A Systematic Review of Escape Room Gaming in Pharmacy Education

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\textbf{ABSTRACT}

Objectives: The objectives of this review were to review the current literature on escape rooms in pharmacy education, determine their impact on educational outcomes, and identify areas for future research.

Findings: A literature search retrieved 14 reports, of which 10 studies met all of the study criteria. The majority of the studies used the escape room to review previously taught content (90%). More than half the studies (60%) assessed a change in a student's knowledge. One study testing a broad content area found a decrease in the before and after knowledge assessment from 70% to 67%, while other studies found before and after content knowledge increase. On average, 5.8 faculty facilitators and 33 h were needed for each activity.

Summary: This review suggests that pharmacy students enjoy escape rooms and perceive that it helps in their clinical knowledge and teamwork skills. Additionally, there is a potential that it can demonstrate an increase in content knowledge, particularly escape rooms that had a singular content focus. Faculty planning on implementing an escape room activity should give strong consideration to the preparation, delivery/logistics, and content.

1. Introduction

In recent years, there has been an increase in the “gamification” of the pharmacy curriculum. This has largely been because of the 2013–2014 Academic Affairs Committee of the American Association of Colleges of Pharmacy’s encouragement to utilize, when appropriate, serious games for learning and professional development.\textsuperscript{1} In serious games, game principles are used for the purpose of education, skill acquisition, and training.\textsuperscript{2} Effective educational gaming pushes the player (ie, student) to perform at their maximum skill level and requires significant cognitive effort.\textsuperscript{3} Attaining the highest score, or completing the game first, is not required to obtain the educational benefit from serious games. All players can be “winners” in these games as each player progresses, attaining higher levels of learning and cognitive development by engaging higher levels of Bloom’s taxonomy than is typically attainable with traditional lecture style teaching.\textsuperscript{4} Examples of serious games include but are not limited to: simulations, strategy games, puzzles, and role-playing.\textsuperscript{5} The opportunities to increase teamwork, critical thinking, and communication skills, along with increased student accountability and engagement are some of the potential educational benefits of serious games. Recently, one particular serious game that has gained popularity in pharmacy education is escape room games, possibly coinciding with the increase in their social popularity.

An escape room allows players to work in teams to solve clues and puzzles to accomplish various tasks to “escape the room” in a pre-specified amount of time.\textsuperscript{6} Potential educational benefits of an escape room activity in pharmacy education are increased content knowledge and teamwork skills. The first published report of an escape game being utilized in pharmacy curricula appeared in 2017, and a number of reports have been subsequently published.\textsuperscript{6–15} These articles have shown various benefits to students; however, the full realization of educational benefits and applicability of these activities have yet to be determined. The objective of this review was to review the current literature on escape rooms in pharmacy education, determine their impact on educational outcomes, and identify areas for future research.

2. Methods

A comprehensive electronic search was conducted to uncover all peer-reviewed articles related to the topic of escape room gaming in pharmacy education. The literature review was conducted based on the principles from the 2020 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. PubMed and Ovid databases were systematically searched using the terms: “escape room and pharmacy education” and “escape game and pharmacy education.” Additionally, the reference sections from the sourced articles were

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screened to identify other publications. Articles that met inclusion criteria for the review were original, published in the English language, included only an escape game or format, were completed at a college or school of pharmacy within the United States (US), and/or included only doctor of pharmacy student learners. Titles and abstracts from the initial literature searches were screened for relevance and eligibility. The full-text review was then completed by 2 authors independently. If disagreements arose on the inclusion or exclusion of an article the dispute was settled by the third author. The following data were extracted by the authors after a comprehensive review of each article: student rank, course type, content, amount of time before the escape room activity was conducted that the content was delivered, paper versus online design, required skills, gaming components, total time allowed to complete the escape room, number of rooms and facilitators required, cost of the activity, primary outcome measure, results, and time it took to develop the escape room. Statistically significant P values, if reported in the article, are included in the results section.

3. Results

An initial literature search describing escape rooms in pharmacy identified 14 articles.6–15 One article had an escape room that was not in the US, only articles held in the US were retained.16 Another article only described the transferability of an escape room from a different college of pharmacy and therefore was excluded.19 Of the remaining 12 studies, 2 others had a mixed cohort that included pharmacists or other interprofessional students and therefore was removed from review.17,18 In the end, 10 articles met the inclusion and exclusion criteria.6–15

General characteristics of the escape room activities can be found in Table 1. Escape room activities were used to reinforce a wide array of content areas and with different ranks of pharmacy students (ie, first-year [P1], second-year [P2], and third-year [P3]). Of the studies reviewed, about 60% provided the escape room to third-year pharmacy students.6–10,13 The P3 courses included an orientation refresher,2 heart failure module in a therapeutic class,3 skills lab focused on diabetes mellitus,4 management,5 nonsterile compounding,6 toxicology,7,8 and a pre-advanced pharmacy practice experience (APPE) readiness course.3 Other studies designed escape rooms for P1 orientation,4 a public health and disaster preparedness seminar,7 and a leadership/teamwork course.12 Three of these studies were done in elective courses.10,11,15 Ninety percent of the escape rooms were designed to review material that was previously taught.6–15 Only 1 study utilized the escape room as a means of teaching new material.15

There was an average class size of 95 students and a median group size of 5.75 students (range 3.5–8) who completed the escape room. As such, this did require significant resources, including faculty, facilitator support, money, and time. The exact number of facilitators was not frequently reported, however, 70% of the studies did mention the need for additional facilitators. Of those that did describe facilitator needs, the number ranged widely from 2 to 13 faculty facilitators at one time, with an average faculty-to-student ratio of 20.7–1.16–19 In 40% of studies, the specifically notated amount of time required by the escape room developers to design and plan the escape room was on average 33 h.6,11,12,14 In 40% of studies, the specifically notated amount of time required by the escape room developers to design and plan the escape room was on average 33 h.6,11,12,14 Frequently, APPE students and pharmacy residents were included in the development process, however, no studies specifically mentioned the time requirements for them.

For delivery of the escape rooms, a combination of online/computer and paper (physical) clues were used by the majority of the escape rooms to successfully administer the activity. The technology most utilized was Google Forms for groups to fill out. To prevent cheating, 1 study only allowed 1 electronic device per group and only the group member had access to the Google Form.13 Gaming components used varied including physical puzzles, props, group assessments, combination locks, word searches, online scavenger hunts, and picture ciphers. The cost was described by 60% of studies to be an average of $192.83 per escape room activity, ranging from $12 to $400.6–8,11,12,14

The outcomes of the 10 trials are described in Table 2. All of the studies evaluated students’ perceptions and found there was a positive perception from students regarding escape rooms.6–15 Six studies evaluated the before and after test performance on the escape room.6–8,10,12,15 In addition to student perceptions, 4 studies evaluated performance on knowledge-based assessment questions.6,8,10,15 Of these 4 studies, all but 1 found an overall improvement in post-test scores compared to their pretest scores.1 The study that did not show improvement found that for the knowledge-based assessment on critical thinking, teamwork skills, and clinical knowledge there was a decrease in overall mean score from the pretest 70% +/- 11.6 (range 41–94) to the post-test at 67% +/- 14.5 (range 29–88).2 However, the remaining 3 studies whose knowledge-based assessments were more focused on one particular disease state (diabetes mellitus disease management, nonsterile compounding, and management of toxicologic emergencies) did show an overall improvement in the assessment scores.3–5

The duration of the escape room activity was documented in 90% of the studies. The average time was 56 min (range 40–120). A debrief session was conducted immediately after the escape room was completed in 30% of the studies, of which 2 studies specify that the debrief sessions lasted 10 min and 30 min, respectively. Four studies also looked at the total time the activity lasted, including any instructions, the escape room itself, debriefing, and follow-up activities.7–9,13 The total time was approximately 105 min.

4. Discussion

There are currently 10 studies describing escape room activities that have been implemented in US colleges and schools of pharmacy. This review represents the current use of escape room gaming in pharmacy curricula and could guide pharmacy instructors on the implementation of these activities at other colleges/schools of pharmacy, as well as identify future areas for research.

Of the studies reviewed, 4 evaluated students’ content knowledge via before and after assessment questions.6,8,10,15 One of the studies conducted by Clauson and colleagues2 in 2019 found when assessing critical thinking, teamwork, and clinical knowledge that assessment scores after the escape room activity were lower (67%) than the pre-assessment (70%). Many authors explained the decrease in scores from before and after the test may have been because of specific reinforcement of the clinical content within the activity, not all students may have participated equally, and because of previous electives, rotations, or personal experiences. However, this escape room activity focused on multiple acute and chronic disease states in multiple phases of patient care (ie, ambulatory care, community, and inpatient). This broad focus of the escape room activity could have limited the improvement in content knowledge that was seen in other published escape room activities or detracted from reinforcement of the most important material within the escape room. The difference in outcomes could also be explained by Cognitive Load Theory.50 As students were presented with more or broader material, they simply may not have had the cognitive space to process all of the information being presented in the escape room and therefore may not have been able to learn all the material within the escape room. The other 3 published reports that assessed student content knowledge with before and after assessments had a more narrow focus in their content. Eukel and colleagues6 in 2017 focused only on diabetes mellitus, Caldas and colleagues10 focused on nonsterile compounding, and the most recently published report by Korenski and colleagues15 focused on 3 different types of toxicologic emergencies. Although this area warrants future research, faculty members creating an escape room should consider narrowing the content in the escape room because there is potential that students’ content knowledge is increased when focusing on a singular content area.

Pharmacy instructors who wish to implement an escape room into their course should consider some key findings from this review, broken
<table>
<thead>
<tr>
<th></th>
<th>Eukel</th>
<th>Cain</th>
<th>Clauson</th>
<th>Gordon</th>
<th>Caldas</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student rank</strong></td>
<td>P3</td>
<td>P3</td>
<td>P3</td>
<td>P2 and P3</td>
<td>P3</td>
</tr>
<tr>
<td><strong>Course type</strong></td>
<td>Lab</td>
<td>Lecture</td>
<td>Lecture</td>
<td>Orientation</td>
<td>Elective Lab</td>
</tr>
<tr>
<td><strong>Content</strong></td>
<td>Diabetes mellitus</td>
<td>Management</td>
<td>Pre-APPE readiness</td>
<td>State/University facts</td>
<td>Nonsterile compounding</td>
</tr>
<tr>
<td><strong>Timing of content delivery prior to escape room</strong></td>
<td>One week</td>
<td>One week</td>
<td>Three weeks</td>
<td>N/A</td>
<td>Not reported</td>
</tr>
<tr>
<td><strong>Paper vs online design</strong></td>
<td>Both</td>
<td>Both</td>
<td>Both</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Skills required</strong></td>
<td>Verbal antidiabetic medication knowledge, patient counseling, how to use an insulin pen and glucagon, perform monofilament test, and navigate paper-based medical chart and EMR</td>
<td>Basic human resources and hiring process knowledge pertaining to pharmacy</td>
<td>Gather a patient history and create a patient care plan</td>
<td>Recall Indiana geography, staff members, and university history</td>
<td>Solve compounding calculations, determine beyond-use dates, evaluate prescription labels for accuracy, and analyze compounding procedures</td>
</tr>
<tr>
<td><strong>Gaming components</strong></td>
<td>Mason cipher, word jumble, coded message, sudoku, combo lock decoding, math riddle, data hunt, jeopardy, dose calculations, rebus puzzle, and interpretive puzzle</td>
<td>Paper and web-based puzzles, riddles, clues (paper, QR codes), and combination locks</td>
<td>Puzzles, boxes with activities to complete, and computer to calculate ASCVD risk</td>
<td>Word search mapping, picture puzzle, data hunt, word riddle, picture cipher, and code puzzle</td>
<td>Word lock, cryptogram, coded message, word jumble, diagram/physical puzzle, directional and numeric lock</td>
</tr>
<tr>
<td><strong>Total time</strong></td>
<td>75 min</td>
<td>5 min for instructions</td>
<td>2 h total</td>
<td>Preassessment was done 3 weeks before</td>
<td>40 min</td>
</tr>
<tr>
<td></td>
<td>45 min for escape room</td>
<td>1 h for the activity.</td>
<td></td>
<td>1 h for intro/presurvey and debrief</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 min debrief</td>
<td>15 min am care</td>
<td>15 min community</td>
<td>30 min inpatient</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>40 min</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>5 min transitions to rooms</td>
<td></td>
</tr>
</tbody>
</table>

| **No. of students**    | 83 | 141 | 62 | 127 | 30 |
| **No. rooms needed**   | 3 | 1 | 6 | Not reported | 3 |
| **No. facilitators needed** | 2 | 3 | 13 | Not reported | 3 |
| **Cost of activity**    | < $75 | $12 | $400 | Not reported | Not reported |
| **Abbreviations:**      | ASCVD, atherosclerotic cardiovascular disease; P1, first professional year; P2, second professional year; P3, third professional year. |

* Specified large room.
Table 2
Escape Room Outcomes.

<table>
<thead>
<tr>
<th>Primary outcome</th>
<th>Results</th>
<th>Time to develop escape room</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eukel</strong></td>
<td>Students’ mean perception showed a statistically significant increase in the mean value of the evaluation scale</td>
<td>∼20 h</td>
</tr>
<tr>
<td><strong>Gain</strong></td>
<td>Students scored 3 points lower on the postassessment (∼2.8 ± 13.4). However, 96% of students (n = 51) felt that the exercise improved clinical skills and facilitated learning.</td>
<td>32</td>
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<td>All but 1 statement (“I am an integral member of the team”) showed a statistically significant increase in those strongly agreeing or agreeing pre to postexercise. The largest shift was seen for the statement “I enjoy working in a team environment”.</td>
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<tr>
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<td>Students’ knowledge improved or stayed the same for all of the assessment questions. Students perceived the escape room as helpful to their learning.</td>
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</tr>
<tr>
<td><strong>Caldas</strong></td>
<td>Students’ knowledge improved or stayed the same for all of the assessment questions. Students perceived the escape room as helpful to their learning.</td>
<td>Not reported</td>
</tr>
</tbody>
</table>

**Primary outcome**
- Change in knowledge from pretest and postassessment
- Student perceptions
- Change in knowledge from before and after assessment
- Change in perceptions from before and after surveys
- Change in knowledge and student perceptions based on before and after assessment

**Results**
- Students’ mean perception showed a statistically significant increase in the mean value of the evaluation scale
- Students scored 3 points lower on the postassessment (∼2.8 ± 13.4). However, 96% of students (n = 51) felt that the exercise improved clinical skills and facilitated learning.
- All but 1 statement (“I am an integral member of the team”) showed a statistically significant increase in those strongly agreeing or agreeing pre to postexercise. The largest shift was seen for the statement “I enjoy working in a team environment”.
- Students’ knowledge improved or stayed the same for all of the assessment questions. Students perceived the escape room as helpful to their learning.

**Time to develop escape room**
- ∼20 h
- 32
- 40

**Clauson**
- Change in knowledge from before and after assessment
- All but 1 statement (“I am an integral member of the team”) showed a statistically significant increase in those strongly agreeing or agreeing pre to postexercise. The largest shift was seen for the statement “I enjoy working in a team environment”.

**Gordon**
- Change in perceptions from before and after surveys
- Students’ knowledge improved or stayed the same for all of the assessment questions. Students perceived the escape room as helpful to their learning.

**Caldas**
- Change in knowledge and student perceptions based on before and after assessment

**Nybo**
- Change in retrospective post-then-prelab questionnaire of student-perceived knowledge & perceptions
- Students reported a statistically significant increase in understanding of leadership concepts and application at the end of global lab activities (P < 0.01) and a majority of the students found the escape room activity “very useful” (56%).

**Plakogiannis**
- Change in student perception from immediately at the end of the activity, to 4 weeks after the activity.
- No statistical difference between initial and follow-up surveys. Positive attitudes did not alter over time. Satisfaction levels were inversely related to grade point average (r = −0.20, P = 0.05)

**Nybo**
- Assess student attitudes
- Students were positively inclined toward the educational activity

**Korenoski**
- Before and after assessment on knowledge and student self-perceived confidence
- Improvements in test scores were observed with both cases’ before and after tests (Students improved from 18% to 82% passing on case 1 and improved from 0% to 68% passing on case 2.)
- Students also found the activity increased their knowledge and level of student-perceived confidence. The majority of students were satisfied with the experience.

**Time to develop escape room**
- ∼20 h
- 32
- 40
down into 3 categories: preparation, delivery/logistics, and content. First, creating an all-new escape room represents a significant time commitment, with published reports indicating anywhere from 18 to 40 person-hours. Instructors should allocate an ample amount of time to create the escape room activity, and consider an approach that involves APPE students and pharmacy residents, as well as other faculty members. This reduces the burden of creation and allows for different perspectives. Regardless of the number of people involved, creating a learning activity that pushes students to engage with the material, rather than the “game,” is a time-consuming task. However, once the escape room activity is created it can be repeated for future groups of students and significantly defray the preparation time. Many of the reports indicated that they “tested” the escape room on APPE students or residents and adjustments were made prior to the delivery of the activity. The testing of the escape room activity should be an integral part of the preparation for any pharmacy instructor prior to rollout.

Although the group sizes for the students were variable, the most common was between 5 and 8 students. Evidence for the ideal group size for escape rooms in pharmacy education is lacking; however, psychological and business research, while still somewhat undecided, suggest teams of 5–9 are best for group learning and cohesion. Instructors should consider their own course enrollment, classroom space, and preceptor availability, but it is reasonable, based on the articles in this review, to consider group sizes of 5–8 students. Delivery of the escape room clues and puzzles can be done electronically, on paper, or a combination of the 2, as both have been used effectively based on the published reports in this review. An important consideration for instructors with limited space is that electronic delivery of escape rooms accommodates a larger number of students in a single classroom, as demonstrated by Cain. Half of the studies opted for a mix of paper and electronic clues and puzzles, making it difficult to compare an entirely paper or entirely electronic format on the logistics and needs of the escape room. Instructors should consider their own course enrollment, classroom space, and preceptor availability, but it is reasonable, based on the articles in this review, to consider group sizes of 5–8 students. Delivery of the escape room clues and puzzles can be done electronically, on paper, or a combination of the 2, as both have been used effectively based on the published reports in this review. An important consideration for instructors with limited space is that electronic delivery of escape rooms accommodates a larger number of students in a single classroom, as demonstrated by Cain. Half of the studies opted for a mix of paper and electronic clues and puzzles, making it difficult to compare an entirely paper or entirely electronic format on the logistics and needs of the escape room. However, this should be a consideration for future research. Delivery of the escape room requires additional facilitators, generally outside of the faculty member who created the escape room. The number of facilitators needed ranged widely (2–13 facilitators) and was frequently not reported. The role of the facilitator during the escape room can be variable, but generally includes ensuring each team, or a group of teams, progresses through the escape room through hints, check-off at various stages, rule adherence, and, if necessary, subject matter expertise. Some of the hints and check-off can be alleviated by using an electronic format; however, considering the level of content expertise needed from a facilitator is important for escape room creators. In addition, considering how many faculty are needed based on their design and delivery further warrants testing of the escape room prior to rollout, as outlined above. Additionally, for colleges and schools of pharmacy that have a limited number of facilitators an escape room activity that utilizes all computer-based clues will generally require fewer preceptors. Another important consideration is if the facilitators need to have content knowledge, or if the activity is designed in a way that content knowledge experts are not needed to facilitate. Lastly, all of the escape rooms were designed to be completed in 2 h (instructions, activity, assessments, etc.), and the majority were completed in 1 h. Given the inclusive nature of these team-based activities, and the time-intensive component of their creation, it is reasonable for escape room creators to design an activity that is completed in about 1 h. The number of activities or rooms within each complete escape game was frequently not reported, so it is difficult to suggest the number of activities students can complete in a 1-hour escape room and should be a consideration for future research. However, faculty creators should consider not only the number of activities but the complexity of the gaming components (ie, puzzles) when designing the escape room because this will likely affect the overall duration of the escape room activity. These components reemphasize the importance of the pilot testing of the escape room prior to the rollout of the activity.

There is a wide variety of content areas that have been covered in published escape room activities, from clinical content to sterile compounding to human resources laws. Faculty members should be encouraged by the wide variety of content that can be covered in an escape room activity. Though caution should be exercised, as mentioned above, to ensure a narrow or singular focus of the escape room activity to potentially maximize student content knowledge enhancement. Additionally, escape room activities have the potential to strengthen some of the “soft skills” like communication and teamwork. These skills are an important component of pharmacy education to produce practice-ready graduates per the Accreditation Council on Pharmacy Education standards. If faculty wish to incorporate development and/or assessment of soft skills into their escape room, special consideration should be given to the design aspects of the game that will lend themselves to development of those skills. For instance, if teamwork is the desired soft skill to be developed by the faculty member, then ensuring that each team participating has well-defined roles and opportunities to select roles at the beginning and, possibly switch roles throughout the game, will aid in the attainment of the desired soft skill.

All of the studies in this review evaluated student perceptions of the escape room activities. Students enjoyed the escape room activities and had overwhelmingly positive reviews of the games. Although student perceptions/enjoyment of an activity is an important consideration, it should not be used as a surrogate for learning or skill development. However, escape room activities have the potential to increase and/or reinforce clinical content knowledge (eg, diabetes pharmacotherapy) and skill development (eg, critical thinking). Only 1 study studied escape rooms as a method for teaching new content. In an acute care elective, they covered toxicologic emergencies that were new to students. This differed from all other published studies that utilized the activity as a means to review content. Of the 22 students in this study, 18% and 0% received passing grades on the preassessments for case 1 and case 2, respectively. On the post-assessment, this increased to 82% and 68%, respectively. Although this was only 1 study with a limited number of students, it represents an area for future research with potential application for utilizing escape room activities to teach new material. However, given the body of literature, faculty wishing to implement an escape room should consider reviewing content previously covered in the curriculum.

Future research should focus on utilizing escape room activities to teach new content in comparison to reviewing content that has been previously taught within the curriculum. In addition, all of the studies in this review describe an escape room that was carried out at a single point in time. Studies in the future should focus on the year-over-year analysis of the activity and potential changes that could be carried out if the escape room activity is repeated over multiple years.

5. Conclusion

Escape room activities have been implemented in a number of colleges and schools of pharmacy. Students enjoy this method of learning and perceive that escape rooms help their clinical knowledge and teamwork skills. Some studies have demonstrated an increase in content knowledge of material previously covered in the curriculum after the activity, particularly escape rooms that had a singular content focus (eg, disease state). Faculty planning on implementing an escape room activity should give strong consideration to the preparation, delivery/logistics, and content. Future research should focus on whether singular versus multiple content is most advantageous for learning, delivery of new material versus reviewing content, and year-over-year analysis of the same escape room activities.

Declaration of Competing Interest

None declared.
References


