequency converter was called Sinamics G120P, which is typically used for air ventilation in car tunnels and car parks. It had the characteristic Cproduct of 6.34, which refers to a medium complexity due to the model of Samy and ElMaraghy (2010).

5. Prior to running the online experiment, we pretested the three experimental conditions several times using different operating systems (macOS and Windows). The pre-tests resulted in including specific instructions in the recruiting material to avoid technical issues (e.g., entering the full-screen mode to start the experiment, not using Safari browser and using a mouse instead of a trackpad) and estimating the duration for completing the experiment to be 30–40 minutes.
6. As people deciding to take part in the retention test might have had higher learning motivation or a higher initial training performance, we calculated the average values for the main variables compared them between training and retention test the participants. The descriptive values were similar between the training and retention samples. We only found small differences in terms of the number of mistakes made.
7. Self-rated performance rated from 1 (good) to 100 (poor); to facilitate interpretation, the item has been inverted and now a higher value is also a better performance.

Author contributions

Vera Maria Eger: Conceptualization, Methodology, Formalization, Visualization, Writing – Original Draft, Writing – Review & EditingEleni Georganta: Conceptualization, Writing – Original Draft, Writing – Review & EditingPaul-David Joshua Zuercher: Conceptualization, Methodology, Formalization, Writing – Original Draft, Visualization Felix Müller: Conceptualization, Writing – Original Draft Thomas Bohné: Conceptualization Sarah Diefenbach: Conceptualization

Data availability statement

The data that support the findings of this study are openly available at https://drive.google.com/drive/folders/1e7WAnz8l5JRblQSbuJsSUDjQ3j8ByugB?usp=sharing.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Appendices

Appendix A

Table A1. Control variables.

Var.	*M*	*SD*	1	2	3	4	5	6	7
1. Age (t0)	31.23	9.32							
2. Gender (t0)	1.29	0.47	.04						
3. Gaming experience (t0)	1.85	1.04	.04	−.17**					
4. TTC	382.19	253.76	.23**	.21**	−.10				
5. Error rate	4.01	1.79	.12*	.08	.16**	.45**			
6. Self-rated performance (t2)	31.21	28.06	.11*	.20**	−.09	.35**	.29**		
7. Satisfaction (t2)	5.20	1.52	.08	−.11*	.18**	.04	.01	−.22**	
8. SA retention (t3)	5.32	1.28	.04	.59**	.05	.51**	.65**	.50**	
9. Performance retention (t3)	7.66	3.25	−.19*	.20**	.02	.18*	.19**	.14	.10

Note. $N = 355$ main experiment; $N_{retention} = 187$; The internal reliability (Cronbach's α) for the total constructs is shown in brackets on the diagonal. Pearson correlations are given for the intercorrelations (two sided); [a]Time to completion (TTC) shown in minutes; [b]Error rate as the number of mistakes was ranging from 0 to 10. [c]Self-rated performance rated from 1 (good) to 100 (poor); [d]Performance as the number of correct answers from 0 to 14. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .00$.

Appendix B

Visual Representation and Description of Game Elements

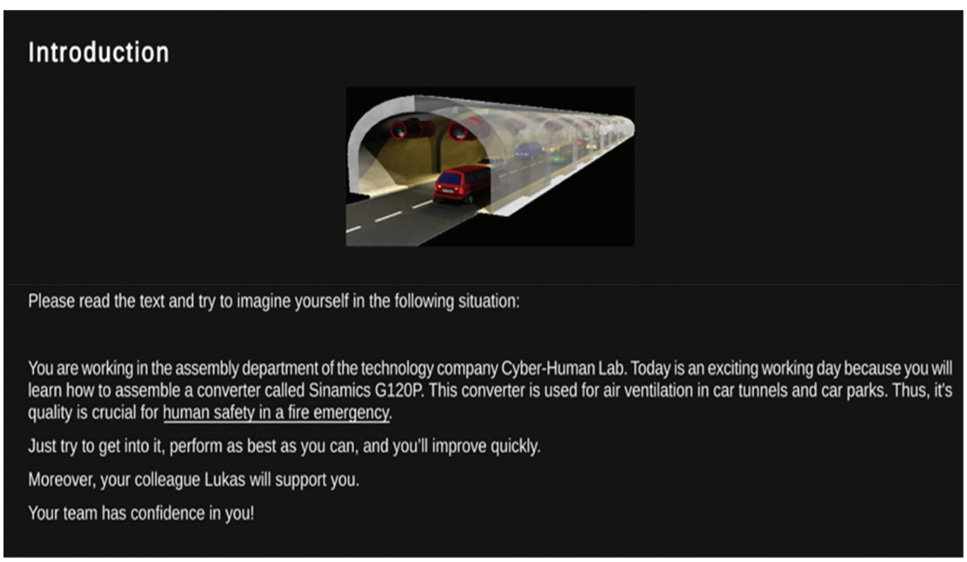

Figure C1. Meaningful story.

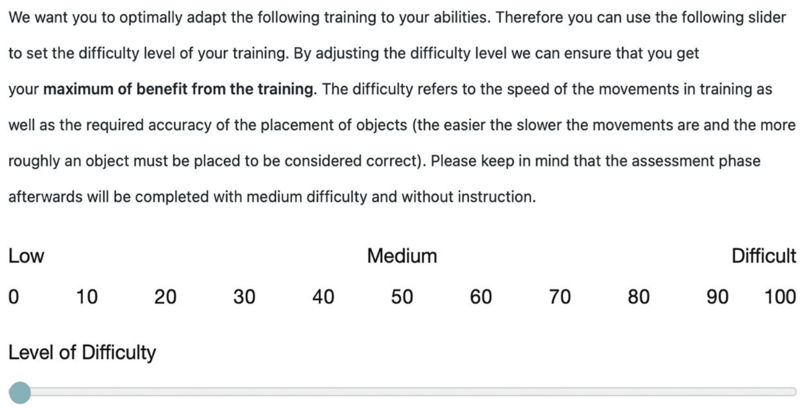

Figure C2. Meaningful choice.

Figure C3. Design elements in the high intensity condition.