Escape rooms in Medical Education: Deductive Analysis of Designs, Applications and Implementations

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Abstract

Background:
Serious games are conceptualized as a broad topic and overlap segments of more modern forms of education: e-learning, edutainment, game-based learning, and digital game-based learning. Serious Games aligns with digitalization and the modern era and creates novel opportunities for learning and assessment in medical education. Escape rooms, a type of serious games, merge mental and physical aspects to reinforce critical skills useful in daily life. It challenges logic and reasoning and demands careful analysis of situations to correlate and solve different stages of the escape room under pressurized, timed conditions. Furthermore, it serves as an adequate environment to build problem-solving skills, communication skills, and leadership skills through the collaboration of people to achieve a common goal. The aim of this study was to investigate the applications of escape rooms in Medical Education.

Method: This study investigated the applications of escape rooms in medical education. Serious games are expanding in education and have attained great relevance due to their intriguing and intrinsically motivating attributes. Within serious games, we focused on escape rooms in which participants are locked in a room, faced with puzzles that must be solved to 'escape the room'. Compiling the data from the first 100 hits of medical application of escape rooms, we found 72 cases and categorized them by year, specialty, participants structure, simulation experience, and design.

Results: We reported on escape rooms in medical education by the year in which they were reported, the medical specialty, the participant structure, grouped or individual, the experience

design; real, hybrid, or digital, and the modality of the delivery. 72% of the escape rooms focused on four main areas: nursing education (25.0%), emergency medicine (22.2%), pharmacy (12.5%), and interprofessional education (12.5%). Most of the escape rooms had a group-based physical design and little attention was given to provide a detailed description of the design considerations, such as the pathway type (linear, semi-linear, open).

Conclusion: Escape rooms are applied in a wide range of medical education areas. In Medical Education, group-based on-site escape rooms with a focus on nursing, emergency medicine, pharmacy and interprofessional education dominates the implementation landscape. To further advance the field, stronger emphasis on making explicit the design considerations will advance the research and inform implementations.

Keywords: Medical Education, Serious games, Escape room, E-learning, Edutainment, Game-based learning

Introduction

As of today, serious games have become very popular and combine entertainment with cognition. It is an exceptional concept that may be found slightly challenging to grasp. By isolating the two terms, "game" and "serious", we are provided with a greater insight into this topic.

Referring to the Oxford Learner's Dictionaries [1], the term "game" [2] is defined as *"an activity that you do to have fun, often one that has rules and that you can win or lose".* This signifies that games encompass a physical activity with an entertaining mental activity. However, an alternative definition states that games are *"a sport with rules in which people or teams compete against each other"*, which may be misleading within this context as the gamification of learning requires effective collaboration, instead of opposition, to achieve a collective goal. "Serious" [3], similar to "game", has multiple definitions, and the correct interpretations should be identified for deeper understanding. An example of an inaccurate interpretation is *"bad or dangerous",* and although there may be some limitations to serious games, it is generally accepted as a successful learning method. Given the context, it may be explained that "serious" means *"needing to be thought about carefully; not only for pleasure"* and *"that must be treated as important".* [4]

Hence, serious games are games used for purposes other than entertainment, to allow for experiences that are difficult to create in the real world due to "safety, costs, time, etc." [5], that *"may be significant without being solemn, interesting without being hilarious, earnest and purposeful without being humorless and difficult without being frustrating"* [4], and this peculiar oxymoron encapsulates the modernization of education.

Serious games are conceptualized as a broad topic and overlap segments of more modern forms of education: e-learning, edutainment, game-based learning (GBL), and digital game-based learning (DGBL) [5]

According to Allison Rossett, *"the concept of e-learning has been described as a revolution, providing new approaches to learning and performance improvement"* [6]. However, today, this concept is familiar due to the impact of covid-19 and uses interactive technology to continue education in unfavorable circumstances.

Edutainment is regarded as an ancient form of education, and it aimed to exhibit education through entertainment. Vastly popular in the 1990s, Zühal Okan explains that *"in the rush to adopt this new seemingly harmless technological fad, both educators and parents overlooked its long-term harmful effects."* [7] This has caused it to lose its purpose and become obsolete. Examples of these are TV shows with entertaining characters that teach viewers ('Barnie', 'Dora the explorer', etc.), certain board games ('scrabble', 'sudoku', 'monopoly', etc.), and many other forms.
Annie Pho and Amanda Dinscore proposed that *"Game-based learning refers to the borrowing of certain gaming principles and applying them to real-life settings to engage users"* [8] This is a section of serious games that adopts gaming models to fulfill key learning outcomes through *"engagement, motivation, role-playing, and repeatability"* [5] Types of GBL activities may include escape rooms and role-play scenarios.

Digital game-based learning extends further from GBL and is a method that "incorporates educational content or learning principles into video games to engage learners", Heather Coffey narrated. [9] DGBL also incorporates aspects of immersive learning to create a virtual learning environment. Some examples could be video games like 'the sims', virtual escape rooms, and extended reality, consisting of virtual, augmented, and mixed reality.

With the rapid rate of digitalization of technology and the more recent introduction of gamification, serious games have been proven to be a successful form of learning. Referring to Linda Stege, Giel van Lankveld, and Pieter Spronck's investigation on whether serious games support learning processes, they tested two groups of individuals who received information via text against serious games. They concluded that *"serious games can be more effective in learning processes than written texts, but that they do not necessarily motivate students better than a textbook."* [10]

Overall, serious games are viewed as prosperous through their captivating, cognitive, alluring fashion, instant interaction with the players, and their capability to compose intricate schemes. [11]

This review focuses on escape rooms as a type of serious game with the implication of GBL and DGBL.

Over the last decade, escape rooms have flourished in popularity among society, and it serves as a recreational activity for leisure. It, more recently, is being used for teaching and training in educational purposes as a form of GBL and DGBL. It's a collaborative effort in which a group of people is faced with a challenge to overcome, a hidden solution needed to be found, and a reward for overcoming the challenge. [12]

Escape rooms display an array of puzzles and can be *set up in three ways*: linear path, open path, and multilinear path. [12]

- The linear path proposes that tasks should be completed in a particular order as a supervised training method and is the simplest form of an escape room.
- The open path design introduces a series of puzzles that can be completed in any arrangement and is seen as more complex than the linear path as there is no direct indication of where to start and multiple pathways can be generated for one solution, and they are connected via a metapuzzle (a puzzle that has many puzzles leading into it)
- The multilinear path design is the most comprehensive yet challenging type of escape room and incorporates aspects of both the linear and open path designs; it presents puzzles that can be executed parallel to one another and delivers multiple starting and finishing points in the game based on player decisions.

In addition, escape rooms *merge mental and physical aspects* to reinforce critical skills useful in daily life. It challenges logic and reasoning and demands careful analysis of situations to correlate and solve different stages of the escape room under pressurized, timed conditions. Furthermore, it serves as a adequate environment to build problem-solving skills, communication skills, and leadership skills through the collaboration of people to achieve a common goal.

The simulation of an escape room in education helps to solidify previously attained knowledge through the applications to virtually real-life scenarios. The gamification concept of learning aids the ability of students to engage in practical tasks and thus aids in achieving and implanting necessary learning objectives. [13]–[15]

The objective of this research is to address:
- What medical fields use escape rooms in education?
- How were the participants structured?
- What type of simulation experience was used?
- How were the escape rooms designed?

Method
Based on previously acknowledged keywords: serious game, escape room, linear path, open path, multilinear path; we searched google scholar identifying the applications of escape rooms in

medical education and categorized them accordingly. As described in a similar study reviewing the use of escape rooms in education, *"some authors use the term "breakout room" as a synonym for an escape room and narrower terms such as "escape game," "serious escape room," and "breakout box.""* [16].

In this research, we reviewed the first 100 hits in Google Scholar with the keywords; ["escape room" AND "medical education"] and synthesized the data. After removing duplicate articles and all immaterial content that doesn't comprise medical applications, a combined 72 articles were analyzed: two from 2017, nine from 2018, twenty from 2019, nineteen from 2020 and twenty-one from 2021. [16]

Results

Through our analysis, we have decided to categorize the information into the year in which the article was published, the specialty in the medical field, the participant structure, grouped or individual, the experience design; real, hybrid, or digital, and the modality of the delivery. The table below provides an extensive report using the before mentioned categories.

Table 1 - Extensive classification of articles into the year, medical field specialty, participants structure, simulation experience, and design

Escape room	Article name	Year	Specialty	Participant's structure	Simulation Experience	Design
1	Educational Gaming for Pharmacy Students – Design and Evaluation of a Diabetes-themed Escape Room [14]	2017	Pharmacy	Group	Real	Unidentified
2	Trapped as a Group, Escape as a Team: Applying Gamification to Incorporate Team-building Skills Through an 'Escape Room' Experience [18]	2018	Emergency Medicine	Group	Real	Linear
3	Incorporating an "Escape Room" Game Design in Infectious Diseases Instruction [19]	2018	Pharmacy	Group	Real	Unidentified
4	Can You Escape Nursing School? Educational Escape Room in Nursing Education [20]	2018	Nursing education	Group	Unidentified	Unidentified
5	The Toxiscape Hunt: An Escape Room-Scavenger Hunt for Toxicology Education [21]	2018	Emergency Medicine	Group	Real	Open

6	Can You Escape? Creating an Escape Room to Facilitate Active Learning [22]	2018	Nursing education	Group	Unidentified	Unidentified
7	P134: Escape game as a theatre-based simulation for teamwork skills training in undergraduate medical education [23]	2018	Emergency Medicine	Group	Real	Unidentified
8	Escape Room Recruitment Event: Description and Lessons Learned [24]	2018	Nursing education	Group	Real	Linear
9	Exploring virtual reality as a platform for distance team-based learning [25]	2018	Pharmacy	Group	Digital	Unidentified
10	Development and evaluation of a trauma decision-making simulator in Oculus virtual reality [26]	2018	Emergency Medicine	Group	Digital	Unidentified
11	Patient Safety Escape Room: A Graduate Medical Education Simulation for Event Reporting [27]	2019	Internal Medicine	Group	Hybrid	Multilinear
12	Patient Safety Escape Room: A Graduate Medical Education Simulation for Event Reporting [27]	2019	Emergency Medicine	Group	Hybrid	Multilinear
13	Escaping the professional silo: an escape room implemented in an interprofessional education curriculum [28]	2019	Interprofessional healthcare	Group	Real	Unidentified
14	Break out of the classroom: The Use of Escape Rooms as an Alternative Teaching Strategy in Surgical Education [17]	2019	Surgery	Group	Real	Unidentified
15	The impact on nursing students' opinions and motivation of using a "Nursing Escape Room" as a teaching game: A descriptive study [15]	2019	Nursing education	Group	Real	Unidentified
16	Priming healthcare students on the importance of non-technical skills in healthcare: How to set up a medical escape room game experience [29]	2019	Non-technical	Group	Real	Unidentified
17	An escape-room inspired game for genetics review [30]	2019	Genetic analysis	Group	Real	Unidentified

18	Escape into patient safety: bringing human factors to life for medical students [31]	2019	Patient safety	Group	Real	Unidentified
19	An innovative escape room activity to assess student readiness for advanced pharmacy practice experiences (APPEs) [32]	2019	Pharmacy	Group	Unidentified	Unidentified
20	Escape Room: An Innovative Approach to Teaching Disaster Preparedness to Emergency Medicine Residents and Medical Students [33]	2019	Emergency Medicine	Group	Real	Linear
21	Escape the Room: Innovative Approaches to Interprofessional Education [34]	2019	Interprofessional healthcare	Group	Unidentified	Unidentified
22	An Escape Room as a Simulation Teaching Strategy [13]	2019	Nursing education	Group	Real	Open
23	Applying educational gaming success to a nonsterile compounding escape room [35]	2019	Pharmacy	Group	Unidentified	Unidentified
24	251 Effects of Escape Room Simulation on Trainee Confidence [36]	2019	Emergency Medicine	Group	Real	Unidentified
25	"Code Purple": A Feasibility Study of Escape Room Development for Medical Students [37]	2019	Emergency Medicine	Group	Real	Linear
26	Effectiveness of the Sloppy Mountain Medical Center Computer-Based Escape Room Game for Teaching Interprofessional Teamwork Concepts [38]	2019	Interprofessional healthcare	Group	Digital	Open
27	Using a Digital Escape Room as a Framework for Deliberate Practice of ID Fundamentals. [39]	2019	Pharmacy	Group	Digital	Unidentified
28	Escape the Trauma Room [40]	2019	Emergency Medicine	Group	Real	Unidentified
29	The escape room as evaluation method: A qualitative study of nursing students' experiences [41]	2019	Nursing education	Group	Real	Unidentified

30	Breakout of the box: Innovative education using an escape room [42]	2019	Emergency Medicine	Group	Real	Unidentified
31	The great escape? The rise of the escape room in medical education [43]	2020	Core medical training	Group	Real	Unidentified
32	The great escape? The rise of the escape room in medical education [43]	2020	Obstetrics	Group	Real	Open
33	The great escape? The rise of the escape room in medical education [43]	2020	Dermatology	Group	Real	Unidentified
34	Exploring the perspectives of dermatology undergraduates with an escape room game[44]	2020	Dermatology	Group	Real	Unidentified
35	Benefits of an Escape Room as a Novel Educational Activity for Radiology Residents[45]	2020	Radiology	Group	Real	Unidentified
36	Interprofessional Health Care Escape Room for Advanced Learners[46]	2020	Interprofessional healthcare	Group	Real	Unidentified
37	Feasibility of a pediatric radiology escape room for undergraduate education[47]	2020	Radiology	Group	Real	Multilinear
38	Comparing the Effectiveness of a Virtual Toxicology Escape Room at Two Emergency Medicine Residencies[48]	2020	Emergency Medicine	Group	Digital	Open
39	Development of a cancer-themed escape room learning activity for undergraduate pharmacy students[49]	2020	Pharmacy	Group	Unidentified	Unidentified
40	Learning good manufacturing practices in an escape room: Validation of a new pedagogical tool[50]	2020	Chemotherapy	Group	Real	Open
41	EscapED: A Medical Escape Room as a Novel Approach in Emergency Medicine Medical Education[51]	2020	Emergency Medicine	Group	Real	Linear

42	Escape the Generational Gap: A Cardiovascular Escape Room for Nursing Education[52]	2020	Nursing education	Group	Unidentified	Unidentified
43	The Research Escape Hunt: An Escape Room-Scavenger Hunt for Resident Education[53]	2020	Emergency Medicine	Group	Real	Unidentified
44	Student pharmacist perceptions of learning after strengths-based leadership skills lab and escape room in pharmacy practice skills laboratory[54]	2020	Pharmacy	Group	Real	Unidentified
45	Escape Rooms as a Clinical Evaluation Method for Nursing Students[55]	2020	Nursing education	Group	Real	Unidentified
46	An Escape Room for Sepsis Education[56]	2020	Nursing education	Unidentified	Real	Multilinear
47	Serious Games for Professional Skills: The Design of an Escape Room to Explore the Possibilities of eMental Health[57]	2020	Mental Healthcare	Unidentified	Digital	Unidentified
48	Escape Tasks: An Innovative Approach in Nursing Education[58]	2020	Nursing education	Group	Real	Unidentified
49	Will You Escape? Validating Practice While Fostering Engagement Through an Escape Room[59]	2020	Nursing education	Unidentified	Unidentified	Unidentified
50	Twelve tips for creating an escape room activity for medical education[60]	2021	Non-technical	Group	Real	Unidentified
51	Shocking Escape: A Cardiac Escape Room for Undergraduate Nursing Students[61]	2021	Nursing education	Group	Real	Linear
52	Effectiveness of an escape room for undergraduate interprofessional learning: a mixed methods single group pre-post evaluation[62]	2021	Interprofessional healthcare	Group	Real	Open
53	There is no I in Escape: Using an Escape Room Simulation to Enhance Teamwork and Medication Safety Behaviors in Nursing Students[63]	2021	Nursing education	Group	Real	Unidentified
54	The COMET framework: A novel approach to design an escape room workshop for interprofessional objectives[64]	2021	Interprofessional healthcare	Group	Unidentified	Unidentified

55	Advancing team cohesion: Using an escape room as a novel approach[65]	2021	Interprofessional healthcare	Group	Unidentified	Unidentified
56	Grant deadline: An escape room to simulate grant submissions[66]	2021	Pharmacy	Group	Real	Unidentified
57	Gaming and anxiety in the nursing simulation lab: A pilot study of an escape room[67]	2021	Nursing education	Unidentified	Unidentified	Unidentified
58	Saving patient x: A quasi-experimental study of teamwork and performance in simulation following an interprofessional escape room[68]	2021	Interprofessional healthcare	Group	Unidentified	Unidentified
59	Escape the EM Boards: Interactive Virtual Escape Room for GI Board Review[69]	2021	Gastroenterology	Group	Digital	Unidentified
61	An evaluation of undergraduate student nurses' gameful experience while playing an escape room game as part of a community health nursing course[70]	2021	Nursing education	Group	Real	Unidentified
62	Can you escape traditional learning? A novel and engaging virtual education tool[71]	2021	Emergency Medicine	Unidentified	Digital	Unidentified
63	From Classroom to Escape Room: Using Gamification for Dynamic Learning[72]	2021	Core medical training	Group	Unidentified	Unidentified
64	Adapting the Escape Room to Engage Learners Two Ways During COVID-19[73]	2021	Nursing education	Group	Digital	Multilinear
65	Using an Escape Room Modality to Teach Mock Code Essentials[74]	2021	Nursing education	Group	Unidentified	Unidentified
66	Escape this Emergency Room: Simulation Education During a Pandemic[75]	2021	Emergency Medicine	Group	Real	Unidentified
67	Can You Escape Sepsis? Using a Healthcare Escape Room as an Innovative Approach to Nursing Education[76]	2021	Nursing education	Unidentified	Unidentified	Unidentified

68	Escaping a Pandemic: Utilizing an Escape Room to Increase Learner Engagement in Infection Prevention and Control Education[77]	2021	Infection prevention	Group	Real	Unidentified
69	Adapting a Classroom Simulation Experience to an Online Escape Room in Nutrition Education[78]	2021	Nutrition education	Group	Digital	Linear
70	Let's Escape Didactics: Virtual Escape Room as a Didactic Modality in Residency[79]	2021	Emergency Medicine	Group	Digital	Unidentified
71	Interprofessional Escape Room: Evaluating Teamwork among Healthcare Profession Students[80]	2021	Interprofessional healthcare	Group	Unidentified	Unidentified
72	Development of an innovative educational escape game to promote teamwork in dentistry[81]	2021	Dentistry	Group	Unidentified	Unidentified

Medical fields where escape rooms are used for education

Based on the 72 articles, we categorized the escape rooms by the field it was created for. We found out that most of the escape rooms were concerned with nursing education (Number: 18; Percentage:25.0%) and emergency medicine (Number: 16; Percentage:22.2%) and followed by pharmacy (Number: 9; Percentage:12.5%), and interprofessional healthcare education (Number: 9; Percentage:12.5%), totaling 72.2% of the fields examined. Table 2 and Figure 1 depict this information further.
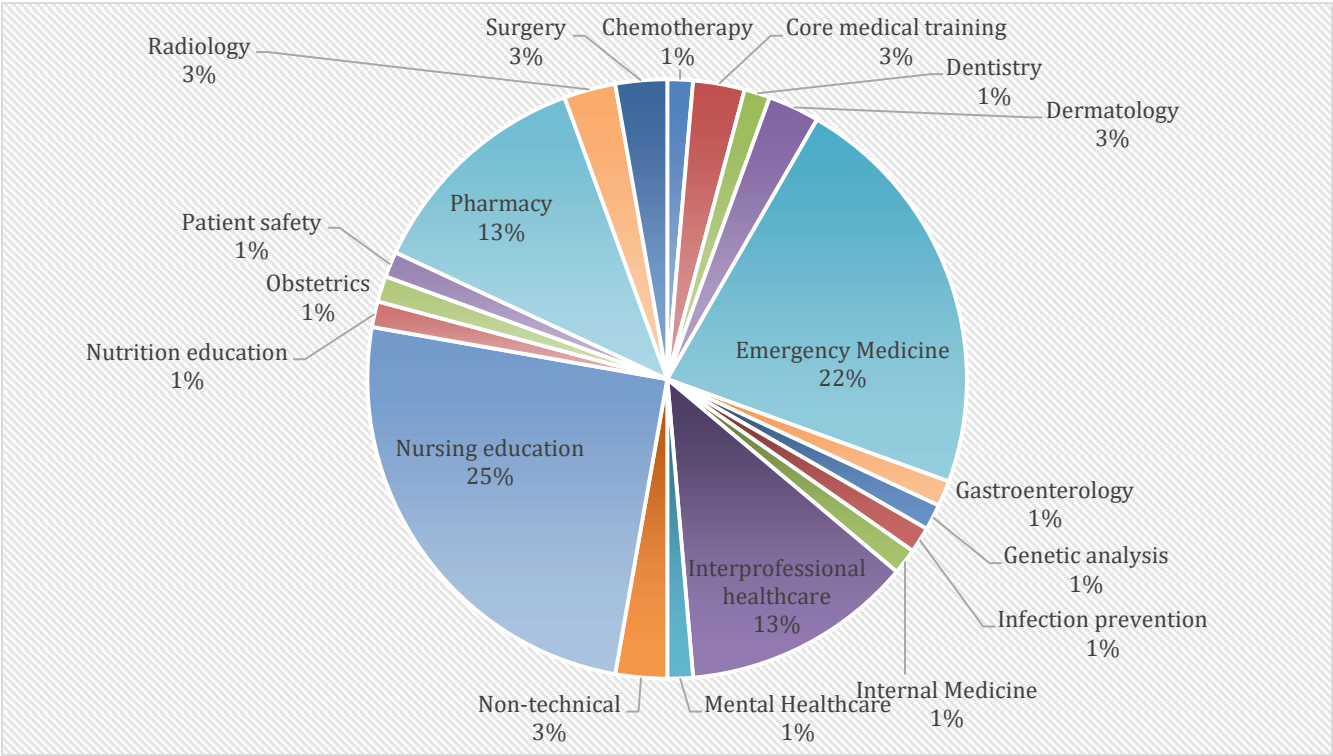
Figure 1. Representation of escape room usage in the medical field sorted by specialty between 2017 and 2021
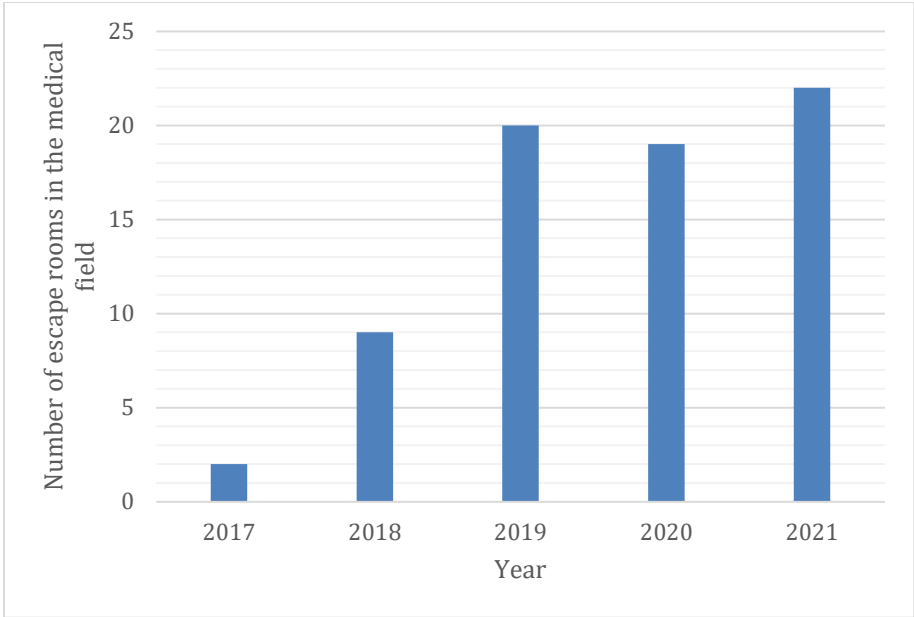
Figure 2 - Representation of medical field escape rooms measured by year

Group vs. Individual based escape rooms

Upon synthesizing, we recognized keywords to determine whether the escape room was done as a group or as individuals to create Table 3 and Figure 2. For grouped escape rooms it was generally specified, however occasionally, we had to confirm this by studying the articles' results and thesis for the skills attained by participants; if team building and collaboration skills were received by the participants, they were also selected as grouped escape rooms. 100% of the 66 identified escape rooms were grouped (91.7%) while 6 rooms; 8.3% could not be verified due to the lack of data.
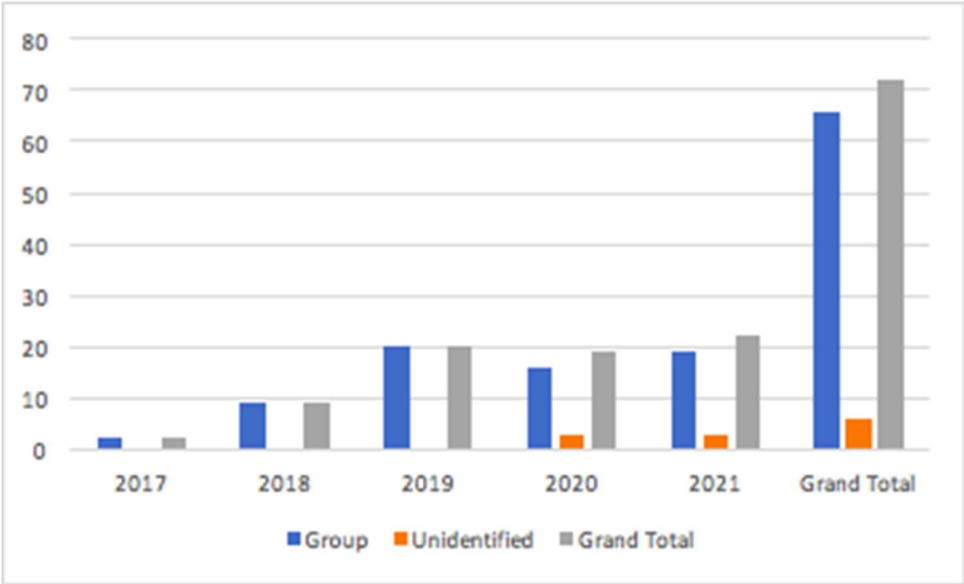
Figure 3. Representation of participants structure measured by year

Linear vs. multilinear vs Open escape rooms

Only 19 (26.3%) of the articles provided enough information to classify which design it was. Some of the articles had it explicitly mentioned while others required assessment of the pathway of the escape rooms. Most of the articles (Number: 53; Percentage:73.7%) excluded this information or did not present enough data to produce an accurate judgment.
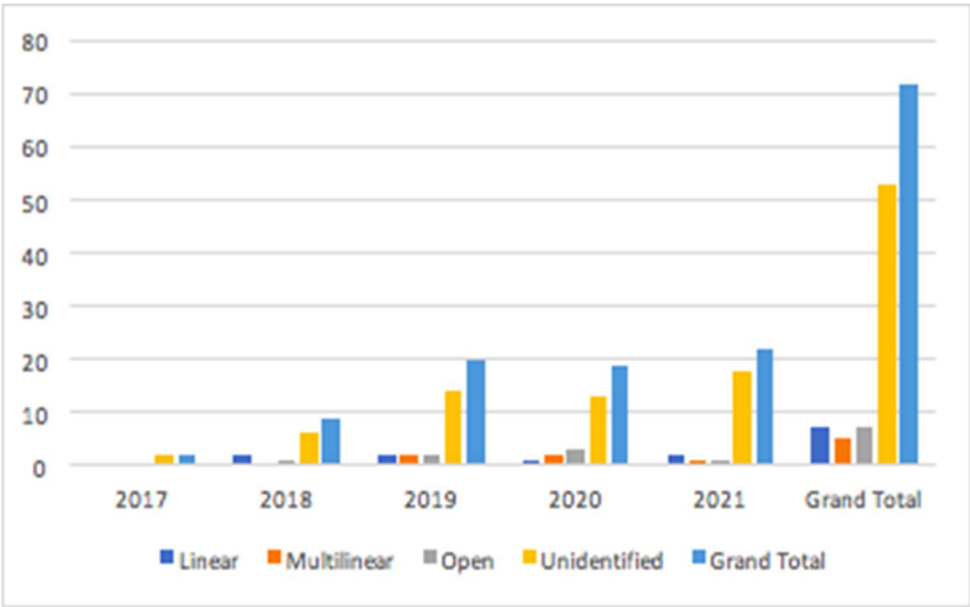

Figure 4. Representation of escape room design measured by year

Distribution of escape rooms by year and by simulation experience

Most of the escape room articles were taken from 2021 (Number: 22; Percentage:30.5%) and closely preceding was 2019 (Number: 20; Percentage:27.8%) and 2020 (Number: 19; Percentage:26.4%). Fewer studies were found from 2018 (Number: 9; Percentage:12.5%) and 2017 (Number: 2; Percentage:2.8%), and a possible reason will be acknowledged in the discussion. As well, in total, 42 or 58.3% of the escape rooms were real, 17 or 23.6% unidentified, 11 or 15.2% digital and 2 or 2.8% mixed, however, more digital escape rooms were identified in 2021, and this will be discussed later. The following table and figure depict this information.
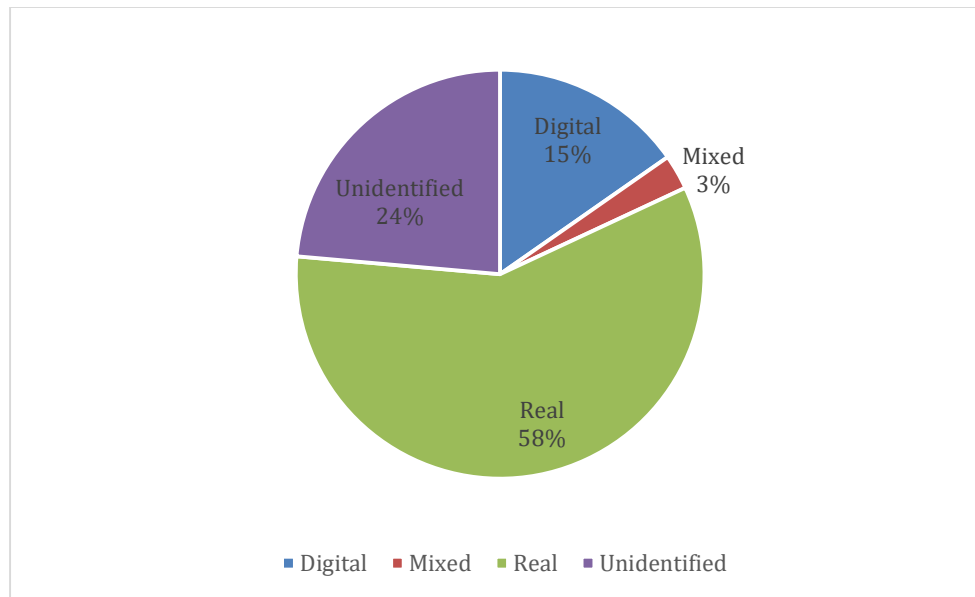
Figure 5. Representation of simulation experience measured by year

Discussion

Escape rooms are a newer concept and have started being integrated into aspects of medical education. Table 2 and Figure 1 illustrate the fields of medicine that our selected 72 articles contained. The lower percentiles consist of the areas: radiology, dermatology, surgery, core medical training, non-technical, genetic analysis, obstetrics, internal medicine, mental healthcare, patient safety, gastroenterology, infection prevention, dentistry, chemotherapy, and nutrition education, and this may indicate the recent divergence of escape rooms. However, based on our assessment, escape rooms are more commonly used for nursing education, emergency medicine, pharmacy, and interprofessional healthcare. This may be because these fields required essential skills such as *"communication", "team-building", "multi-tasking", "critical thinking"* and *"rapid recall of extensive medical knowledge"* [28], [32], [44], [45] and that escape rooms are an engaging method that provides a safe, simulated environment to build and enhance these skills.

Furthermore, Table 3 and Figure 2 signifies not only the importance of teamwork and collaboration skills in the four medical categories in the previous paragraph, but for all other categories too (as all identified escape rooms were grouped based), and it establishes the magnitude of teamwork in medicine and the necessity of implementing it into medical education.

From Table 4 and Figure 5, we are provided with trends linking the type of escape room design with the year. From the total (row), we understand that for all identified designs, there was an equal number of linear and open escape rooms but fewer multilinear rooms. This may be due to the different objectives of the escape rooms. According to Anson Dinh's escape room, their objective was *"to improve the clinical knowledge and teamwork skills of medical students"* [37], and

therefore it didn't require a multitude of parallel puzzles, as they intended to strengthen the core knowledge. Similarly, another linear escape room stated that they intended *"to reinforce EM knowledge and professional skills in a fun, team-based, "escape room" style game."* [46] Contrastingly, in an exemplary multilinear escape room, their *"team-based simulation of an escape room successfully reinforced (their) hospital's patient safety priorities",* alluding to their objective being to simulate real circumstances through a *"complex active learning session".* [27]

Additionally, to elaborate on the distributions of escape rooms by year, the total (column) signifies a general increase in the articles published about escape rooms from 2017 to 2021. This may represent the accumulating interest in serious games and escape rooms for medical education. It demonstrates vast success in the modern era and serves as a new and innovative way to support learning.

Moreover, the further categorization, including the simulation experience, further denotes significance. Best illustrated by figure 4, there are trends concerning whether the escape room is digital or real. Up until 2021, there was a standard increase in the number of real escape rooms and no increase in the number of digital escape rooms. However, in 2021, the number of real escape rooms has not yet peaked as time remains for more projections, while the number of digital escape rooms is greater than the other years. Thus, it may be interpreted that the influence of the unfortunate calamity of covid-19 has encouraged the digitalization of escape room games to promote the vital medical objectives in an alternative environment. To verify this, more research should be conducted on whether covid-19 is the main contributing factor to the digitalization of escape rooms for education and how this technique compares in efficacy to real, physical escape rooms.

Conclusion

Therefore, gamification is a concept that aligns with digitalization and the modern era and creates a suitable and enjoyable method of education. The field of serious games has been integrated into learning strategies, and one approach is the usage of escape rooms. We researched and categorized the first 100 hits, in google scholar, of escape rooms used for medical education and analyzed this data. To consolidate the usage of escape rooms in medical education, their general purpose has been to progress interpersonal skills: leadership, teamwork, etc. that are crucial in medical circumstances, to enhance critical thinking and the capability of working under pressure, to solidify key knowledge to support rapid recollection of medical information and applications, and to manage stress to increase confidence and motivation for the student's future careers. From our results, escape rooms have the potential to expand in medical and all education and are promising alongside the progression of technology in the future.

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