



Break out of the Classroom: The Use of Escape Rooms as an Alternative Teaching Strategy in Surgical Education

Anna Eva Kinio, MSc, ^{*,†} Laurence Dufresne, MD, ^{*,†} Tim Brandys, MD, FRCSC, ^{*,†} and Prasad Jetty, MD, FRCSC ^{*,†}

^{*}Faculty of Medicine, University of Ottawa, Ottawa, Ontario, Canada; and [†]Division of Vascular and Endovascular Surgery, The Ottawa Hospital, Ottawa, Ontario, Canada

OBJECTIVE: To implement and assess the impact of a Vascular Surgery-themed Escape Room on medical student motivation, satisfaction, and engagement in CanMEDS roles.

DESIGN: The authors designed an Escape Room combining Vascular Surgery objectives, knowledge-based problems and technical skills into Vascular Surgery-themed stations. Groups of 3 to 4 medical students participated in the activity. Data collected included time to escape, CanMEDS roles covered during the activity, debriefing interview session, and satisfaction survey.

SETTING: The Escape Room was installed at the University of Ottawa Skills and Simulation Centre at the Ottawa Hospital, a tertiary care center.

PARTICIPANTS: Medical students in their preclerkship years of study were invited to participate in the Escape Room. In total, 13 medical students completed the experience, divided into 4 groups.

RESULTS: Thirteen medical students divided into 4 groups participated in the Escape Room. Two teams used a collaborative strategy to complete the activity and successfully escaped with an average time of 53.6 minutes, whereas only 1 of the 2 teams completing the experience employing an individualistic strategy successfully escaped. Following the experience, 83% of participants stated that the experience motivated them to prepare beforehand and believed that the experience consolidated the knowledge that they had read. All the participants also reported that the experience encouraged the use of the CanMEDS communicator and

collaborator roles. As well, 76.9% of students mentioned that they enjoyed the practical exercises incorporated into the experience and 53.8% stated that they would like to see the Escape Room format included in the medical curriculum.

CONCLUSIONS: By combining knowledge-based problems, key learning objectives, technical skills, and CanMEDS themes into the Escape Room, the authors have developed a learning platform that may be more enjoyable and provide an adjunct to traditional didactic lectures. (J Surg Ed 76:134–139. © 2018 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: Escape Room, Gamification, Active learning, CanMEDS, Game-based learning

COMPETENCIES: Practice-Based Learning and Improvement, Medical Knowledge, Interpersonal and Communication Skills

INTRODUCTION

Despite significant advances in medical education in the past decade, didactic teaching remains a mainstay in Canadian medical and surgical education. However, many Canadian medical schools have implemented active learning strategies such as case-based learning and team-based learning to transform the learner from passive spectator to active participant. These methods have been shown to have beneficial effects for students across educational programs, with studies demonstrating improved grade point averages,¹ understanding of concepts,² increased positive student perception of learning material,³ and decreased course drop-out rates⁴ compared to students taught with traditional lecture-

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Correspondence: Inquiries to Anna Eva Kinio, MSc, Division of Vascular and Endovascular Surgery, The Ottawa Hospital – Civic Campus, 1053 Carling Avenue, Ottawa, ON K1Y 4E9, Canada.; e-mail: akini016@uottawa.ca

centered methods. Case-based learning, problem-based learning, and surgical simulations have become accepted components in medical education, and there has also recently been validation for game-based learning, or “gamification” of medical curriculum. Gamification involves the integration of game components into previously nongame teaching contexts.⁵ The value of gamification lies in its ability to engage and augment learning in the modern adult student. The medical community has largely embraced gamification as a complement to both resident subspecialty and student education. For instance, Thoracic Surgery residents in the United States who engaged in technical and knowledge-based gamified learning increased the use of their simulation training in order to compete against each other at a national meeting.⁶ Similarly, medical students who were involved in Jeopardy-style games compared to lectures on ectopic pregnancy rated their enjoyment, information retention, and faculty/student interactions higher than those involved in a teaching lecture on the same topic.⁷

Escape rooms are interactive games in which players are locked into a room and collaborate to solve a series of riddles and puzzles in order to escape from the room within a set time limit. Most escape rooms are purely recreational; however, educational escape rooms are becoming more popular with professional programs as a means to engage students in their learning environment, and encourage collaboration and social skill set development. Extensive data have been published on the benefit medical students obtain from active learning strategies, including educational games. However, due to the recent advent of escape rooms, there is a paucity of published information on the value of such educational games for medical and surgical education. Our study proposes to fill this knowledge gap and assess the impact of escape rooms on medical student learning, preparation, retention, motivation, and overall experience satisfaction. Ultimately, escape rooms could provide an exciting and engaging addition to medical education programs.

MATERIALS AND METHODS

Approval for the study was obtained from the Ottawa Hospital Research Ethics Board. The study design was a prospective educational study. Thirteen medical students in their preclerkship years at the University of Ottawa were divided into 4 groups to complete the Escape Room challenge. Participants were recruited via e-mail sent to medical interest groups at the University of Ottawa. The 13 participants who expressed interest in participating were then sent details of their group composition and schedule, as well as 6 *New England Journal of Medicine* (NEJM) articles covering

fundamental Vascular Surgery topics such as abdominal aortic aneurysms, carotid stenosis, intermittent claudication, and acute limb ischemia. Students were instructed to read through the material as preparation for the Escape Room.

The Escape Room stations were designed to test basic Vascular Surgery knowledge as well as technical skills such as ultrasound imaging, embolectomy, and endovascular wire manipulation (Fig.). It was installed at the University of Ottawa Simulation Centre using props, riddles, knowledge-based puzzles and problems requiring application of manual techniques to reinforce points read from the resource NEJM articles and CanMEDS competencies defined by the Royal College of Physicians and Surgeons of Canada. Participants were given 1 hour to complete the challenge, and were initially introduced into the Escape Room concept with a video that explained the scenario and the result that they would have to obtain to complete the Escape Room. The Escape Room itself was designed to resemble a clinic and included different stations, each representing a patient coming to the clinic and testing clinical knowledge or technical skills. Hidden objects and puzzles were also used to emulate a traditional escape room design. Multiple choice and fill-in-the-blanks-based problems tested knowledge and provided lock codes or further instructions to the participants when correctly answered. For example, participants were at 1 point asked to fill in the blanks on a page with the 6 well-known symptoms of critical limb ischemia. When appropriately filled, several highlighted letters provided the code for a lock. A box secured with 6 locks was sitting on a table in the center of the room and contained an aortic cross clamp. Opening this master box with lock codes obtained by finishing each challenge represented the successful completion of the experience. During the Escape Room experiences, 2 organizers were able to observe the participants' progress throughout the challenge behind a 1-way mirror and recorded the time to completion, the number of hints provided, and the team collaboration strategies used.

Following completion of the Escape Room, teams were asked to participate in a 15-minute debrief session during which they could ask questions about their experience and were asked to complete a survey assessing for experience enjoyment and motivation for preparation (Table). A follow-up e-mail was sent 2 weeks following the experience to assess for time spent reading and the use of supplemental preparation material for the Escape Room.

RESULTS

Thirteen medical students agreed to participate in the experience. The majority of the respondents were in their first year of medical study, and only 1 student

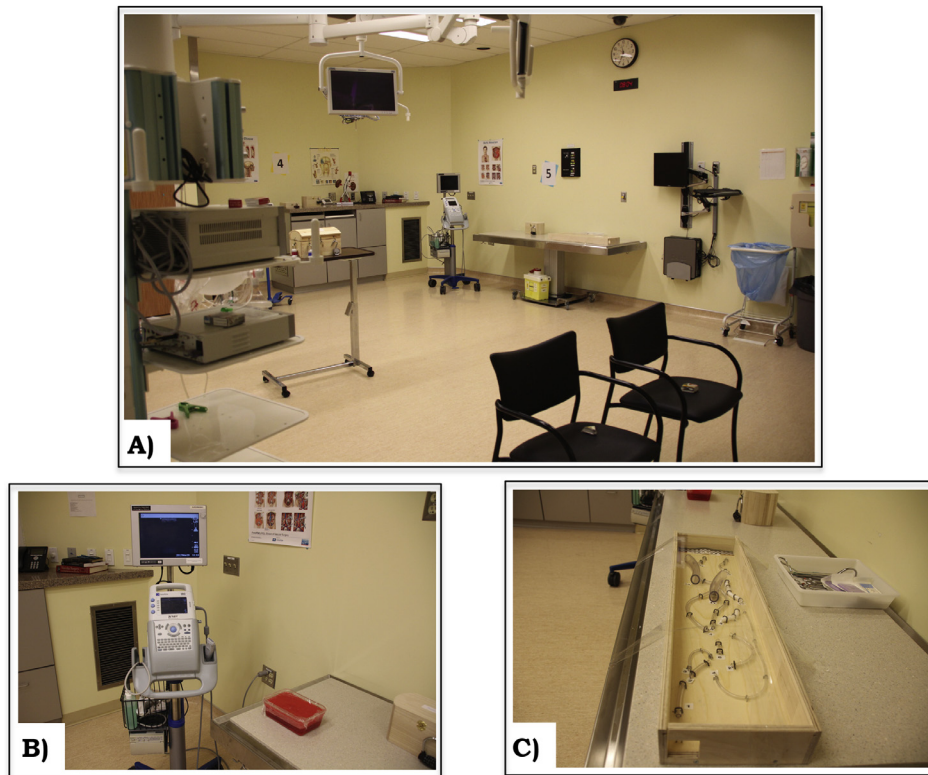


FIGURE. The Escape Room design and technical skills. (A) The Escape Room was set up to resemble a Vascular Surgery clinic at the University of Ottawa Skills and Simulation Centre. (B) Student knowledge was tested after using ultrasound to measure the dimensions of an “abdominal aortic aneurysm” suspended in the gelatin in the container on the right. (C) Students were asked to obtain keys using a wire to overcome obstacles in the endovascular board.

expressed having previous exposure to Vascular Surgery. Following distribution of the preparation materials, 83% of students said that they felt motivated to study and the average time students spent in reading the 6 assigned *NEJM* articles was 83.5 minutes. The average number of readings completed was 4 articles, although 2 students reported having used supplementary material to prepare for the experience in addition to the assigned material. Three of the 4 groups successfully escaped from the room by removing the aortic cross clamp from the locked box within the 60 minutes designated for the activity. The average time to escape was 56.8 minutes, indicating that teams had to collaborate at a swift pace to successfully complete the experience. Interestingly, 2 of the teams used a collaborative method to progress throughout the activity, essentially completing each challenge as a team, whereas the other 2 teams had members that individually completed challenges. Both of the teams using a collaborative strategy escaped, whereas only 1 of the teams using an individualistic approach was able to successfully escape from the room. Surprisingly, the unsuccessful team also tried to cut corners by breaking a lock and attempting to determine lock codes by trial and error.

During the debriefing session held following the Escape Room, 12 of the participants completed a postexperience survey. Interestingly, 75% of respondents said that they felt that the experience augmented their ability to retain course information and 92% felt that the format was appropriate for testing knowledge. With regards to the use of CanMeds roles during the experience, all of the participants felt that collaboration and proper communication were essential for completing the activity, and the majority of students felt that leadership had been encouraged through the activity. Importantly, 92% of students gained interest in Vascular Surgery following the experience and all of the participants enjoyed the experience.

DISCUSSION

Active learning, and particularly gamification of medical curriculum, has become increasingly employed in medical education. This change from the traditional didactic teaching method is largely due to the principles of adult learning theory, which emphasize the need for internal motivation, problem solving, and experience in the adult learning

TABLE. Survey Completed by Medical Students During the Debrief Session Following the Escape Room

Please mark your answers with a "X".

1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly agree

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Satisfaction | | | | | |
| Overall, I enjoyed this activity. | | | | | |
| This format was stressful. | | | | | |
| This format was an appropriate method for testing knowledge. | | | | | |
| Motivation | | | | | |
| This activity increased my interest in vascular surgery. | | | | | |
| I felt motivated to prepare for this activity. | | | | | |
| I read in other resources to prepare for this activity. | | | | | |
| Learning | | | | | |
| This activity increased my general knowledge in vascular surgery. | | | | | |
| This format assisted me in retaining course information. | | | | | |
| This activity helped me identify my weaknesses. | | | | | |
| CanMEDS | | | | | |
| This activity encouraged the use of communication skills. | | | | | |
| This activity encouraged the use of collaboration skills. | | | | | |
| This activity encouraged the use of leadership skills. | | | | | |

Suggestions for improvement:

Additional comments:

Students were also provided with the ability to ask questions and give verbal feedback on the experience.

process.⁸ While the correct use and theoretical mechanisms behind gamification remain unclear, the medical community has nonetheless embraced this new learning tool in the teaching of medical students and residents. The goal of the study was to gamify Vascular Surgery medical student curriculum by restructuring the traditional didactic lecture taught to medical students into an escape room format. Despite the preliminary nature of the results obtained, our experience reflected the basic tenets of successful gamification and emphasized the usefulness of the Escape Room model as an addition to the current medical curriculum.

According to Rutledge et al., successful gamification intrinsically motivates candidates to learn, which is

linked to longer self-study periods, more successful knowledge retention and application.^{5,9} This motivation in turn is affected by the gamified learning tool's ability to pose a significant but attainable challenge, the amount of freedom of choice the experience provides the participants with, and the amount of interaction between participants and their instructors.⁵ Our participants on average spent over an hour preparing for the experience during their curriculum-heavy preclerkship years, a remarkable outcome that demonstrates a considerable motivation to prepare for the Escape Room. It is also interesting to note that teams in which participants interacted regularly during the experience were most

successful in completing the challenge. In this sense, the goal of a successful gamified experience is to encourage collaboration and communication, 2 of the 7 CanMEDS roles defined by the Canadian Royal College that Canadian medical students must strive to master prior to graduation.

Escape rooms could also prove to be valuable tools in postgraduate medical education, as competency-based medical education increasingly focuses on the ability of graduates to apply competencies learned during their training to real-world scenarios with the use of entrustable professional activities. For instance, escape rooms could be designed to assess an individual's ability to manage a scenario that they might encounter during their practice. Attitudes that are vital in practice, for example, cooperation and the ability to ask for help from colleagues when required, could also be incorporated into an escape room and assessed. The amazing flexibility allowed in escape room design means that escape rooms could conceivably be used to assess any skill or attitude required in professional practice when tailored appropriately.

Ultimately, the experience will need to be repeated with a larger number of participants and groups in order to properly assess the Escape Room's usefulness as a learning tool and to assess its impact on student motivation and long-term knowledge retention. Given the current group format, it is unlikely that the Escape Room model designed for this study could be used to test an individual's fundamental knowledge. Even quantifying the collective knowledge of a group advancing through the experience is not currently possible, as a group that has difficulty advancing early in the experience might never gain exposure and, therefore, not complete all of the knowledge-based problems available in the Escape Room. This might be partially remedied by providing hints to groups that are unable to advance past an activity in the room or by incrementally increasing the difficulty of the challenges as groups advance through the Escape Room. However, despite these changes, the Escape Room will likely not rival the testing modalities currently used to quantify individual knowledge and competency. Nevertheless, it would be interesting to compare the learning and student preparatory motivation elicited by the Escape Room compared to a traditional lecture. Most likely, the Escape Room will find its usefulness as an adjunct instead of a replacement for traditional didactic teaching. Many of the study participants commented on this themselves, noting the potential use of an escape room experience in re-enforcing the learning following the completion of a unit such as Cardiology, where a month of didactic lectures could be followed by an escape room combining clinical and technical skills to engage them and summarize the unit

curriculum. Preclerkship students especially appreciated the hands-on practical stations included in the experience. As an additional benefit, our escape room garnered a significant interest in Vascular Surgery in students who had largely no knowledge or experience of Vascular Surgery prior to the experience. Given the decline in the number of Vascular Surgery Residency Program applicants in recent years, this early exposure to the specialty could influence a larger number of medical students to consider a career in Vascular Surgery at an early stage in their training.

Limitations of the study include the small number of participants, the lack of control group, and the fact that the evaluations tested the knowledge of a group instead of individual knowledge. Some groups did admit to dividing the reading up between members of the group, so that no individual had read all of the assigned articles. The experience also tested skills in a population naive to vascular procedures, so the usefulness of this is entirely to engage the students instead of testing their technical aptitude. Repetition of the experience for an entire class of medical students is questionable, as the process would be quite labor-intensive and could take days, during which earlier participants could share the stations and questions with their peers undergoing the experience at a later time. Lastly, the supervision of each group, requirement for a 1-way observation room and equipment, and the intellectual and physical labor involved in the creation of the Escape Room make it a labor-intensive and high resource process that may not appeal to medical educators.

CONCLUSION

Overall, the study authors were able to demonstrate the educational potential for escape rooms in medical training. By combining puzzles, riddles, and manual techniques into the room with key learning objectives, this pilot project created a learning experience, which is enjoyable and encompasses the tenets of adult learning theory to engage medical student learners in Vascular Surgery curriculum and CanMEDS role learning.

ACKNOWLEDGMENTS

Thank you to the University of Ottawa Skills and Simulation Centre, including Stephanie Jones, for providing a room and equipment for the Escape Room. Thank you to Dr. Allan McDougall for his advice on the study design and enthusiastic support. Thank you to Joanne Brennan for her assistance with protocol submission to the TOH Research Ethics Board.

REFERENCES

1. Dilmac O. The effect of active learning techniques on class teacher candidate's success rates and attitudes toward their museum theory and application unit in their visual arts course. *Educ Sci Theory Pract*. 2016;16(5):1587-1618.
2. Chamundeswari S, Bakiaraj S. Attitude towards and problems faced by teachers in the implementation of active learning methodology (ALM) in schools at the upper primary level in the Dharmapuri district. *Global Inst Res Educ*. 2015;4:57-61.
3. O'Brocta R, Swigart S. Student perceptions of a top 200 medication course utilizing active learning techniques. *Curr Pharm Teach Learn*. 2013;5:49-53.e2. Available from: Education Source, Ipswich, MA. Accessed November 9, 2016.
4. Felder R, Felder G, Dietz E. A longitudinal study of engineering student performance and retention v. comparisons with traditionally-taught students. *J Eng Educ*. 1998;87:469-480.
5. Rutledge C, Walsh C, Swinger N. et al. Gamification in action: theoretical and practical considerations for medical educators. *Acad Med*. July 2018;93(7):1014-1020.
6. Mokadam NA, Lee R, Vaporciyan AA, et al. Gamification in thoracic surgical education: using competition to fuel performance. *J Thorac Cardiovasc Surg*. 2015;150:1052-1058.
7. O'Leary S, Diepenhorst L, Churley-Strom R, Magrane D, et al. Educational games in an obstetrics and gynecology core curriculum. *Am J Obstet Gynecol*. 2005;193:1848-1851.
8. Orey M. Global text: emerging perspectives on learning, teaching, and technology. The Global Text Project. Zurich, Switzerland: The Global Text; 2010.
9. Van Roy R, Zaman B. Why gamification fails in education and how to make it successful: introducing 9 gamification heuristics based on self-determination theory. *Serious Games and Edutainment Applications, Vol II*. Cham, Switzerland: Springer; 2017. p. 485-509.

SUPPLEMENTARY INFORMATION

Supplementary data associated with this article can be found in the online version at <https://doi.org/10.1016/j.jsurg.2018.06.030>.