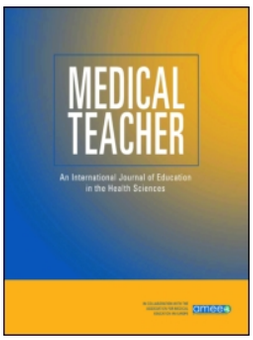

Medical Teacher

ISSN: 0142-159X (Print) 1466-187X (Online) Journal homepage: https://www.tandfonline.com/loi/imte20

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To cite this article: Oscar Rosenkrantz, Theo Walther Jensen, Senay Sarmasoglu, Sophie Madsen, Kristine Eberhard, Annette Kjaer Ersbøll & Peter Dieckmann (2019): Priming healthcare students on the importance of non-technical skills in healthcare: How to setup a medical escape room game experience, Medical Teacher, DOI: 10.1080/0142159X.2019.1636953

To link to this article: https://doi.org/10.1080/0142159X.2019.1636953

MEDICAL TEACHER
https://doi.org/10.1080/0142159X.2019.1636953

Priming healthcare students on the importance of non-technical skills in healthcare: How to setup a medical escape room game experience

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ABSTRACT

Background: Non-technical skills (NTS) are essential for healthcare professionals. Earlier the students are made aware of this, the more time they have to acquire these skills. Escape rooms have been introduced in the medical literature but a detailed published manual on setting up and running such a learning modality is lacking. The purpose of this paper is to describe the use of an escape room to create learning opportunities, including detailed instructions, as well as an evaluation from two settings.

Methods: A medical escape room focusing on NTS was developed and run in two different settings: a university summer school – EMSS17, and an international healthcare congress – EMS2018. Questionnaire data investigating entertainment value, self-evaluated use of NTS and ideas for further use of the escape room concept was obtained. Further, video analyses were conducted to triangulate self-rated analyses.

Results: Majority of the participants found the escape room psychologically safe and enjoyable and would recommend the concept to other students and healthcare professionals. Video analyses showed the same tendencies regarding the use of NTS as reported by participants.

Conclusions: This paper presents a fully applicable escape room manual, ready to implement, adapt, and modify. Evaluation data support the proof of concept.

Introduction

Non-technical skills (NTS) are essential for healthcare professionals. Studies support the positive effects on patient safety, efficiency, and caregiver satisfaction (Gordon et al. 2012; St Pierre et al. 2017).

Using NTS requires an understanding of complex concepts. In this regard, there are potential benefits in game-oriented, out of context exercises (Dieckmann, Glavin, et al. 2016). Considering the changing expectations of the "generation Z". The construct is defined differently in different papers – we work with the definition that sees those, who are born mid towards the late 1990s (Moore et al. 2017). Generation Z students, according to this paper, prefer innovative education styles such as gamification, which might improve their motivation and might expect catering to the information-processing strategies of current healthcare students. Out of context exercises can support psychological safety among students, as no patients' health is at stake and the pressure of performing as a medical expert, is significantly reduced. In addition, game-oriented teaching concepts may change some of the preexisting hierarchies and group dynamics, providing new learning opportunities (e.g. the less outspoken might become more active). As NTS are applied already in different contexts, taking NTS concepts out of their original context will also help acquisition in a generalizable way (Dieckmann, Glavin, et al. 2016).

Practice points

- The escape room felt psychologically safe and was enjoyable.
- Fully applicable escape room manual is provided.
- Evaluation data supporting proof of concept is provided.

In this paper, we introduce the Medical Escape Room Game Experience (MERGE) as an exercise that can be used to create learning opportunities for healthcare students and professionals in NTS. The pedagogical arena in which an escape room plays is Edutainment. Edutainment is centered around the use of entertaining elements to move learners towards increasing motivation and enhanced learning outcome (Broudo and Walsh 2002; Spedding et al. 2013; Jarvin 2015). These pedagogical approaches revolve around the idea that education should involve entertaining elements to boost participants' knowledge and motivation toward the educational subject. Escape rooms could be a valuable addition in this canon of methods. The MERGE teaching concept combines the educational elements mentioned above and provides a potentially valuable supplement for existing teaching concepts.

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Supplemental data for this article can be accessed here.

Modern competency frameworks (e.g. CanMEDS) require more than "just" the healthcare expertise, e.g. skills in collaboration and communication (van der Lee et al. 2013; Jilg et al. 2015; Voll and Valiante 2017). Therefore, these skills are an integrated part of what is expected from healthcare professionals today, and they need to be taught. The earlier students are aware of these issues, the more time they have to acquire them. If these skills are established as relevant parts of being a healthcare professional from the beginning (Reeves et al. 2012; Aase et al. 2013), they can possibly prevent the building of silos and tribes that seem to influence healthcare education from the beginning (Dieckmann 2009; Margalit et al. 2009). Other studies emphasize the benefits of whole task training over part-task training, where the different aspects of learned abilities need to be combined at a later point in time (Wickens et al. 2013). This means that the ongoing strategy focusing on training the technical aspects of healthcare professionals first and then human factor aspects later, might not be effective in supporting patient safety and that instead educational approaches that combine those aspects from early on in any healthcare professionals' career are needed.

The term "escape room" describes settings where teams of participants solve puzzles and riddles in a closed space with a particular theme to achieve predetermined goals, in a limited amount of time (Nicholson 2015). These exercises are described as "experiential at their core and appeal to players looking for a non-traditional game" (Wiemker et al. 2015), and thus seem to fit especially learners from "generation Z". The concept has shown to be a popular entertainment exercise. Recently, the concept has caught the attention of corporations as a team-bonding experience (Wiemker et al. 2015; Hagerty 2017).

In the medical literature, the use of an escape room has been described for different purposes: Six related studies have been published. Zhang et al. used a commercial escape room as a team-building exercise among a small group of young emergency medicine physicians, who found the experience positive. (Zhang et al. 2018). In a rural medical center college, Connelly et al. used an escape room as a recruitment tool to nursing education (Connelly et al. 2018). Friedrich et al. successfully used debriefing while implementing an escape room in interprofessional education curriculum (Friedrich et al. 2018) and published a "Design Guidebook", a general introduction to escape rooms focusing on collaboration in patient care (Friedrich 2018). Adams et al. tested knowledge of nurses in an escape room (Adams et al. 2018). Kinio et al. looked at the impact on pre-graduates' motivation, satisfaction, and engagement in CanMEDS and report that about half of their participants wanted to see the concept integrated into the medical curriculum (Kinio et al. 2018). The study reported an endorsement of only 53.8%. This might suggest that not all participants find the concept that appealing. More data is needed to explore if the concept can appeal to a broader audience. Furthermore, the use of an escape room has been described for teaching about diabetic patients (Eukel et al. 2017) and cardiovascular medications (Hermanns et al. 2017). Lastly, Brown et al. describe the use of escape room concepts within a high-fidelity simulation setting for nurses (Brown et al. 2019).

This paper provides detailed instructions on how to build the MERGE and how to use it in a teaching session to facilitate the learning of NTS. Further, this paper also provides evaluation data from two settings as proof of concept. Finally, we discuss the further use and development of the concept.

Methods

The MERGE concept

A 28-page manual describes essential material for running a session from start to end. The manual contains pictures and text instructions for setting up the room, the riddles and hints, the briefing before entering the session, scenario lifesavers (Dieckmann et al. 2010), and for re-setting the room. The manual was developed iteratively with pilot testing and refinements of individual elements. The full manual is provided in Supplementary Appendix 1 and a budget in Supplementary Appendix 2, where all expenses are summarized. The MERGE was run in two settings with participants of rather different characteristics to explore its feasibility in different contexts and with different relevant participants. Hence the main focus is "generation Z" participants. Including a broader audience enables arguments on feasibility of using the MERGE model for different groups. Data were handled and analyzed separately with some explorative comparisons.

All sessions were run in English. The MERGE was designed to apply NTS in a complex team-based situation. All riddles had a medical aspect to them, e.g. simple electrocardiography interpretation or basic knowledge about the Airway, Breathing, Circulation, Disability, Exposure (ABCDE) approach (Thim et al. 2012). Riddles were deliberately kept simple in medical terms to keep the focus on NTS. Participants were not reminded about the aim of using NTS before nor during the session. Anaesthesiologists' Non-Technical Skills in Denmark (ANTSdk) was used as NTS framework, comprising four major categories (situation awareness, decision making, team working, leadership) each containing three to five elements (Jepsen et al. 2016).

The narrative

The narrative was that a zombie-like virus had spread throughout the world despite an (unsuccessful) attempt to contain it with nuclear weapons. A professor had developed "The Cure" and hid it in his bunker - the room, in which participants solved the riddles. The objective of the participants was to get "The Cure" out of the room faster than the other teams and that the fastest team would be announced after all the sessions ended, thereby adding a competition element between the different teams to increase engagement. No prize was presented to any team.

Setting the scene

The room in which participants were solving the riddles was darkened, with enough light for basic orientation. It was set up to create a bunker-like environment with old

furniture, books, and paintings illustrating a library, and conical flasks and test tubes with colored and liquid nitrogen illustrating a laboratory. Participants entered the room. A video-sequence on a TV was started, explaining the breakout of the virus including a hint leading to the first riddle. The end of the video-sequence marked the beginning of the session with eight riddles, connected by hints, eventually leading to the opening of combination locks revealing "The Cure" and ending the session.

MERGE at EMSS17

The MERGE was first conducted as part of the Emergency Medicine Summer School 2017 (EMSS17), Copenhagen, Denmark. This was a seven-day international summer school for pre-graduates with interest in emergency medicine, organized by the Students' Society for Anesthesiology and Traumatology (SATS), Copenhagen, Denmark. Forty-nine students in eight groups of five to seven participants each, participated on the same day. Two identical Escape Rooms were setup to run simultaneously, this was done for logistical reasons to enable more teams to participate. All participants only experienced the concept one time in one of the two rooms. The MERGE operators were responsible to guide the participants through a session with the necessary instructions and guidance. All operators were involved in the development of the concept and were very familiar with the procedures as described in the manual. Prior to their participation in the MERGE, summer school participants attended a variety of workshops including a one-hour session on NTS among healthcare professionals (Kristensen 2017a, 2017b).

The EMSS17 sessions were held at the Copenhagen Academy for Medical Education and Simulation (CAMES), Herlev Hospital, Denmark. The two 15 m^2 high fidelity simulation rooms used provided a one-way "see-through" mirror to the connected control room. An operator controlled the sessions from the control room while following the participants' actions with an audio system and video cameras from three different angles of the room and through the one-way mirror.

The MERGE at EMS2018

The second session was conducted to explore the feasibility of using the MERGE with healthcare professionals in general, as opposed to pre-graduates from the first sessions. This conduct took place at the European Emergency Medical Services Congress 2018 (EMS2018), Copenhagen, Denmark. This international congress included approximately 1500 international delegates, with a wide variety of roles and professions within healthcare. Delegates could sign up in teams of five to participate (EMS2018 Copenhagen 2018). The last riddle of the MERGE from EMSS17 was removed at EMS2018. This modification was implemented for several reasons: Firstly, the content of the riddle referred to a workshop held at EMSS17. Secondly, solving the riddle did not entail possession of central knowledge or skill of the typical EMS2018 conference delegate. Lastly, for logistical reasons to ensure sufficient time for each team. The possibility for modified individual riddles to suit the relevant participants is further elaborated in the manual.

At the EMS2018 congress, the sessions were held in a 30 m^2 conference room with AV-equipment (i.e. webcam, speaker and computers). A group of three "operators" controlled the sessions from outside the room while following the participants' actions in real time through webcam and audio connection.

Data collection and study design

The evaluation study was designed as a qualitative triangulated observational study based on evaluation data. Data were collected from four sources, three at EMSS17 (post-session questionnaire, video recordings, and web-based questionnaire) and, to explore the use of the concept in other participants than pre-graduates, one at EMS2018 (web-based questionnaire). Participation was voluntary, and the use of participant data was mandated by written consent. If one person in a team did not consent to participate, the data of the whole team were excluded. To gain insight into the subjective experience of participating in the sessions, we used questionnaires that allowed to easily collect the data from all participants in an efficient manner. To increase the validity of these measures we triangulated the data with separate assessments of raters that described core issues that happened in the room. Raters were not aware of how the participants themselves rated the use of NTS during their session.

At the end of each session at EMSS17, all participants were given a post-session questionnaire regarding which three NTS skills were used most often, who they considered team leader, and who found the first and the last hint in the session (see Supplementary Appendix 3). Participants were given fifteen minutes to fill in the questionnaire in paper form. Data were excluded from the analysis if responders gave an inconclusive response to the question "Rank the top three non-technical skills" (e.g. checking the boxes with crosses instead of numbers). To triangulate this self-reported data, session videos were recorded during the entire sessions (Short et al. 2009). Timelines of events were constructed from the video by three raters. Participants' self-evaluation was compared to the raters' view of the videos. Raters had no time limit and were allowed to scroll back and forth in the recordings. Before starting the video rating, they were asked to read a list of relevant identified biases for rating and commenting (see Supplementary Appendix 5).

Video recordings were used to explore possible connections between the speed of solving the riddles and dynamics in the team (having a clear team leader or not).

Five months after EMSS17, all participants received a web-based questionnaire via SurveyXact® concerning their experience as team members, entertainment value, self-evaluated use of NTS and thoughts about the further use of an escape room (see Supplementary Appendix 4). The different questions were answered using seven-point Likert scales, multiple choice, and open-ended questions. Participants at the EMS2018 MERGE received the same web-based questionnaire one month after participation. In both web-based questionnaires, all data were excluded from the analysis if one or more obligatory questions were

not answered (see Supplementary Appendix 4). Due to logistical reasons surrounding the events, participants from both conducts received the questionnaire in considerably different timings.

Data analysis

All video recordings from EMSS17 were watched to identify time marks for several key events: when a team solved the first riddle, the fourth riddle (midpoint) and finished the session. Full recordings from the fastest and the slowest team were analyzed by three raters of the research group separately according to a predefined manual, asking raters to identify an overall strategy to work through the situation and a possible team leader, rank the top five most used NTS and to obtain a timeline for riddle one, four and eight (Supplementary Appendix 5). This allowed for data triangulation between participants' self-ratings and external raters' views.

Ethical approval

No healthcare data or identifiable personal data was collected or stored, and the data protection agency was not waived. The Danish Ethical Committee waived a formal review of the study, as no patients were involved [case number: 17040458]. Further, all researchers followed the Declaration of Helsinki for Ethical Principles for Medical Research Involving Human Subjects.

Results

At EMSS17, all 49 attending pre-graduates from eleven countries participated and at EMS2018, 29 delegates from seven countries participated.

Post-session questionnaires at EMSS17

The post-session questionnaire from EMSS17 reached a high response rate ($n = 38$; 78%). The questions concerning participants' view on the team leader role and on who participants thought solved the first and last riddle, had a slightly lower response rate (67% and 71% respectively). One team of five participants was excluded due to lack of consent, four responses were excluded because participants checked the boxes with crosses instead ranking using numbers when answering the first question "Rank the top three non-technical skills", and two participants did not fill out the questionnaire at all.

All NTS were reported as used by one or more participants during the EMSS17 MERGE. "Gathering information" and "Exchanging information" were the NTS aspects that were mentioned most often (Figure 1).

The responses concerning who the participants' saw as the team leader and who the participants thought solved the first and last riddle, did not show any tendencies. Further analyses were not merited in this study, as the dataset was not comprehensive enough to make conclusions in either direction.

Video recordings of EMSS17

Video recordings had a total number of missing values of 25% (two of eight videos). Most sessions were recorded (seven of eight), with a total video duration of approximately four hours and fifteen minutes. One video session was lost due to technical issues and one was not recorded due to lack of consent.

The videos allowed to measure the overall time each team used to solve the riddles (measured from the end of the introduction video to solving the last riddle). The fastest team used 23 min and the slowest 41 min. The duration for the other four teams recorded clustered at 30 ± 3.5 min.

Video recording revealed that four teams used "trial and error" to determine the last digit of at least one lock. Participants were not introduced to any rules regarding this. In one instance this resulted in a discussion in the team about whether or not this was acceptable according to the rules of the game.

Data did not show any tendencies of connection between the time used to solve the first riddle, the midpoint riddle and to finish the MERGE. Furthermore, it was not possible to show an overall connection between the time used to finish the MERGE and whether a team agreed on having a leader or not (Figure 1).

Comparison between post-session questionnaire and video analysis at EMSS17

Comparing which NTS were rated most frequently in the post-session self-reported data and the video analyses, of

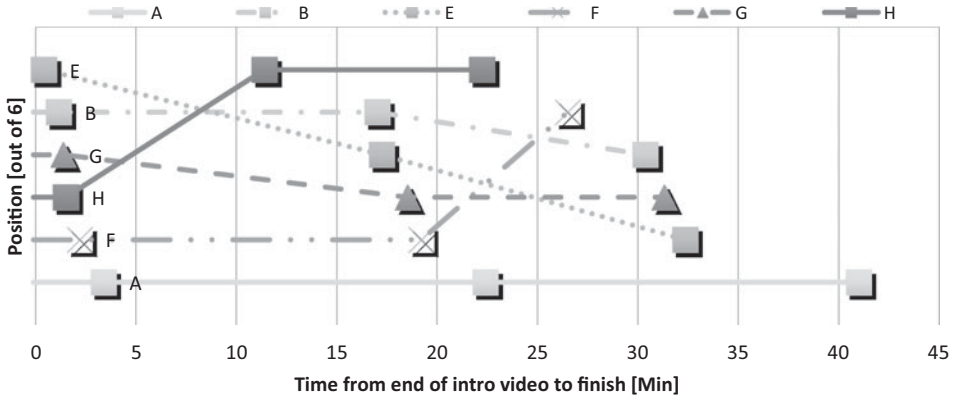

Figure 1. Timeline derived from video analysis of the MERGE at EMSS17. Each point indicates, in order, time for: the first riddle solved, the fourth riddle solved (lock 1), and finishing the MERGE (lock 2). Icons of each graph represent the leadership status of the team. Square: agreement within a team on who is team leader; triangle: disagreement within a team on who was team leader; cross: agreement within the team that no team leader was present. Team leader information was derived from the post-session questionnaires.

Table 1. Frequency of highest ranked NTS used by the fastest and the slowest teams at EMSS17 given by numbers (*n*) and proportion (%).

NTS skill	Video raters [*n*, %]		Participants [*n*, %]	
Gathering information	3	50%	4	31%
Recognizing and understanding contexts	0	0%	1	8%
Choosing, communicating, and implementing decisions	0	0%	2	15%
Reassessing decisions	1	17%	0	0%
Exchanging information	2	33%	4	31%
Prioritizing	0	0%	2	15%
Total	6	100%	13	100%

Three video raters of the research group rated the use of NTS by ranking the top five most used NTS in the two sessions. Participants ranked their own use of NTS by ranking the top three most used NTS. In this table the highest ranked NTS by each video rater and each participant, receptively are presented.

the fastest and slowest teams, showed that in both data sets *Gathering information* and *Exchanging information* were rated highest and second highest, respectively (Table 1).

Web-based questionnaire from EMSS17

Questionnaires from EMSS17 had a high response rate ($n = 41$; 84% response rate) on all questions. One team of five participants, was excluded due to lack of consent, and three participants did not respond. Overall, the responses were almost unilaterally positive, rating high on a seven-point Likert scale (Table 2). One person at the EMSS17 rated the workshop substantially more negative than all others (Table 2). Notably, the vast majority of the participants agreed or completely agreed that they: Enjoyed participation (98%), felt psychologically safe (90%), found the MERGE workshop motivating to train NTS (78%) and would recommend the concept to other students/healthcare professionals (85%).

Web-based questionnaire from EMS2018

Questionnaires from EMS2018 had a medium high response rate ($n = 18$; 62% response rate). One participant was excluded due to an incomplete questionnaire, and ten participants did not respond. Overall, the responses were unilaterally positive, rating high on a seven-point Likert scale (Table 2).

The majority of congress respondents agreed or completely agreed that they: Enjoyed participation (100%), felt psychologically safe (100%), found the MERGE motivating to train NTS (83%) and would recommend the concept to other students/healthcare professionals (90%).

Discussion

This paper describes the concept of using an escape room in medical education to a degree that it can be replicated (Supplementary Appendix 1). The manual can easily be modified to match the specific requirements for other institutions if needed. This paper also provides evaluation data from two different settings that show the feasibility and perceived value for participants in different settings. Further, an estimate of costs and a model for how to practice and evaluate the use of NTS with an escape room is presented. Both pre-graduates and healthcare professionals with mixed backgrounds found the MERGE enjoyable, felt safe and were motivated to train NTS using the MERGE. Looking at all the sessions combined, all NTS were used during the MERGE by students as well as professionals respectively and thus MERGE offers the potential for learning these skills. However, participants in each session saw different NTS aspects as relevant within their session, indicating a different interpretation of the NTS terms used. Gathering information and exchanging information were the two aspects used most, as shown by self-analysis and external evaluation of video material. Given the nature of the task – orienting oneself in an unfamiliar, strange environment, solving riddles in a team, the use of these aspects has high plausibility.

The data show that the concept can provide learning opportunities that different groups of participant's value. The MERGE allows for discussing all NTS skills, and also, why some of them might be perceived as more relevant than others and by whom. Whether participants' enjoyment of the session and their perceived learning will impact clinical practice, and whether such changed practice has a relevant clinical effect is beyond the scope of this study.

Debriefing to foster the learning potential even further

To use the full potential of the MERGE, it would be ideal to debrief the teams afterward, as debriefing allows for stimulating reflections about educational experiences (Steinwachs 1992; Fanning and Gaba 2007). This was not feasible in the settings in which the concept was tested, but there seem to be no good reasons, why the MERGE could not be debriefed like similar "non-medical" exercises (Dieckmann, Zeltner, et al. 2016), or, indeed, like regular patient simulation scenarios. The different perceptions of the importance of individual NTS elements would make valuable starting points for discussions of these concepts.

> Further, the video analysis from EMSS17 emphasized the potential for debriefing. The video raters independently saw similar aspects as the participants themselves. The similar conclusion from both external analysis and self-ratings supports the assumption that an escape room experience could trigger relevant reflections around NTS.

Implications of the results

The tested manual in Supplementary Appendix 1 provides guidance for trainers and researchers to set up the MERGE. They could rebuild the room step-by-step or use the room described as the inspiration for a new escape room. As shown in both test settings, the MERGE can stand on its own, but can also work in combination with other teaching

Table 2. Web-based questionnaires summary of participants' engagement given by numbers (*N*) and percentage (%).

Questions	Completely agree	Agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Disagree	Completely disagree	Not applicable	
"I enjoyed participating in the medical mystery room" EMS2018	17	1	0	0	0	0	0	0	[*n*]
	94.4	5.6	0.0	0.0	0.0	0.0	0.0	0.0	[%]
"I enjoyed participating in the medical mystery room" EMSS17	30	10	0	0	1	0	0	0	[*n*]
	73.2	24.4	0.0	0.0	2.4	0.0	0.0	0.0	[%]
"I felt psychologically safe in the team environment during the medical mystery room" EMS2018	15	3	0	0	0	0	0	0	[*n*]
	83.3	16.7	0.0	0.0	0.0	0.0	0.0	0.0	[%]
"I felt psychologically safe in the team environment during the medical mystery room" EMSS17	28	9	4	0	0	0	0	0	[*n*]
	68.3	22.0	9.8	0.0	0.0	0.0	0.0	0.0	[%]
"Using the medical mystery room to train non-technical skills was motivating" EMS2018	11	4	2	1	0	0	0	0	[*n*]
	61.1	22.2	11.1	5.6	0.0	0.0	0.0	0.0	[%]
"Using the medical mystery room to train non-technical skills was motivating" EMSS17	16	16	7	1	0	0	1	0	[*n*]
	39.0	39.0	17.1	2.4	0.0	0.0	2.4	0.0	[%]
"I would recommend the concept of an escape room to other healthcare professionals" EMS2018	14	2	2	0	0	0	0	0	[*n*]
	77.8	11.1	11.1	0.0	0.0	0.0	0.0	0.0	[%]
"I would recommend the concept of an escape room to other healthcare professionals" EMSS17	22	13	3	1	1	0	1	0	[*n*]
	53.7	31.7	7.3	2.4	2.4	0.0	2.4	0.0	[%]

$N = 41$ for EMSS17 and $N = 18$ for all questions.

sessions and formats. Relevant briefings (regarding procedures and relevant NTS content) should facilitate that participants see the concept as a relevant learning setting.

Using MERGE for different groups of participants

We found that there was a slightly more positive response regarding enjoyment, psychologically safety, motivation to use MERGE to train NTS and will to recommend the concept to other students/healthcare professionals among healthcare professionals than among pre-graduates. It is possible that the concept has appeal beyond the initial hypothesized student audience. With the current concept, it was not challenging to modify riddles or learning objectives as was done between EMSS17 and EMS2018. Further, the MERGE can be used with different focus points and help to address a variety of learning goals.

Pedagogical considerations

As with all educational interventions, it is essential to consider the pedagogical approach on how the MERGE should be used and what purpose it can serve. As it involves many different NTS, it can also be used to create learning opportunities around those. Facilitators can decide, which of the NTS they would like to focus on specifically, but issues around information gathering and exchange seem to be a natural focal point.

The concept can be used in at least two ways. First, to sensitize participants to the importance of NTS and how those are linked to task-related work (e.g. considering, how communication patterns influence the recognition and implementation of solutions to problems). The participant's experience how these constructs support or hinder solving the tasks at hand and thus might be more willing and interested to learn around these constructs. The debriefing could focus on investigating such links. The second approach concerns training and application possibilities for specific NTS discussed previously in different parts of a course (e.g. after the discussion of different leadership styles in a workshop, the MERGE could be a setting, in which the newly learned skills are applied). Participants, in this case, try to apply, what they learned before in the room. The debriefing could focus on investigating how closely the leadership style put into practice came to the models taught and what effects the style was related to.

The fictitious character of the MERGE can open possibilities regarding increased psychological safety, where no one is in danger and where one can engage in a joyful challenge. On the other hand, the concept does not speak to all learners equally, as it is illustrated by the marked negative response by one participant at EMSS17. This implies the need to explain the learning potential of the MERGE to participants and elaborate relevant contribution to learning NTS. It also implies the need to consider alternative learning formats for different types of learners.

As an escape room experience is taken out of the context of healthcare, reflections are needed to help participants in bridging this gap. One possible strategy to do so would be a two-step approach. In the first step, the facilitator helps the participants to identify phenomena they noted during the MERGE (e.g. issues of hierarchy, group dynamics, decision making, information gathering). In the second step, the group can then investigate, to what extent these phenomena can occur in clinical practice and what kind of relevance they have there (e.g. how are decisions actually made in clinical settings, what are mechanisms indicate, who is leading a specific situation).

Escape rooms have another pedagogical value, it can easily involve pre-graduates as co-designers. They know the challenges of their peers, when getting in contact with actual clinical settings, and often have the creativity to translate those challenges into riddles in an escape room. The whole room can be seen as a metaphor for a complex and often opaque system, as healthcare is. In designing riddles for escape rooms, pre-graduates can learn a lot about how NTS and other clinical skills interact.

An interesting pedagogical consideration concerns the "breaking of the rules" by using a trial and error approach to the last digit at the locks, as reported for some groups.

In the interest of solving the problem at hand, this is a very effective approach, even, if it does not follow the rules of the game. This can make an interesting point of discussion and learning for the actual clinical practice: should you follow the rules or do what gets the job done? There is no clear answer to this question but can raise interesting points for reflections.

For the future application of this concept and accompanying manual, the authors consider it valuable to exchange user information to further revise the manual allowing for multiple application and relevant local modifications. In the manual, the relevant contact information for authors to exchange and revise the manual, is present.

Limitations

This study is the first to give a detailed manual for an escape room, including evaluation data about its feasibility.

It was, at times, challenging for the operators running the MERGE to keep an overview of the progress as many things happen at the same time in the darkened room. This, combined with technical errors, made it difficult to do time measurements. The duration of the work in the room depended not only on the performance of the team but also to a portion of luck of whether the complex interplay between riddles unfolded as planned. Careful documentation of unexpected events and necessary corrections might mediate some of the unwanted variability. These control challenges might have contributed to the unclear patterns in the timing of the riddle's solution between the teams. The current participants included in this study were the participants from EMSS17 and participants volunteering to try the MERGE at a congress. Both populations might have been particularly open-minded. The study might thus overestimate the value of the MERGE for the general target population. The questionnaire after EMS2018 was sent out after only 1 month, while the questionnaire after EMSS17 was sent out after 5 months. The prolonged period between EMSS17 and the questionnaire might have led to a more positive result, as the positive part of an event are more readily remembered over time (Walker and Skowronski 2009). Inter-rater reliability was not calculated between video raters before video analysis as the current paper is not aiming to validate any certain method for evaluating participants using the described concept. The video rater analysis is done as explorative conduct to understand if this modality is an effective tool to describe NTS dynamics NTS in the actions of participants. For broad use and for a more comparable way of evaluation it is recommended to use at least six raters and apply tests of inter- and interrater reliability. Measuring with this modality not applying these limits the general internal validity, which we accepted in this explorative stage of the research. The list of 15 biases, raters were asked to consider before video analysis, might have been too comprehensive and therefore difficult to remember while conducting the analysis. The raters were not expected to remember the collective number of biases rather we intended to create awareness of possible pitfalls when rating.

Conclusions

This paper presents a fully applicable medical escape room manual, ready to be implemented, adopted, and modified. The use of an escape room has potential as a setting to train and use NTS (i.e. situation awareness, decision making, team working, leadership). All NTS were used during the MERGE at two different settings. The MERGE was attractive to the participants, in entertainment value, perceived learning, and psychologically safety. All NTS were seen as relevant for solving the riddles in the MERGE and thus the concept offers reflection possibilities around NTS.

Acknowledgments

Left out to avoid identifying any of the authors prior to peer review.

Disclosure statement

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

Funding

The present work was financially supported by the University of Copenhagen's Innovation & Entrepreneurship student fund.

Glossary

Escape Room: The term "escape room" describes settings where teams of participants solve puzzles and riddles in a closed space with a particular theme to achieve predetermined goals, in a limited amount of time.

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