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ORIGINAL RESEARCH

Using an “Escape Room” toolbox approach to enhance pharmacology education

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ABSTRACT

Background: Faculty are encouraged to use a variety of teaching/learning strategies to engage nursing students. While simulation and games are now common, there were no reports in the nursing literature using an “escape room” concept. Escape rooms use an entertainment approach as teams engage in critical thinking to solve puzzles and find clues to escape a room. In the classroom setting, this concept is modified to solve a mystery by finding various objects through a series of puzzles to locate clues. Some of these games involve finding numerical clues to open locks on a box, such as a toolbox. The purpose of this study was to describe the use of a toolbox gaming strategy based on an escape room concept to help students learn about cardiovascular medications in a pharmacology course.

Methods: This pilot study employed a descriptive qualitative method to investigate an approach to pharmacology education. The sample consisted of first semester nursing students.

Results: Student responses to criteria-based questions resulted in three themes: engaging, teamwork, and frustration, related to using a toolbox scenario strategy as a pathway to learning.

Conclusions: This descriptive study yielded mixed results from the students who were frustrated by time constraints but engaged in the learning experience. Lessons are offered for future improvements.

Key Words: Undergraduate nursing students, Pharmacology, Teaching/learning strategy

1. INTRODUCTION

Faculty are encouraged to evaluate curricula to ensure core competencies are addressed and students remain engaged in the learning process. To this end, educators engage in a continual search for innovative ways to deliver course content. The demographics of today’s students include Millennials who represent the largest population (28.7%) in the United States^[1](U.S.) with estimates of 83.1 million Millennials compared to 75.4 million Generation Xers.^[1,2] Faculty are now expected to utilize a variety of teaching methods

to address diverse student needs and expectations. For example, pharmacology has traditionally been taught using a lecture approach with occasional case studies. Teaching pharmacology presents challenges to creating innovative and engaging learning experiences. At the same time, students often struggle to learn medications names and actions, calculate the medication dosages, and understand medication administration techniques. It is crucial that students learn the fundamental pharmacological concepts to deliver safe and effective care. In an attempt to address these challenges,

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a novel approach to reviewing the fundamental concepts of pharmacology was introduced in a baccalaureate pharmacology course at a university in the southern U.S. using an escape room concept to facilitate learning about cardiovascular medications. Escape rooms are gaining popularity in the U.S. with a focus on strategy, problem solving, and cooperation in an entertainment approach. The goal is for a team to work together to solve puzzles and find clues to escape a room. In the classroom setting, a similar concept was developed to solve a mystery by finding various objects through a series of puzzles to locate clues. The activity in this study involved finding numerical clues to open locks on the toolbox (see photos).

1.1 Background and significance

Faculty are encouraged to use a variety of teaching/learning strategies to engage nursing students from diverse backgrounds and mixed age groups. The literature reflects that simulation is an effective learning modality to enhance learning.^[3,4] Simulation is gaining popularity as a strategy that fosters a deeper understanding of didactic content.^[5] Studies have examined baccalaureate nursing students who participated in virtual simulation and compared them to students who did not participate. Those who participated in the virtual simulation demonstrated transference of knowledge which is a goal of nursing education.^[6] Other strategies, such as games, have been used to engage students in a fun way as a means to enhance learning.^[7,8] While simulation and games have been used in nursing education, no reports were found in the literature using an escape room concept. However, Xu and colleagues (2016) discussed a variety of teaching strategies used in nursing education. Although not an escape room concept, they reported using a “Jigsaw Classroom” followed by a debriefing session as an effective teaching and learning strategy.^[8]

The advent of interactive adventure games, such as escape rooms for adult entertainment have been increasing in popularity across the United States.^[9] A literature review of the database Academic Search Complete returned one article with the search terms escape room and education. The authors discussed EscapED, a framework in progress in the United Kingdom, for the purposes of providing interactive game-based learning experiences.^[10] Only two additional articles were found describing the escape room concept as a teaching strategy. One article described an escape room (“Dr. Nickelby’s Laboratory”) that was devised and implemented in a middle school class.^[11] Magiera (2015) discussed Break-out Edu, an immersive learning games platform, as a novel learning concept for teachers and students.^[12] However, there is a paucity of research of this type of activity used in

nursing education. The purpose of this study was to describe the use of a toolbox gaming strategy based on an escape room concept to help students learn about cardiovascular medications in a pharmacology course.

1.2 The learning activity

The escape room premise is a teaching/learning strategy to enhance student learning as they work together to solve puzzles. This hands-on, team-based approach to learning requires student engagement in a pre-arranged scenario, promotes communication and collaboration with each other, and utilizes critical thinking to solve a problem. We used the basic escape room concept on a space-limited scale by using a locked toolbox as the puzzle to be solved. Undergraduate pharmacology students were divided into teams of 4-5 and were given a toolbox with two padlocks (see photos) and various puzzles.

The scenario. A super hero theme was used; the Riddler and his nemesis, Batman, from the Marvel Comic Book series were the two main characters. Specifically, “The Riddler” theme was used to mark, the various items and props to draw the students’ attention to the steps needed to successfully open the toolbox and navigate inside the box to “solve the riddle.” Faculty explained the storyline to all of the student teams. The premise of the story was: the Riddler poisoned Batman with an unknown concoction which has affected Batman’s cardiovascular system.

The Process. Faculty created a toolbox for each student team. The objective of the game was to be the first team to present to the instructor the two opened padlocks with the correct medicine in order to save Batman’s life. The students were instructed to bring a device (smartphone or tablet) that had the ability to scan Quick Response Code or QR codes (barcodes); students were instructed to preload a free downloadable application to scan the codes. Specific verbal instructions on how-to play the game were given beginning with the objective, rules of the game, and an instructional team packet.

The Activity. Following review of the scenario and the rules, the activity began with the instructor handing a packet to each team. Each packet contained the letter from the Riddler, a reference page (to be utilized at some point in the activity), a word search puzzle with a coded message at the bottom, and two hint cards. In line with the escape room concept, pre-set hints were made available to the student teams. The hint cards could be used any time throughout the activity. The first puzzle was a word search puzzle, and the first hint was that they should be looking for antianginal drugs. Once the student teams found all 12 antianginals

in the word search, the unused letters (this was the second hint), formed a sentence when reading from left to right and top to bottom: “You should treat me with a healthy dose of MONA.” The students scanned the QR code, and it asked for a password. The password/answer code, MONA, from the first puzzle opened the second puzzle on their device.

There were four puzzles using this same format with the answers being passwords to progress until both locks were opened. These words developed a code that would be utilized to unlock the next puzzle that was online and could be accessed by a QR scan with their smartphone or tablet (they were made aware that at least one person from each team would need a device). The puzzle solutions and QR scans provided a progressive pathway toward achieving the objective which was opening the toolbox. Each QR scan led to a website with a locked entry that required the code to be decoded from solving the previous puzzle. Sometimes the codes unlocked the next online puzzle while other codes were for the locks on the toolbox. One of the first codes opened with the puzzle required dosage calculation skills, while the other puzzle required the conversion of a word to a number using an alpha-numeric conversion (A = 1, B = 2, etc.).

The Outcome. The toolbox contained the last puzzle and “medications” (candy) for Batman. This was a logic puzzle with a grid that was used to determine the color of the pill and the type of medication used. The students needed to determine the cardiac condition Batman encountered after being poisoned by the Riddler and the medication needed to remedy the cardiac condition. This final puzzle also had a scrambled letter section revealing the medication Batman needed (Amiodarone). The scenario was specifically constructed to identify antidote for the poison (the cardiac medication) that the Riddler used. Throughout the entire activity, course faculty observed the interaction among the group, but they did not provide any assistance or answer any questions. Students were given one hour to complete the activity – “solve the riddle and save Batman’s life.” When completed, the student teams were to bring the two opened locks and a white pill to the instructor to save Batman; however, no student team actually succeeded in the final quest.

Using an interactive game, such as the escape room-based toolbox, requires students to work collaboratively, communicate effectively, and think critically and analytically to solve problems by using the knowledge that they have learned in pharmacology. This activity required a higher level of thinking to be successful. The toolbox activity was set-up and performed using three separate pharmacology sections/classes. Following the toolbox class, a debriefing session was con-

ducted to elicit students’ perspectives of the learning activity. The goal of the debriefing sessions was to increase the students’ understanding of cardiovascular medications using the toolbox. It was anticipated that this experience would help prepare the beginning nursing student to use critical thinking and problem-solving skills in real-life patient encounters in an effort to prevent or decrease errors in the administration of cardiovascular medications.

1.3 Research questions

A descriptive qualitative approach was used to gather data relating to student perceptions of the toolbox experience for cardiovascular medication learning in an undergraduate pharmacology course. The research question was:

What are the students’ perceptions of their experiences of using a toolbox as an activity to learn cardiovascular medications?

1.4 Framework

Fink’s (2003) Taxonomy of Significant Learning was used to guide this study (see Figure 1).^[13] The Taxonomy of Significant Learning framework includes: learning how to learn, caring, the human dimension, integration, application, and foundational knowledge. In Fink’s textbook, Larry Spence (2001) stated, we won’t meet the needs for more and better higher education until professors become designers of learning experiences and not teachers (p. 1).^[14]

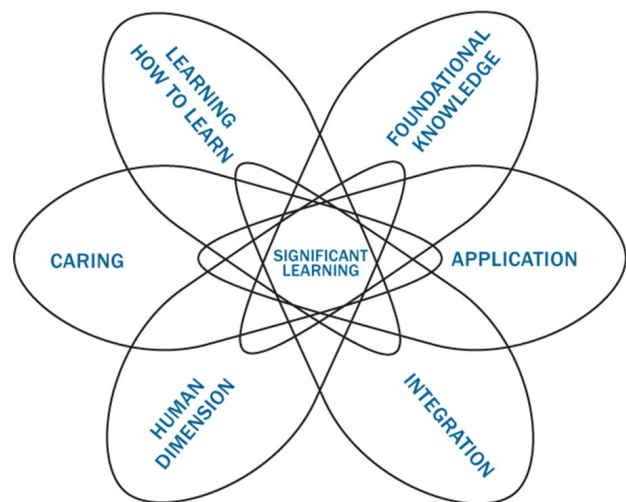


Figure 1. Dee Fink’s taxonomy of significant learning

For this learning activity, the course faculty were willing to “think out of the box” and create a fun and creative strategy for the cardiovascular medication content. Fink described the process of significant learning strategies as “engaged and high energy” (p. 7) and the outcome as “...being of

value in their lives after the course is over. . .” In the development of this activity, faculty focused on two of the taxonomies of significant learning: (1) foundational knowledge and (2) application.^[13] No attempt was made to measure learning how to learn, caring, or the human dimension in this pilot descriptive study. Furthermore, integration was assumed by the team approach to solving progressive levels of puzzle toward a single goal. From the faculty’s lens, developing a significant learning experience was the primary concern and purpose of this activity. Support from the faculty team as well as administration was obtained and faculty focused on basic knowledge (foundational knowledge as described by Fink) of cardiovascular medications required to complete the activity and solve the riddle to save Batman’s life. Attention to the taxonomy of application was used to purposely create an engaging activity which would require critical thinking as well as communication among the team members.

2. DESIGN/METHODOLOGY

This descriptive study employed a qualitative approach to inquiry into the student experiences when using the escape room as a teaching strategy in a pharmacology course. The sample consisted of first semester (level one) nursing students enrolled in three sections of pharmacology.

2.1 Data collection

Following approval from the university’s Institutional Review Board, faculty carried out the study in three different sections of the same course. During the activity, faculty walked around the classroom and observed the students, but they did not answer any questions. The escape room-based activity took place in a large auditorium-style classroom with a capacity of 90 students. After completion of the activity, all students participated in a debriefing session conducted by course faculty and a doctoral student. While all students participated in the learning activity, participation in the evaluation phase was voluntary. Consent was gathered after the activity so students were aware of their freedom of choice to engage in evaluation or not. The rationale for obtaining post-hoc consent was to account for the potential response bias if students knew they were in a research study. All students were given a stapled packet that included information about the study which were distributed at the end of the debriefing session by the doctoral student without faculty in the room. The first page of the packet explained that this was a research study with specific instructions – if you choose to participate in the study, you may complete the demographic survey and an evaluative survey. Students who did not wish to participate were asked to remain seated until all of the forms were collected. There were no identifying information on any forms, and all students had the forms so faculty did

not know who participated in the study and who did not to ensure anonymity. Students were instructed that their participation in completing the forms was voluntary and declining participation would have no effect on their course grade.

2.2 Data analysis

Descriptive statistics (means, frequencies, percentages) were entered into SPSS© version 22.0 to analyze demographic data. Following Creswell’s (2014) steps for data analysis, the student evaluative criteria forms were read and re-read for repetitive themes in order to systematically describe the learning exercise.^[15] All documents were hand-coded: Yellow highlighting, circling of words, and underlined and handwritten words/notes on the evaluative forms were made to aid in the identification of categories and themes.

3. FINDINGS

3.1 Student demographics

Students from all three sections of a baccalaureate pharmacology course (n = 145) participated in the activity and debriefing at their respective class times regardless of whether or not they participated in the study. Students who voluntarily consented to participate completed the demographic survey and evaluative criteria (n = 119; 82% response rate). The large majority of the students were female (n = 96; 80.7%) and Caucasian (n = 65) with a mean age of 22.96 (sd 4.045).

3.2 Themes

Three themes emerged from the students’ responses to the evaluative criteria questions: (1) engaging, (2) teamwork, and (3) frustration. These themes were confirmed by two qualitative experts.

3.2.1 Engaging

The majority of students (n = 89, 74.8%) felt that this was a valuable learning activity; however, 30 students (25.2%) responded negatively and neutrally. More than half of the students (86, 72.2%) indicated that they learned from this activity and would like more of this concept learning for upcoming pharmacological content. Specifically, sixty-three students (52.9%) indicated that their understanding of cardiovascular pharmacology increased as a result of participating in the escape room activity.

The students viewed this activity as a fun way to review and apply their knowledge of cardiovascular medications. They stated that this activity allowed them to ‘think outside the box’: “Yes, it made me think outside of the box and to retrieve information learned already.” Students said they appreciated the departure from the normal lecture and concept map format of class. When asked if they found the learning activity valuable, the one student said, “Yes, it was engaging

and required actual thought.” Several students mentioned that it was challenging but in a positive way. One student shared, “It was challenging and drove me to think of things I never would have.” Another student spoke to the kinesthetic aspect of the activity, “I understand and retain information more doing hands-on work rather than reading from a book.”

3.2.2 Teamwork

Students valued the opportunity to collaborate with their peers. This theme was articulated as the students answered the question, “What was most memorable?” and “What other factors helped to increase your understanding of this activity?” Students reported, “The most memorable aspect was ... coming together as a class to solve a common goal.”

3.2.3 Frustration

Students reported feeling frustrated that they did not have enough time to complete the activity. This is congruent with feedback from the faculty who observed the students as well as the doctoral student who observed all of the activities and sessions in all three sections of the pharmacology class. As the time was nearing an end, students became increasingly anxious to solve the riddle. This student expressed concern that the activity did not increase knowledge of cardiovascular pharmacology, “No, I spent the time figuring out short cuts for the answers rather than learning any more material.”

In addition to the time constraints, students felt frustrated because they did not fully understand the verbal instructions and needed more direction. For example, one student commented, “We need printouts of the instructions. We missed the first puzzle because we didn’t realize the password was in all caps.” Additionally, they felt like they did not know how to start the activity. They were trying to ‘figure it out’ and did not have enough time for completion. Students wanted faculty to provide them with more guidance and answers. Faculty noted that while most of the student groups were actively communicating with each other, the class section that included students with a prior bachelor’s degree were working quietly with more of an individualized focus. While all of the groups were concentrated on the task, they were interested in the rank their group received and seemed distressed about coming in ‘last place’ which resulted in further frustration. One student summed it up, “I was very frustrated.” This student showed insight in identifying a learning deficit, “My critical thinking ability isn’t that great so it made this kind of hard.” Some of the students (3 out of 119) preferred more of a traditional approach to learning, such as case studies. One student reported not benefitting from the activity, “Games and activities do not help me learn.”

3.3 Lessons learned and recommendations

In the construction and subsequent delivery of the activity, faculty learned that what appeared to be easy was challenging for the student. Faculty realized that it was essential to see the innovative learning activity from the students’ perspective. While it was anticipated that some of the puzzles would be challenging, the activity itself showcased the difficulty in anticipating how students would react to the puzzles. It became clear that the complexity of the puzzles and the determination of the time allowed for completion should be trial tested in order to prevent frustration and enhance engagement. In retrospect, faculty should have tested the activity themselves before implementing with the class. An important lesson learned was the importance of faculty taking time to test the puzzles, checking for errors, and identifying the time needed before presenting the activity to the students. We recommend having a run through trial on a few students and then adapting the activity accordingly before it is offered to the entire class.

Recommendations to faculty who would like to implement a similar activity are outlined below.

- Start planning well in advance.
- Test the puzzles to determine time involved.
- Re-review and refine the instructions.
- Engage other faculty to assist on the day of the event so that adequate support is provided to students.
- Create a fun scenario for the activity.
- Ensure positivity as well as short and specific goals.
- Tell the students, in advance, that the activity may be challenging.

3.4 Limitations

This study has several limitations. Any time you use a derivative of technology in a non-traditional way, you are breaking new ground. This innovation limits the conclusions one can draw from an activity because there are many variables which cannot be controlled. However, using technology in a new way is vital to growth, so a further limitation is a lack of historical documentation presenting the material in this new way. Since knowledge and self-confidence were not measured, it is impossible to determine the efficacy of this escape room toolbox strategy in actually conveying information or building competence. Thus, another limitation was the use of the innovation as a means to test a learning activity rather than derive actual change in student behavior. The fact that the majority of the student participants were Caucasian and female as well as the geographic location of the study participants also decreased generalizability beyond the target population. A final limitation is acknowledgement of the fact that actual medication administration is a solo activity which

may or may not benefit from a group approach to learning about drugs. This limitation was believed to be offset by encouraging students to ask questions and think critically about medications in all venues.

4. DISCUSSION

The purpose of this descriptive qualitative study was to describe the use of a toolbox gaming strategy based on an escape room concept to help students learn about cardiovascular medications in a pharmacology course. Guided by Fink's Taxonomy of Significant Learning, researchers observed two of the taxonomies believed to be most relevant to the toolbox learning strategy in pharmacology education: (1) foundational knowledge and (2) application.^[13] The activity addressed foundational knowledge for a specific scenario, and students were able to apply the information in cardiovascular medication in a fantasy-based scenario. It was evident that students were able to effectively calculate the medication dosages as well as recall the medications they had learned in the course. Students were interested in the activity and cared about saving Batman's life. In turn, students expressed that they learned about themselves, some stating that they were unaware that they knew so much or that they knew so little. Faculty observed the students making connections among the team members, i.e., when one student would share what they recalled in class and/or the textbook, this would then spark a connection from another student. In addition to the sharing of facts and ideas which required foundational knowledge, students were actively engaged in the activity by communicating to search for answers, solving the problems, and agreeing or disagreeing with their peers. Godin and colleagues state that active learning is crucial to students' learning.^[16]

This pilot study revealed an important finding for educators to consider before planning and conducting a similar learning activity. While the majority of students felt like this was a valuable learning activity, 25.2% responded negatively and neutrally. Faculty observed that students were engaged and recognized that this was a novel approach to learn and make

decisions about cardiovascular medications. This innovative teaching strategy appears to have the potential to benefit both the course faculty and the students. We acknowledge that perhaps more students would have responded positively if the activity had been pre-tested with better verbal instructions and more time allotted for the completion of the activity. Clearly these actions would have helped decrease student frustration by providing clarity and support. While none of student teams completed the activity in the time allotted and thus did not save Batman's life, both the students and the faculty concluded that this activity helped students apply the didactic content to a specific scenario while working with their team members. Given that no student team was able to 'save Batman' faculty observed several teams got close and concluded that an additional 2-10 minutes would have helped them to solve the riddle. This activity proved to be effective in promoting teamwork and collaboration to achieve a common goal.

5. CONCLUSION

In conclusion, this hands-on, team-based approach to learning required students to be immersed in a scenario as they worked as a team to communicate with each other to solve a problem. We recommend this escape room toolbox strategy as a way for faculty to add some spark and innovation to a course which traditionally has a lot of reading and memorization. Further, we believe this approach is consistent with the experience of younger students who have grown up with virtual strategy games. We do recommend that future studies be conducted to quantify the students' academic success, i.e., test grades, self-confidence, and perceived competence after engaging in a non-traditional learning activity such as the toolbox puzzle exercise.

BIO STATEMENT

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