

Proceedings of the 35th European Safety and Reliability & the 33rd Society for Risk Analysis Europe Conference
 Edited by Eirik Bjorheim Abrahamsen, Terje Aven, Frederic Boudier, Roger Flage, Marja Ylönen
 ©2025 ESREL SRA-E 2025 Organizers. Published by Research Publishing, Singapore.
 doi: 10.3850/978-981-94-3281-3_ESREL-SRA-E2025-P3295-cd

Interactive learning in safety: how serious game can enhance retention and collaboration

Larouzzée Justin

Center for Risk and Crisis Research (CRC), Mines Paris - PSL, France. E-mail: justin.larouzee@minesparis.psl.eu

Robba Julien

THALES, AVS, France. E-mail: julien.robba@fr.thalesgroup.com

Guarnieri Franck

Center de recherche sur les Risques et les Crises (CRC), Mines Paris - PSL, France. E-mail: franck.guarnieri@minesparis.psl.eu

Bosc Maxime

THALES, AVS, France. E-mail: maxime.bosc@fr.thalesgroup.com

Portelli Aurélien

Center de recherche sur les Risques et les Crises (CRC), Mines Paris - PSL, France. E-mail: aurelien.portelli@minesparis.psl.eu

Training employees on critical safety protocols is a challenge in many industries, with traditional methods often resulting in disengagement and poor retention. Gamification offers a promising alternative by using game mechanics to foster active participation, thereby enhancing memory retention and learning outcomes. This communication explores the theoretical foundations of gamification in training, focusing on its ability to create immersive, interactive learning environments that stimulate motivation and engagement. However, applying gamification to safety raises important questions about balancing entertainment with the gravity of the content. Are playful elements compatible with the responsibility of ensuring employee safety? To address this, we propose a concrete experiment: a low-tech orienteering-based training for Second Intervention Teams (ESI) in an industrial setting. The gamified training integrates fire safety challenges into a real-world navigation task, prompting participants to recall safety procedures while working together to achieve goals. After a first full-scale experimentation, observations and debriefing with the trainees shows that this approach improves engagement, teamwork, and safety protocol retention. However, the experiment also highlights the limitations of gamification, particularly the need for careful design to prevent trivializing serious safety content. This study concludes by reflecting on the conditions under which gamification can serve as an effective complement to traditional safety training, without compromising the importance and seriousness of the subject matter.

Keywords: Gamification, safety, training, engagement, risk education, experiential learning.

1. Introduction

Providing effective and engaging professional training is a major challenge for companies seeking to guarantee and improve the safety of their employees. In recent years, an innovative and complementary approach, known as "edutainment," has emerged in the field of industrial safety training. This approach aims to transform employees from passive receivers of top-down information to active participants in

their own training. The edutainment approach engages the body and senses, activating various memory and reactivation mechanisms (Damasio, 1996; Carter & Smith Pasqualini, 2004), thus fostering dynamic and engaging learning. This article begins by presenting the theoretical foundations of edutainment approaches, with a view to considering their applicability to industrial safety issues and challenges (2.). Secondly, we present the design and

experimentation on an industrial site of a low-tech edutainment add-on to compulsory annual safety training, in the form of an orienteering race for Second Response Teams (referred to as 'ESI' for the French 'Equipiers de Seconde Intervention'). This initiative combines the traditional elements of orienteering with fire safety related questions (3.). The results obtained from this study confirm the effectiveness of the edutainment approach in reinforcing practical knowledge of safety in the workplace. Finally, the strengths and limitations of the edutainment approach are discussed, and the possibility of integrating orienteering as a validating part of the training or extending this approach to other training courses is considered.

2. Literature review on gamification

The use of games in the learning process is ancestral and natural. From the pioneering ethological work of Darwin and Lorenz to contemporary studies, it is recognized that games and playing offers numerous advantages for development and learning: it increases interest and competence, teaches how to decide, solve problems and follow rules, as well as how to regulate emotions and interact socially (Burghardt, 2005). When it comes to humans, playing is not confined to awakening and primary education; it is also used for secondary education and the development or enhancement of specialized skills. This is notably the case with board games such as chess, which have been used for millennia for training in the art of military strategy (Murray, 1913). In recent years, the concepts of *edutainment*, referring to the use of games in a teaching context, and *gamification*, referring to the transformation of a given process or activity using game principles, have emerged (Cher-Filippi *et al.*, 2023). The following state of the art aims to determine the contribution of these approaches to training (2.1) and their applicability to risk and crisis management training (2.2).

2.1 Gamification to foster training

Gamification is reputed to have positive effects on learner's engagement, motivation and performance (Santos, *et al.*, 2021; Lei, *et al.*, 2022). Still, its effectiveness seems to depend on several factors, including repetition over time, users' profiles (age, grade level), the discipline or subject being gamified, the design principles chosen for gamification (with an increased effect when several gamification elements are

combined), and the learning environment (Li *et al.*, 2023). These findings should underline the importance of design choices in the process of gamifying a training course, to maximize its impact.

In the professional environment, when it comes to lifelong training or continuing education, especially for matters with vital stakes such as safety, the use of gamified approaches must be used carefully and thoughtfully, to avoid disempowerment of the learners. Still, studies carried out specifically in the context of corporate training reveals that gamification is particularly effective for integrating new employees, developing or reinforcing skills, but also that gamification could reduce the time and resources needed for training by creating "self-reminders" that encourage employees to complete their training (Tanner & Preiksaitis, 2023). It is important to note that gamification is not a one-size-fits-all solution. Although gamification is increasingly common in employee training, the scientific understanding of gamified learning is still developing, and the didactic and pedagogical science community continues to study, conceptualize and theorize the mechanisms via which gamification influences learning and motivation (Armstrong & Landers, 2018).

Academic literature therefore suggests that gamification can be a powerful tool for improving engagement and motivation in training, but its effectiveness depends on careful design and thoughtful implementation. Finally, the detailed understanding and exploration of the long-term effects of gamification on learning and skills transfer remains a field of knowledge to be explored. In any case, as an opportunity to make training more attractive and effective, gamification seems to find applications in the professional world, also in the safety-critical fields.

2.2 Gamification for safety matters

The use of games in safety matters is not as new as it may seem. Sixty years ago, Jacques Castan designed the '*Noble jeu des lois de la radioprotection*' (Portelli, 2023) as part of the radioactive risk education program at the French Marcoule nuclear center. This variation on the snakes and ladders game combines the principles of the classic game with the rules of radiation protection on a board of sixty-two squares

forming a spiral. This game forms a low-tech^a edutainment tool that works in two ways: it reminds workers of the preventive instructions they received during their training, while at the same time aiming to play down the activities carried out in the nuclear center with a sense of humor. The game and its illustrations are designed to allay concerns by showing that the radioactive risk is under control. It also implies, through its simplicity, and its lookalike reminding childhood games, that following safety instructions is *kid's stuff*. By playing, the worker takes an active part in the educational process, voluntarily submitting to the rules of the game, just as he or she would be expected to do in professional and corporate life.

A recent systematic literature review (Condori Colan & Barco Peralta, 2023) has listed several examples of safety-specific edutainment training. The authors notably present an escape game for medical students training in patient safety and human factors; a game called 'The Sound Games' developed for the use of ultrasound; and various gamified simulations for training in patient safety. In the field of industrial safety, Condori Colan & Barco Peralta (*opcit*) have identified a serious game using Lego[®] Serious Play[®] (Blair & Rillo, 2016) to train industrial risk prevention skills, and the use of virtual reality for training in human-robots' collaborations in manufacturing tasks. In the mining industry, the Lowell Institute for Mineral Resources at the University of Arizona has developed a serious game called 'Harry's Hard Choices' (HHC) (Brown & Pulton, 2019) based on emergency response exercises. In HHC, the player takes on the role of a foreman who must evacuate his team from a mine during a disaster. Users' feedback shows general satisfaction, highlighting the quality of the simulation and the learning experience, with a strong desire to play again expressed by all participants. Users' performance improved with each iteration, from 0 or 1 teammate (out of 9) evacuated on the first attempt up to an average of 3.80 for their best attempts.

The literature indicates a trend towards high-tech edutainment approaches, although low-tech

approaches continue to be developed. Examples of low-tech initiatives include serious board games such as 'Under Pressure' and 'Wei Ji'. The former is designed to facilitate discussion and transformative learning on resilience in which the players navigate diverse roles, gaining insights into negotiation strategies and decision-making processes (Oscarsson & Olsson, 2024); the latter hybridizes board game and role-playing principles to train members of a crisis unit on different internal emergency plans (Meyong *et al.*, 2025).

Gamification is thus increasingly used in various safety critical fields. Both high-tech approaches (video games, simulations) and low-tech approaches (role-playing games, board games) aim to make learning more engaging and effective. Despite its potential advantages, gamification in safety training faces certain challenges, such as potentially high development costs (particularly in high-tech approaches) versus long-term effectiveness that has yet to be demonstrated (requiring in-depth longitudinal studies). In any case, the success of gamification relies on a careful design adapted to specific needs of learners and objectives of each organization. The design is thus the starting point of our experimentation of a low-tech gamified fire safety training on an industrial site in the form of an orienteering course.

3. Low-tech gamified safety training

In France, employers must take the necessary measures to ensure the safety and protect the physical and mental health of workers (article L4121-1 of the Labor Code). These measures include informing and training employees. Our contribution relates more specifically to fire hazards training, which concerns most companies, subject to the minimum provisions laid down in the French Labor Code (INRS, 2023), which require employers to train all staff to: sound the alarm, use first aid equipment and perform the various maneuvers required (making the workstation safe, evacuation, etc.). Certain employees are specifically trained to be key actors

^a Designates techniques that are sustainable, simple, appropriable, resilient and not technology-centric (Tanguy & *al.*, 2023); in gamification this includes board games, card games, role-playing games, play workshops or escapades. High-tech refers to complex knowledge and practices, centered on technological

innovation (Cortright & Mayer, 2001); in gamification this includes video games, computer simulations, the use of virtual or augmented reality (Guimarães *et al.*, 2024).

in the event of a fire. The role of Second Response Teams (hereafter 'ESI' for the French *Equipier de Seconde Intervention*) is to extinguish the fire; protect and rescue those present at the scene of the fire. ESIs are regularly trained in the use of all fire-fighting equipment. In our case, ESIs receive periodic one-day refresher training every year, most of which is provided by an external provider supported by the HSE department. With a view to improving this periodic training, an edutainment approach was designed and tested.

3.1 Periodic training for ESIs

The annual training course for ESIs begins with exercises to drill the use of extinguishing equipment facing different types of fire. In the afternoon, two practical exercises are carried out (a fire starting in an electrical cabinet and the rescue of a lone worker in a room lacking oxygen) to test the organization implemented during an alert. The day ends with a questionnaire to validate the refresher course. This training, which follows a classic pattern and is repeated every year, neglects certain essential aspects, such as knowledge of the site, the key locations and the resources associated with these locations. In fact, apart from drills in two specific premises, there is no activity to review the site's key locations in terms of fire hazards, nor any exercise to find one's way around the site. However, the ESIs are employees, accustomed to their work area, with limited knowledge of the rest of the site. This observation is confirmed by the need expressed by some ESIs to re-appropriate the site during training sessions. Taking this need into account, it was decided to set up an orienteering course specifically designed for ESI training, we will refer to as 'CO-ESI' (for the *French Course d'Orientation pour ESI*). Partly inspired by military orienteering courses, this sporting activity enables participants to complete a predefined circuit on the site, revisiting important places while exercising their sense of direction. This also brings physical and mental benefits while strengthening team cohesion and self-awareness (Băițan, 2022).

3.2 Designing a fire hazard orienteering course

The development of the CO-ESI entailed a comprehensive evaluation of the site's critical aspects related to fire hazards. Occupational risk assessments were utilized as a reference to

identifying the areas of highest fire hazards. In addition, the internal directory of fire safety and extinguishing devices was considered, including water, powder, and CO2 extinguishers, as well as armed fire valves. Subsequently, a coherent route was established to facilitate the ESIs' evaluation of the equipment's practicality. To this end, we employed the detailed site plan to identify all areas of interest, including but not limited to a technical room that is difficult to access, a space containing numerous flammable chemical substances, a restricted basement, or areas that have undergone major modifications following recent works. The final route thus formed a loop of 16 stages, distributed over the whole site. The installation of 16 numbered markers was completed to facilitate navigation. Finally, we created the associated documents, including a map of the site locating all markers, the orienteering punch card and a zone-specific fire hazards questionnaire. The map and questionnaire were printed on A3 cardboard. The CO-ESI was subjected to two rounds of testing by the design team, who were also responsible for installing the markers. A collaboration with the external training provider facilitated the determination of the optimal timing for the first user test, which was scheduled just after the lunch break of an annual refresher session.

3.3 First CO-ESI session

The CO-ESI's objective is twofold: first, to review essential fire safety instructions, and second, to promote orientation and memorization of the location and use of available extinguishing equipment. To that end, it was integrated from 1 to 2 pm, following the morning of practical exercises and preceding the zone-specific exercises. The ESIs (N=7) were assembled at the starting point. To enhance engagement and motivation, the participants were divided into three teams and informed that the race would be timed, thereby creating a competitive and challenging atmosphere. Materials such as maps, questionnaires, and writing tools were distributed to the participants, who were informed of the conditions for success. These conditions included the requirement of obtaining all 16 punches in the correct order and answering all questions correctly. The three teams began the race at three-minute intervals. The test proceeded smoothly and was observed by the design team. Participant

feedback was collected immediately upon their arrival and later via a survey questionnaire.

4. Feedback

Although the sample size of seven participants does not meet the criteria for statistical significance, the empirical data collected offers preliminary feedback. The principle of a CO was well received by the site's HSE department, and the design and implementation stages proved inexpensive in terms of both equipment and organization. The CO-ESI was integrated coherently into the pre-existing training program. Observations made during the race revealed that for all groups, ESIs shared tasks and roles spontaneously, indicating some emerging group dynamics (Anzieu & Martin, 2013). In groups of two, one individual assumed the role of leader, maintaining possession of the map to provide directions and record responses on the questionnaire, while the other individual was responsible for locating the marker and punching the card. In groups of three, a similar distribution of roles was observed, with the third individual seemingly having no explicit role. Feedback from the finish point was unanimous in its enthusiasm and positivity. It was noted that some ESIs were not previously informed about the new premises and the proximity of the fire extinguishing equipment prior to the orienteering course, nor were they aware of recent work that had altered certain premises. The participants expressed a strong willingness to participate in another orienteering race. The survey questionnaires administered to the ESIs post-session identified areas for enhancement, particularly the general difficulty level, which was deemed to be insufficiently challenging (notably due to the abundance of indications or the placement of certain markers that were overly apparent) and the pertinence of specific locations (which were already well-known).

The objective of the ESIs was to review critical fire safety instructions and to memorize the location and functionality of extinguishing equipment. The CO-ESI approach, which mobilized the body and invested physical spaces, fostered mutual aid and team spirit (essential skills for actual intervention). Feedback from the ESIs confirmed strong involvement, unanimous motivation and general satisfaction, thus fulfilling the initial ambitions of the approach.

5. Discussion and perspectives

In this section, we examine the strengths and limitations of an edutainment approach to safety training, in the light of our experiment. We then discuss the possibilities for improving the design and implementation of orienteering courses, and the conditions for generalizing this type of approach.

5.1 *Strengths of the edutainment approach*

The empirical results obtained from this study indicate a notable increase in the commitment of the trainees. The novel and original approach adopted in this work has been shown to foster motivation and interaction among the trainees. This phenomenon is further reinforced by the challenge of time and the aspiration to succeed, both of which are deeply rooted in the field of gaming. In addition to commitment and motivation, our approach appears to contribute to enhancing the orientational skills of ESIs within their respective sites and facilitating the rediscovery of specific locations. The practice of orienteering as a team fosters interpersonal bonds, promotes mutual enrichment, and facilitates knowledge exchange, which are all important non-technical skills for the effectiveness of ESIs' intervention (Ceschi et al., 2019).

Additionally, orienteering introduces a sporting dimension to the concept of serious games, distinguishing it from role-playing or board games. Research has demonstrated that brief physical exercise combined with a learning task enhances memory, thereby reinforcing the contribution of serious gaming to memory mechanisms (Weinberg et al., 2014). Indeed, the process of memorization is linked to a variety of sensory inputs, including lexical, pictorial, semantic, motor, and auditory senses, and the game engages all these senses (Bevins & Howard, 2018). Furthermore, playing constitutes a moment that is generally rare in adulthood and provides pleasure, which in turn increases memorization and emotional engagement, favoring inscription in long-term memory. In this case, our feedback confirms that CO-ESI transforms the "abstract" analysis and memorization of maps and sectors into a "concrete" physical and competitive activity.

In terms of resources, the adoption of a low-tech approach facilitates ease of implementation and requires minimal investment, apart from the time

allocated to its design and integration. Despite these advantages, it is important to note that games do not inherently guarantee effectiveness in learning outcomes.

5.2 Limits

The assessment of the pedagogical quality of a game is a multifaceted endeavor, necessitating a comprehensive evaluation in relation to the subject matter, objectives, learners, and context. It is noteworthy that games rarely substitute entirely for conventional training methodologies, such as top-down presentations, formal exercises, and knowledge assessment. Consequently, the integration of gamified sequences may encounter challenges or be perceived as superfluous by trainees. To integrate gamified elements effectively, trainers must transition from a traditional teaching role to that of a game master or referee. While this transition can be facilitated by the involvement of other players, as in the CO-ESI model, it can impose constraints on resources, particularly human resources. Constraints in resources, particularly human resources, are also often present in the case of high-tech approaches, and external dependencies may arise (design, implementation, maintainability and evolution of technical devices such as virtual reality headsets or content; Lampropoulos & Kinshuk, 2024).

It is also critical to maintain a balance between the playful and formal, serious dimensions of the activity. The playful aspect may repel individuals with a negative perception of play, potentially infantilizing or superficial (Lampropoulos & Kinshuk, 2024). This rejection can be attributed to the professional, social, or age category of the trainees, thereby negating intrinsic motivation to play, which is not guaranteed and may require special conditions (Lavigne, 2016).

One of the widely acknowledged benefits of serious games is their reproducibility, which is evident in the previously mentioned games, such as "HHC" and the "*Noble jeu des lois de la radioprotection*" where players can engage with these games repeatedly. Repetition is a fundamental mechanism of learning. In contrast, the CO-ESI, in its present form, cannot be repeated outside the annual refresher sessions. In fact, markers being located on industrial sites had to be removed for safety reasons, and it is not advisable for employees to roam freely in certain areas without supervision or awareness-raising.

Finally, as previously mentioned in the literature review (2), the methodological limitations of gamification studies must be acknowledged, including small sample sizes, lack of validated psychometric measures, over-reliance on user evaluation, very short experimental time frames, and a lack of temporal hindsight and meta-analyses regarding intended effects (Faiella & Ricciardi, 2015). At this stage, the observed strengths of CO-ESI are subject to the same uncertainties. For this reason, we wish to perpetuate and generalize the approach to consolidate, over time, a dataset. This will allow us to contribute to the structuring of robust knowledge on the subject.

5.3 Perspectives

Our experimentation with an orienteering race as part of the annual refresher course for fire safety training tends to confirm that serious gaming is a complementary, effective, and profitable approach to training in safety rules and principles. The following prospects and development avenues are currently being explored: (1) Increase the difficulty of the CO-ESI (by reducing the level of cartographic guidance or by making the markers less visible). The incorporation of varying levels of difficulty, tailored to employees' seniority on site or their declared familiarity with the premises, could further enhance the engagement and retention of the target audience. The transposition of this activity into other contexts, such as site discovery for new arrivals, is a promising avenue for expanding the practice of CO. The development of a methodological guide and templates, along with a kit designed to facilitate the creation of COs specific to the needs and environments of other departments or sites, has the potential to broaden the application of CO, thereby enhancing its effectiveness and impact. The methodological guide would ensure that the course design meets the training challenges, such as identifying the objective, determining the target audience, and selecting the message or information to be conveyed. The generalization of the approach would enable the collection of a statistically significant amount of empirical data more efficiently. However, this can only be achieved if a robust data collection method is developed, including the characterization of the audience, the activity, the modality, and the type of information to be collected. Although commitment has not been identified as an area for

improvement, as it is currently deemed to be highly satisfactory, it could be further strengthened by making the CO-ESI a valid part of training retraining. In fact, this is one of the ambitions of the pilot site's HSE department.

6. Conclusion

The edutainment approach has the potential to offer occasional advantages in safety training practices and to lead to genuine improvements. Among its advantages are improved involvement, commitment, and team cohesion; the possibility of creating original scenarios in a safe, controlled environment; and the development of practical skills and reaction efficiency. It also has a strong effect on memory and learning mechanisms, enhancing the appropriation of essential knowledge in the targeted field. However, the approach is not without limitations. The effectiveness of this approach is contingent upon its design and contextual adaptation, which underscores its suitability for integration into a training program. Additionally, its acceptance by participants and their preconceived notions of the approach, a parameter that is difficult to control, is a key factor in its efficacy.

It is essential to assess the impact of such an approach when integrated into "classic" training, while maintaining an objective view of its usefulness, lest we lose the added value it could bring. Additionally, it must be acknowledged that changes in learning and training take time, and emerging from a phase of experimentation could take several years.

In conclusion, after thorough consideration of its advantages and limitations, the edutainment approach emerges as a potentially suitable learning method for safety-matters. Its application on a transitional basis, between the transmission of formal knowledge and realistic simulation, could be a fruitful strategy. Notably, the edutainment approach holds promise in safety training, where it can transcend beliefs and convictions to foster more comprehensive learning.

References

- Anzieu, D., & Martin, J.Y. (2013). The dynamics of restricted groups. Presses Universitaires de France.
- Armstrong, M. B., & Landers, R. N. (2018). Gamification of employee training and development. *International Journal of Training and Development*, 22(2), 162-169.
- Băițan, G. (2022). Orienteering - A Necessary Sports Discipline For Training The Military. *Bulletin Of "Carol I" National Defense University (Print)*, 11, 110-116.
- Bevins K.L. & Howard C.D., (2018) "Game mechanics and why they are employed: What we know about gamification so far", *Issues and Trends in Educational Technology* 6.
- Blair, S., & Rillo, M. (2016). Serious Work: How to Facilitate Lego Serious Play Meetings and Workshops. *Promeet (Nov 1, 2016)*.
- Brown, L.D., Poulton, M.M. (2019). Improving Safety Training Through Gamification: An Analysis of Gaming Attributes and Design Prototypes. In: Cassenti, D. (eds) *Advances in Human Factors in Simulation and Modeling*. AHFE 2018. *Advances in Intelligent Systems and Computing*, vol 780. Springer, Cham.
- Burghardt, G. M. (2005). *The genesis of animal play: Testing the limits*. MIT press.
- Carter, S., & Smith Pasqualini, M. (2004). Stronger autonomic response accompanies better learning: A test of Damasio's somatic marker hypothesis. *Cognition and Emotion*, 18(7), 901-911.
- Ceschi, A., Costantini, A., Zagarese, V., Avi, E., & Sartori, R. (2019). The NOTECHS+: a short scale designed for assessing the non-technical skills (and more) in the aviation and the emergency personnel. *Frontiers in Psychology*, 10, 902.
- Cher-Filippi, É., Dinger, D., & Éline, É. (2023). Du jeu à la ludopédagogie: détournements de jeux de loisirs pour la sensibilisation de concepts managériaux. In: 7th International Game Evolution Colloquium, online, May 25-26, 2023.
- Condori Colan, C. A. N., & Barco Peralta, D. A. (2023). Gamification In Occupational Safety Training: A Systematic Literature Review. *Proceedings of the 4th South American International Industrial Engineering and Operations Management Conference*, Lima, Peru, May 9-11, 2023.
- Cortright, J., & Mayer, H. (2001). *High tech specialization: a comparison of high technology centers*. Washington, DC: Brookings Institution, Center on Urban and Metropolitan Policy.
- Damasio, A. R. (1996). The somatic marker hypothesis and the possible functions of the prefrontal cortex. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, 351(1346), 1413-1420.
- Faiella, F., & Ricciardi, M. (2015). Gamification and learning: a review of issues and research. *Journal of e-learning and knowledge society*, 11(3).
- Guimarães, A., Cavalcanti, M., & Vasconcelos, B. M. (2024). Gamification using technologies for occupational safety training in the civil construction sector. *Work*, 77(2), 477-485.

- Lampropoulos, G., & Kinshuk. (2024). Virtual reality and gamification in education: a systematic review. *Educational technology research and development*, 1-95.
- Lavigne, M. (2016). The playful and pedagogical weaknesses of serious games. *Numérique & éducation*. 978-2-8143-0287-7.
- Li, M., Ma, S., & Shi, Y. (2023). Examining the effectiveness of gamification as a tool promoting teaching and learning in educational settings: a meta-analysis. *Frontiers in Psychology*, 14, 1253549.
- Meyong, F., Page, M., Tissot, J., Vincendeau M., Larouzée, J. (2025, à paraître). Questionner l'engagement dans la conception d'un jeu sérieux : le cas Wei Ji, un serious game pour la formation à la gestion de crise industrielle. In Colloque « Questionner l'engagement dans la conception et les usages du jeu en situation d'apprentissage », Université Côte d'Azur, LIRCES & Mines Paris – PSL, CRC. 15 et 16 mai 2025, Sophia-Antipolis, France.
- Murray, H. J. R. (1913). *A history of chess*. Clarendon Press.
- Oscarsson, O. & Olsson, D. (2024). Under Pressure: A 'serious game' to build resilience through interactive learning. Paper presented at the 16th European Sociological Association Conference (ESA 2024), Porto, Portugal, August 27-30, 2024.
- Portelli, A. (2023). Chance and necessity. Le jeu de l'oie comme moyen d'éduquer au risque radioactif dans les années soixante. *Images du Travail, Travail des Images*, 14.
- Santos, S. A., Trevisan, L. N., Veloso, E. F. R., & Treff, M. A. (2021). Gamification in training and development processes: perception on effectiveness and results. *Revista de Gestão*, 28(2), 133-146.
- Tanner, A., & Preiksaitis, M. (2023). Perspectives of Learning and Training Practitioners on Gamification. *CORALS' Journal of Applied Research*, 1(1).
- Tanguy, A., Carrière, L., & Laforest, V. (2023). Low-tech approaches for sustainability: key principles from the literature and practice. *Sustainability: Science, Practice and Policy*, 19.
- Weinberg, L., Hasni, A., Shinohara, M., & Duarte, A. (2014). A single bout of resistance exercise can enhance episodic memory performance. *Acta psychologica*, 153, 13-19.

