

Key issues and pedagogical implications in the design of Digital Educational Escape rooms

Manuela Repetto^{a,1}, Barbara Bruschi^a, Melania Talarico^a

^aUniversity of Turin, Dept. of Philosophy and Education Sciences – Turin (Italy)

(submitted: 14/9/2022; accepted: 24/4/2023; published: 3/5/2023)

Abstract

Educational Escape rooms are game-based environments that may involve students of all school orders in engaging learning experiences. COVID-19 pandemic has increased the proliferation of escape rooms in a digital format whose use appeared meaningful for their generative effects on knowledge acquisition and on 21st century skills development. Nevertheless, the design of educational escape rooms is an essential process requiring a deep knowledge of both game design principles and learning design approaches. Moreover, teachers and educators willing to design and to experiment escape rooms with their students need to know how to connect these principles belonging to apparently distant fields and to balance them, to make these learning environments effective from an educational point of view and, at the same time, highly and intrinsically motivating.

The aim of this contribution is to focus on the design related aspects of educational digital escape rooms, providing a pedagogical foundation and discussing implications for learning. A Design-Based Research (DBR) has been conducted, involving two cohorts of undergraduate students who attended the Game-based learning course in the last two academic years. The educational escape rooms designed by them in the two editions of the course, corresponding to two iterations of a DBR cycle, were compared to investigate if the progressive enhancement of the design approach has affected the quality of the realized educational escape rooms.

From evaluation of DEERs designed by students a taxonomy was derived that, listing the main design characteristics for the development of DEERs, can be used as a tool that can guide educational designers in the development of effective DEERs, where game aspects are closely intertwined with the educational ones.

KEYWORDS: Game-Based Learning; Educational Escape Rooms; Technology-Enhanced Learning; Learning Design; Social Constructivism.

DOI

<https://doi.org/10.20368/1971-8829/1135749>

CITE AS

Repetto, M., Bruschi, B., & Talarico, M. (2023). Key issues and pedagogical implications in the design of Digital Educational Escape rooms. *Journal of e-Learning and Knowledge Society*, 19(1), 67-74.

<https://doi.org/10.20368/1971-8829/1135749>

1. Introduction

The last years have seen an important increase in the use of escape rooms in the educational context. Escape rooms can be defined as live-action and team-based games in which players face a series of challenges aimed at completing a mission or solving a mystery within a

limited time (Nicholson, 2015). As soon as the mission is completed, achieving a combination of hands-on and minds-on activities (Fotaris & Mastoras, 2019), players may leave the room in which they were closed.

The playful character of escape rooms associated with the use of cognitive skills required for players to discover clues and solve puzzles, made some teachers come up with the idea to replicate in the classrooms the escape room model born for entertainment purposes. They individuated in this approach a novel way to involve students fostering their learning processes. Moreover, in the last two years, the COVID-19 pandemic accelerated the need for teachers, who had to quickly convert the lessons in presence into online activities, to find more engaging and effective learning approaches for digital learning environments (Heim, 2022). Thus, Digital Educational Escape Rooms

¹ corresponding author - email: manuela.repetto@unito.it – address: Via Gaudenzio Ferrari 9, 10124, Turin (TO).

(DEERs) can be considered the digital transposition of the classical escape rooms created for leisure or physically reconstructed in the classrooms for educational purposes. Nevertheless, this passage cannot be considered a mere transposition, because it implies to consider game aspects such as the structuration of the game, the creation of a background narrative, the construction of the puzzles; but these elements require, as underlined by Veldkamp et al. (2020), a meaningful correspondence with the learning objectives. Moreover, this alignment involves the relation between game mechanics with pedagogical approaches. Thus, it involves a design approach that should be pedagogically informed as well as be infused with game design principles.

Recent scholarship has been investigating characteristics, applications and effects of educational escape rooms, both physical and digital, experimented in different subject domains and in various formal or informal contexts. Considering the impact on the development of general skills, literature provides evidence on the value of this approach for supporting collaborative teamwork, promoting persistence on tasks, or to help learners to consider problems from different perspectives (Fotaris & Mastoras, 2019). The active role taken by learners foster the development of 21st century skills such as critical thinking (Adams et al., 2018), problem solving (Veldkamp et al., 2021) and creativity (Foster and Warwick, 2018); this kind of involvement allows them to collaboratively construct knowledge as they progress through a series of tasks. These tasks scaffold learning, while providing students with a dynamic and exciting experience (Makri et al., 2021). Some literature provides empirical evidence on the positive impact of DEERs on students' motivation and on gameful experience (Fotaris & Mastoras, 2019; Vidergor, 2021).

Little evidence has been instead reported on the effectiveness of DEERs to foster domain specific skills and knowledge mastery; only few studies examined learning achievements comparing knowledge acquired prior and post intervention (Makri et al., 2019; Berthod et al., 2020; Caldas et al., 2019). Lathwesen & Belova (2021) found in these studies the need for multiple post-tests to be undertaken at different times and the demands of further findings on which components of escape rooms influence student achievement. Similarly, Taraldsen et al. (2022) advocate further research on DEERs use and outcomes and requires the application of more complex research designs, underlying the need for defining and validating through empirical evidence a set of design principles. Moreover, As Veldkamp et al. (2020) claim, relying on their literature review, little research has been conducted on the pedagogical foundation of DEERs.

Against this background, the present study is aimed at bridging the gap underlined in these studies, focusing on design principles derived from the integration of game theory with pedagogical perspectives. A design

approach was experimented with two cohorts of undergraduate students of the Bachelor in Education who, during the third-year course on Game-based learning, were trained to develop DEERs on the basis of theories and design principles acquired in the first part of the course. The methodological approach adopted for this study was Design Based Research (DBR), with a macrocycle made of two iterations, one for each edition of the course, during which the design approach proposed to the students was continuously refined. The DEERs implemented in the former edition were compared with those created in the latter on the light of some quality criteria previously identified. Results showed that students need to be trained on a consistent design approach, appropriately integrating game-based and pedagogical principles. On the basis of the results obtained, this contribution provides a taxonomy with the main design characteristics for the development of DEERs, in which game aspects are connected with the educational ones and where the main pedagogical approach adopted - behaviorism or constructivism - permeates both the aspects.

Before focusing on the research method and on the outcomes of the present study, a background on the main learning design models adopted for DEERs development are presented in the next paragraph, in order to draw out the need of developing new design models taking greater account of pedagogical principles and approaches.

2. Learning design models of educational escape rooms

The learning design models adopted for the development of DEERs and examined in this study were three:

- the EscapED framework (Clarck et al., 2017);
- the Six-phases approach (Eukel & Morrell, 2021);
- the Star Model (Botturi & Babazadeh, 2020).

The EscapED framework developed by Clarck and his colleagues (2017) is the most common framework that is considered as a reference from teachers and educators willing to design classical or digital educational escape rooms. This model is articulated in six dimensions (Participants, Objectives, Theme, Puzzles, Equipment, and Evaluation) and can be considered an effective guideline (Grande-de Prado et al., 2020) to create escape rooms for several learning contexts. These six areas are considered as the steps of a linear and sequential process of learning design that appears comprehensive but lacks important references to pedagogical principles.

Eukel & Morrell (2021) suggest a six-phase approach to create DEERs according to a methodical and iterative process that should ensure quality and an effective learner experience. The design process is cyclic and comprises design, piloting, evaluation, redesign, re-evaluation and repetition. The strength of this model lies

in the attention for the construction of each puzzle, which is thoughtfully designed to meet learner needs and to activate deep learning. However, also this model seems not pedagogically oriented.

A third approach is the Star Model (Botturi & Babazadeh, 2020), which comprises five interdependent elements corresponding to the five points of the star within a layer and other four contextual elements in a second layer. One point of the star deals with learning, that focuses both on learning outcomes in terms of competences to develop and on the expected learning process, dealing with the arrangements under which learning can occur.

The three aforementioned design models are meaningful to identify the main characteristics of the targeted educational escape room and to plan its underlying structure according to game design principles such as narrative, rewards, level of challenges and, as suggested by Veldkamp et al. (2021), alignment of puzzles with learning objectives. Explicit references to pedagogical perspectives and a stronger connection between game design and learning design could be opportunely provided in a design learning model. This connection can be identified in two main aspects: the scenario and the flow.

The first aspect, the scenario selected for the educational escape room, is related with the experience of immersion that the player/learner lives in as the game context, inspired by real-life context (Nicholson, 2015). Scenario recalls the situated learning theory (Lave & Wenger, 1991), that is coherent with game design principles and mechanics. In fact, this learning theory states that learning takes place in an environment, the scenario of the escape room representing a story or the context of a problem, in which knowledge would be applied. Thus, pedagogy can inform game design providing more indications based on the principles of situated learning.

The latter aspect aligning game with pedagogy, the concept of flow, has a double meaning for the involvement of the player on one side and for his/her learning process on the other: in the game theory flow is a state of optimal experience for the players, who consider it motivating and fun (Csikszentmihalyi, 1990); in pedagogy, the flow corresponds to the state of Vygotskij's zone of proximal development. A balance is created between learners' skill level and the challenge presented, preventing them from becoming bored or frustrated (Fotaris & Mastoras, 2019).

In the present research, whose method and results are described in the next paragraphs, the advances provided by the learning design models herein illustrated, as well as the implications of the relationship between game theory and pedagogy were considered.

3. Research method

In order to identify meaningful design principles for the development of DEERs that, as already mentioned, should derive from the integration of game design theory with learning design perspectives, faculty adopted a Design-Based Research (DBR) methodology that involved two different cohorts of undergraduate students of the Bachelor in Education, for a total of 65 students. The participants of the first cohort were 28, while the students of the second cohort were 37. They respectively attended two editions of the Course on Game-based learning in which, after a first theoretical part devoted to acquisition of game theories and design methods, they were trained to design individually or in pair DEERs on a disciplinary or interdisciplinary topic chosen by them.

Faculty chose DBR to address the gap found in the literature (Armstrong et al, 2022) on the lack of pedagogical foundation during the design of DEERs. The objective was bridging this gap through the development and the refinement of a learning design model based on principles connecting game and pedagogical aspects. This design model was proposed to students to develop their own DEERs and was progressively refined during the DBR macrocycle, that was made of two iterations, one for each edition of the course, for a total duration of two academic years. The approach chosen for DBR was that of McKenny and Reeves (2012), who identified three core processes made of two tasks: analysis and exploration, design and construction and evaluation and reflection. The aim of each iteration, that is represented in Figure 1, was to analyze literature starting from the identified problem, build and refine a learning design model for the development of DEERs, create DEERs and evaluate them. The findings obtained in the first iteration were used to refine the second iteration that followed the same process.

In the first iteration, the first cohort of students adopted an initial version of the learning design model based on existing literature models. This preliminary version was based on a project-based scheme guiding designers in a sequential way on how to build their DEER. The first element to define was the DEER's theme, represented through a main scenario and of other connected digital environments; the theme should find its counterpart in the specific topic of a subject domain or of an interdisciplinary area. Then, the scheme guides designers in identifying a series of learning objectives and building the corresponding puzzles or digital games. Each puzzle has to be designed in order to achieve its underlying objective; the solution of each puzzle leaves a clue that, together with the other clues obtained from the respective puzzles, allow learners to overcome the escape room's challenge and, at the same time, to achieve all the learning objectives set for the targeted topic. The DEERs designed by learners were assessed by faculty, who applied an evaluation approach based on

the satisfaction of five requirements, described in the next paragraphs.

In the second iteration, on the basis of the evaluation performed in the previous cycle, a reflection process on the critical points emerged during it was carried out, actively involving student designers. Reflection was aimed at understanding the reasons why some DEERs didn't meet certain requirements. The outcomes of this reflection activated a new analysis of literature conducted by faculty, who revised the first version of the learning design model and created an updated version of it, trying to overcome the encountered criticalities. The new version of the design model incorporated more specific pedagogical principles and included precise guidelines on how to connect game design theories with the educational ones. The new cohort of students developed their DEERs according to the approach of this revised version. Faculty assessed the developed DEERs through the same criteria defined in the previous phase.

4. Results

The 41 DEERs created by students were various for disciplinary area but were quite homogeneous in terms of target audience: they were designed especially for primary school students. The main subject areas were History, Grammar, English, Geography, Science and Maths. All students used Thinglink as digital learning environment to create their DEERs and the majority of them used yet existing spherical pictures to reproduce the settings and incorporated external digital games for puzzles and cues. The pedagogical approach adopted for these DEERs was more frequently behavioral than constructivist.

The ratings obtained with the evaluation of these 41 DEERs implemented by the two cohorts of students, were compared matching the scores of the 19 DEERs developed in the former course edition with the scores obtained by the 22 DEERs in the latter edition. The five prerequisites were:

- usability;
- pedagogical soundness;
- internal coherence;
- creativity;
- engagement level.

Usability is the correct implementation of technological aspects characterizing educational escape rooms, that make it easy and intuitive for the final user navigating it, understanding the tasks to be accomplished and performing all the required actions to overcome the challenges.

Pedagogical soundness means that the designer through its DEER shows his awareness on the choices made from an educational point of view, connecting game issues with pedagogical ones and allowing an expert eye to glimpse the underlying pedagogical drawing and orientation.

Internal coherence makes the DEER consistent and effective in the sense underlined by Botturi & Babazadeh (2020): all the elements of the DEER (puzzles, clues, narratives, structure, challenges) should be consistent with each other. This means that, for instance, if a learning objective states that the learner should be able to apply a concept, the puzzle to reach that objective can't be only a quiz or a fill in the blank exercise, but rather an interactive digital game requiring decision making.

Creativity is a qualitative criterion that a novel educational environment such as that of DEERs should be always satisfied. Creativity can be traced in several aspects that make DEERs original and innovative, such as the way a structure is built, the narrative through which the topic and the challenges are expressed, the type of puzzles that are incorporated in the DEER, or the ways in which keys and codes can be obtained and assembled to escape. According to Nicholson (2018), designers are creative if they are able to exploit the features of a design process that is generative and iterative.

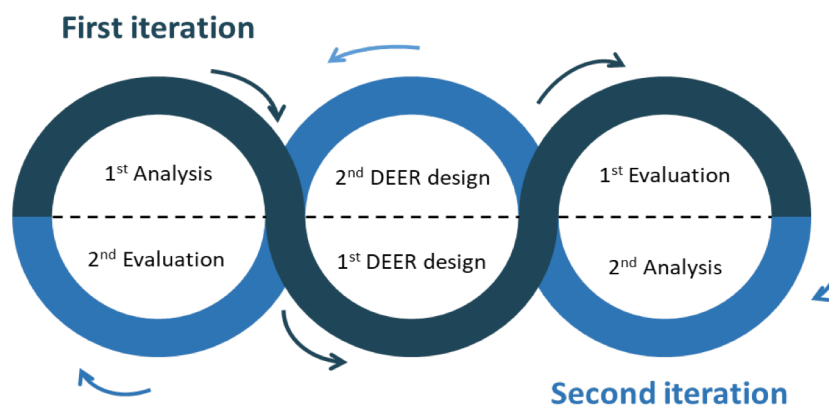


Figure 1 - The DBR macrocycle on the development of DEERs learning design model with two iterations.

Engagement level deals with the level of interest and of involvement that a DEER can potentially raise among learners. Considering the learning objectives and the needs of learners for whom a DEER is targeted, the state of flow defined in the previous paragraph can be considered an indicator of the engagement level.

These five qualitative criteria were assessed as 0 if they weren't satisfied or with 1 if they were satisfied. The total score was the sum of these five ratings, which thus could vary between 0 (minimum score) and 5 (maximum score). The Student t-test for independent samples was performed to compare the scores of the first group of DEERs with the scores of the second group. The latter group of 22 DEERs compared to the former group of 19 DEERs obtained significantly higher scores: the t -value was 2.301 and the p -value was .0134. This result was significant at $p < .05$. The effect size calculate with Hedges' g was 173.123, thus it can be considered relevant.

These results showed that students need to be trained on a consistent design approach for the development of high quality DEERs, appropriately integrating game-based and pedagogical principles.

5. Discussion

In the light of the obtained results from evaluation of DEERs designed by students, the taxonomy with the main design characteristics for the development of DEERs that was progressively created during the DBR macrocycle and that is part of the learning design model used during the study, appears an important tool that can guide designers in the development of effective DEERs. In this model, that can be considered a sort of dashboard, game aspects are closely intertwined with the educational ones, but the main pedagogical approach adopted - behaviorism or constructivism - permeates both the aspects and affects their alignment. The dashboard represents the four elements of game design and the corresponding four elements of educational design:

- structure vs. aim;
- reward vs. assessment;
- puzzles vs. feedback;
- level vs. learning strategy (see Figure 2).

The distinction between the constructivist orientation and the behaviorist one is not trivial, because it can affect the playful experience of a learner and can have an adverse effect also on the learning process itself. A hypothetical behaviorist DEER on analytical chemistry can be built as a series of exercises of growing difficulty, in which learners have to demonstrate that they have memorized chemical formulas. Nevertheless, a similar DEER created with a constructivist approach can involve students to solve an analytical problem, playing the role of forensic scientists that investigate a crime following the steps of the scientific method (Gonzalez).

Comparing the two DEERs, undoubtedly higher order skills can be reached in the latter DEER. Furthermore, a DEER that entails first-person experiential learning and elicits inquiry-based learning, which requires decision making - and not only to give correct answers, supports meaning making and makes them more effective for learning (San Chee, 2016).

These two types of DEERs described above can be considered as instances to illustrate the main elements of the dashboard and how these can be used as reference points to design effective DEERs.

A first element of the dashboard is the aim, that is meant here as the educational aim of the DEER, which triggers off a series of learning objectives. As seen in the example, while a constructivist approach supports the development of higher order skills, the behaviorist one considers information delivery as the main learning goal, stressing the importance of content knowledge. The counterpart of the aim is the structure of the DEER, that can be linear and sequential or open and reticular. In a constructivist open structure, as underlined by Nicholson (2015), learners are divided to simultaneously solve different puzzles, following diverse paths and gathering and negotiating solutions to solve the final meta-puzzle. Collaborative learning in this context, as shown by Ho (2018), promotes a deeper understanding of concepts and their transferability beyond the classroom. In a behavioral linear structure, instead, learners must solve puzzles one after the next. According to Zhang et al. (2018) learners, as soon as they solve a puzzle, obtain progression to the next puzzle as a reinforcement of their positive behavior.

A second element of the dashboard is assessment that, according to a constructivist perspective, should be formative for learners to make them more aware of their own learning processes. Formative assessment is not provided only by DEERs, but also by teachers at the end of the DEER: as Vedkamp et al. (2020) state, a debriefing afterward is essential to make a DEER more effective. Adopting a behavioral perspective, assessment is instead based on the scores obtained by learners that positively reinforce the overcoming of challenges, extrinsically motivating them. Reward is the counterpart of assessment for game design, that adopting a behavioral approach is meant as a simple recognition, usually expressed through a landing page with congratulations; a constructivist reward is something different, it can be represented as a sort of diploma or certificate which acknowledges learners' achievements and make them more aware of the meaningful experience lived through the targeted DEER.

Feedback is the third element of learning design. Adopting a constructivist approach, providing formative feedback to learners makes them more aware of their own learning processes and more able to self-regulate these processes. The feedback can be provided by the DEER itself during each challenge and is aligned with the targeted learning objective; it should be given

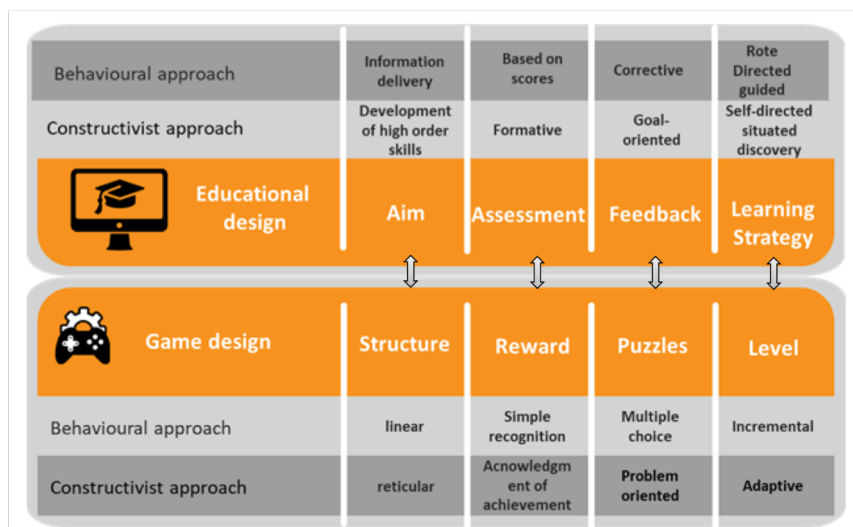


Figure 2 - The dashboard integrating game design and learning design for the development of DEERs.

whether the challenge was overcome with success, or the learner encountered difficulties. Moreover, teachers can act as facilitators during fruition of DEERs (Fotaris & Mastoras, 2019), although their scaffolding should counterbalance students’ feeling of ownership and mastery (Veldkamp et al., 2021). The feedback provided through the behavioral approach isn’t formative and gives a mere response about the rightness or the wrongness of a puzzle solution.

Puzzles are the third element of game design that, according to a constructivist approach, have to be aligned with the learning objective and with the curriculum. They are problem oriented and ensure the right level of flow for the targeted learner to prevent frustration or boredom. If well designed, they stimulate higher order thinking skills and allow learner to construct new knowledge (Zhang et al., 2018; Ouariachi & Wim, 2020). Puzzles following a behavioral scheme achieve low-order thinking skills since these use what Eukel & Morrell (2021) calls a game loop structure consisting of a challenge, a solution and a reward, such as in multiple-choice quiz.

The fourth element of learning design, the learning strategy, in a constructivist perspective includes strategies such as situated learning, discovery learning and self-directed learning. If DEERs support these learning strategies, learners construct their own knowledge living real-time and situated experiences. Instead, the behavioral approach inspires directed, guided and rote learning; in DEERs based on these learning strategies knowledge can only be transmitted and acquired (Bakker, 2018).

The corresponding fourth element of game design is difficulty level that, according to constructivism, is adaptive and tailored based on the decisions taken by learners: like in an adaptive system, a DEER can be designed to offer different learning pathways that change on the basis of learners’ choices. The behaviorist

approach fixes a unique pathway for all where puzzles and challenges are designed with an incremental difficulty.

The DEERs implemented in the second iteration were characterized by a more relevant pedagogical orientation, even if most of them mixed elements inspired by constructivism with elements designed according to behavioral principles. In any case, most students after the course were ready to design DEERs to propose to schools in their near future as educators or teachers.

6. Conclusions

DEERs appear promising and innovative learning environments for students of all ages, who can develop higher order thinking skills, strengthen their social competencies, and reach deep learning when facing complex problems and challenges. Contexts in which students play are highly situated and foster authentic learning if learning scenarios are appropriately designed.

The concept of knowledge underlying the design of DEERs is critical because considering it as a set of notions to transmit to learners is different from considering it as meanings to construct to make sense of the world. These different concepts can affect the way in which a DEER is designed and its effectiveness. Moreover, if the focus of the design process is mainly on game design aspects or mostly on learning design issues, it is to the detriment of DEER’s relevance.

The main aim of this study was to experiment a learning design model for DEERs in which game design and learning design aspects are more balanced; through this model designers become aware of learning strategies to adopt and of the consequences of their application for learning processes. The model derives from the

combination of the outcomes of the main exploratory studies in the field of DEERs and the results of experimentation carried out in the present study.

A limit of this study is the absence of the experimentation phase of the DEERs designed by undergraduate students with the targeted students for whom DEERs were conceived. This missing part would be essential to definitely validate DEERs and to assess their effects on students' learning. However, further studies could include this phase involving in-service teachers as potential designers, who could adopt the learning design model of the present study to design DEERs and experiment in the classroom with their own students.

Future research could also include the design of DEERs pedagogically grounded exploiting virtual and augmented reality, that could lead to new research interests on immersive learning environments with no spatial limitations (Lathwesen & Belova, 2021), with relevant implications at social, cognitive and educational levels.

Notes

Bruschi authored paragraphs 1 and 6; Repetto authored paragraphs 4 and 5; Talarico authored paragraphs 2 and 3.

References

- Adams, V., Burger, S., Crawford, K., and Setter, R. (2018). Can You Escape? Creating an Escape Room to Facilitate Active Learning, *Journal for Nurses in Professional Development*, Vol. 34, No. 2.
- Armstrong, M., Dopp, C., & Welsh, J. (2022). Design-based research. *Education Research*.
- Bakker, A. (2018). Discovery learning: zombie, phoenix, or elephant?. *Instructional Science*, 46(1), 169-183.
- Berthod, F., Bouchoud, L., Grossrieder, F., Falaschi, L., Senhaji, S., & Bonnabry, P. (2019). Learning good manufacturing practices in an escape room: Validation of a new pedagogical tool. *J. Oncol. Pharm. Pract.*, 26, 853-860.
- Botturi, L., & Babazadeh, M. (2020). Designing educational escape rooms: validating the Star Model. *International Journal of Serious Games*, 7(3), 41-57.
- Buchner, J., Rüter, M., & Kerres, M. (2022). Learning with a digital escape room game: before or after instruction?. *Research and practice in technology enhanced learning*, 17(1), 1-16.
- Caldas, L.M., Eukel, H.N., Matulewicz, A.T., Fernández, E.V., & Donohoe, K.L. (2019). Applying educational gaming success to a nonsterile compounding escape room. *Curr. Pharm. Teach. Learn.*, 11, 1049-1054.
- Clarke, S., Peel, D. J., Arnab, S., Morini, L., Keegan, H., & Wood, O. (2017). EscapED: A framework for creating educational escape rooms and interactive games for higher/further education. *International Journal of Serious Games*, 4(3), 73-86.
- Csikszentmihalyi, M. (1990) *Flow: the psychology of optimal experience*, New York: Harper and Row.
- Eukel, H., & Morrell, B. (2021). Ensuring educational escape-room success: the process of designing, piloting, evaluating, redesigning, and re-evaluating educational escape rooms. *Simulation & Gaming*, 52(1), 18-23.
- Ferreiro-González, M., Amores-Arrocha, A., Espada-Bellido, E., Aliaño-Gonzalez, M. J., Vázquez-Espinosa, M., González-de-Peredo, A. V., & Cejudo-Bastante, C. (2019). Escape classroom: Can you solve a crime using the analytical process?. *Journal of Chemical Education*, 96(2), 267-273.
- Foster, T., & Warwick, S. (2018). Nostalgia, gamification and staff development – moving staff training away from didactic delivery, *Research in Learning Technology* 2018, 26: 2021.
- Fotaris, P., & Mastoras, T. (2019). Escape rooms for learning: A systematic review. In *Proceedings of the European Conference on Games Based Learning* (pp. 235-243).
- Grande-de-Prado, M., García-Martín, S., Baelo, R., & Abella-García, V. (2020). Edu-Escape Rooms. *Encyclopedia*, 1(1), 12-19.
- Heim, A. B., Duke, J., & Holt, E. A. (2022). Design, discover, and decipher: student-developed escape rooms in the virtual ecology classroom. *Journal of Microbiology & Biology Education*, 23(1), e00015-22.
- Lathwesen, C., & Belova, N. (2021). Escape rooms in stem teaching and learning - prospective field or declining trend? A literature review. *Education Sciences*, 11(6), 308.
- Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge university press.
- Lopez-Pernas, S., Gordillo, A., Barra, E., Quemada, J. (2019). Analyzing Learning Effectiveness and Students' Perceptions of an Educational Escape Room in a Programming Course in Higher Education. *IEEE Access* 2019, 7, 184221-184234.
- Makri, A., Vlachopoulos, D., & Martina, R. A. (2021). Digital escape rooms as innovative pedagogical tools in education: a systematic literature review. *Sustainability*, 13(8), 4587.

- Mckenney, S., & Reeves, T.C. (2012) *Conducting Educational Design Research*. New York, NY: Routledge.
- Nicholson, S. (2015). Peeking behind the locked door: A survey of escape room facilities. White Paper available at <http://scottnicholson.com/pubs/erfacwhite.pdf>
- Nicholson, S. (2018). Creating Engaging Escape Rooms for the Classroom. *Childhood Education* 94 (1): 44–49. doi:10. 1080/00094056.2018.1420363.
- San Chee, Y. (2016). *Games-to-teach or games-to-learn: Unlocking the power of digital game-based learning through performance*. Springer.
- Taraldsen, L. H., Haara, F. O., Lysne, M. S., Jensen, P. R., & Jenssen, E. S. (2022). A review on use of escape rooms in education—touching the void. *Education Inquiry*, 13(2), 169-184.
- Veldkamp, A., Knippels, M. C. P., & van Joolingen, W. R. (2021). Beyond the early adopters: Escape rooms in science education. In *Frontiers in Education* (Vol. 6, p. 622860). Frontiers Media SA.
- Veldkamp, A., van de Grint, L., Knippels, M. C. P., & van Joolingen, W. R. (2020). Escape education: A systematic review on escape rooms in education. *Educational Research Review*, 31, 100364.
- Vidergor, H. E. (2021). Effects of digital escape room on gameful experience, collaboration, and motivation of elementary school students. *Computers & Education*, 166, 104156.