



EXPLORING STUDENTS' PERCEPTIONS OF COLLABORATION AND CRITICAL THINKING SKILLS FOLLOWING AN ESCAPE ROOM EXPERIENCE

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Collaboration and critical thinking are 21st century skills employers value. Campus programming offers a space where, through intentional design, post-secondary students may develop critical thinking and collaboration skills. This study investigates survey data collected after a campus program that engaged participants in an escape room experience. Descriptive statistics were utilized to investigate students' perceptions of collaboration and critical thinking skills use and improvement during the experience. Comparison analysis was employed to explore if the structure of the escape room produced any difference in results. Findings indicate the majority of participants reported being able to practice and improve collaboration and critical thinking skills in the escape room experience. Patterns suggest that the escape room structure may impact participants' perceptions of collaboration and critical thinking skills. Limitations and recommendations for areas of future research are discussed.

EMPLOYERS HAVE IDENTIFIED COLLABORATION AND CRITICAL THINKING as important 21st-century skills necessary for college graduates to succeed in today's workforce (Pace, 2012). Accordingly, there is a need for post-secondary students to be given opportunities to develop their critical thinking and collaboration skills while also developing professional knowledge (Cevik & Senturk, 2019). However, cultivating these skills is often considered secondary to the coursework students are expected to master (Dede, 2010; Voogt & Roblin, 2012). Therefore, colleges and universities may find it valuable to seek ways beyond the classroom to develop students' collaborative and critical thinking skills and, in turn, support their future career success. One such opportunity could occur during campus-wide events, such as the activities planned to welcome students to campus for the academic year.

This paper investigates students' perceptions of their collaboration and critical thinking skills following an escape room experience. The event was held by a College of Education during a university-wide Week of Welcome. Further analysis compares the designs of two different escape rooms, providing insight on how to best implement similar campus-wide events that may support collaboration and critical thinking skills.

Literature Review

21st Century Skills: Collaboration and Critical Thinking

Historically, educational systems have focused attention on ensuring that students build knowledge and skills around specific content areas such as English language arts, mathematics, science, and social studies (Dede,

2010; Voogt & Roblin, 2012). However, due to the impact of an ever-changing technological, social, and cultural landscape, educators sometimes question if they are adequately preparing young adults to be successful upon entering the workforce as they realize the need for teaching students 21st-century skills (Care et al., 2016; Todd, 2017). Wagner (2008) contends that 21st-century skills include critical thinking and problem solving, collaboration and leadership, agility and adaptability, initiative and entrepreneurialism, effective oral and written communication, accessing and analyzing information, and curiosity and imagination. While each of the skills mentioned above is important, this article will focus on collaboration and critical thinking skills.

To support students' development of collaboration and critical thinking skills, educators must shift their approach from viewing students as the recipients of knowledge to active contributors in their acquisition of knowledge (Nissim et al., 2016). Unfortunately, according to Saavedra and Opfer (2012), most schools currently teach through the transmission model. With this model, students learn information given or lectured to them, but "typically don't have much practice applying the knowledge to new contexts, communicating it in complex ways, using it to solve problems, or using it as a platform to develop creativity" (p. 8). Consequently, when post-secondary learning is garnered through the transmission model, students lose the opportunity to gain 21st-century skills and subsequently enter the workforce without them. Researchers have noted this concern as Pace (2012) states, "Employers are observing a lack of critical soft skills, such as communication, creativity, collaboration, and critical thinking" (p. 43). Therefore, to ensure students are leaving higher education with the knowledge and skills to make them successful in the 21st century, it is vital that higher education faculty and staff identify innovative methods for adequately preparing students.

Collaboration

Hesse et al. (2015) define collaboration as "the activity of working together towards a common goal" (p. 38). They suggest collaboration requires effective communication, cooperation amongst group members, responsiveness, or a willingness to participate and contribute to the task set before them. "Collaboration is a useful tool, especially when specific expertise is needed (and available), and relies on factors such as a readiness to participate, mutual understanding, and the ability to manage interpersonal conflicts" (p. 38).

Within the context of higher education, providing opportunities for students to engage in collaborative activities strays from the more traditional teaching style, which typically includes passive learning on the part of students (Barkley et al., 2014; Lee et al., 2018). For those interested in shifting to a more hands-on learning and collaborative approach, incorporating an escape room experience might be considered. A study conducted by Pan et al. (2017) found participating in an escape room experience not only enabled participants to strengthen their collaboration skills, but to also learn strategies for navigating their individual roles within and across groups, strengthen their ability to communicate with others, become more aware of their surroundings, and construct a "shared mental model" (p. 1361). Within the context of an escape room experience, a shared mental model would be constructed based on the knowledge and experiences of all team members and would support the team's ability to "share the workload, monitor the work behaviors of other members, and develop and contribute expertise on subtasks" (Mathieu & Goodwin, 2000, p. 273). All of these are skills that could support an individual's success within a 21st-century workforce.

Critical Thinking

Robert Ennis, a leader in the conceptualization of critical thinking, contends that critical thinking "is reflective and reasonable thinking that is focused on deciding what to believe or do" (1985, p. 45). Specific skills necessary for critical thinking include the ability to analyze and evaluate situations and construct novel ideas (Campbell, 2015). According to Ennis (2018), critical thinking can be broken down into dispositions which include but are not limited to (a) being knowledgeable, (b) basing decisions off of reliable sources and observations, (c) considering the totality of a situation, (d) being willing to look for alternative solutions, (e) maintaining an open mind, (f) demonstrating flexibility to change positions in light of new evidence, and (g) striving for accuracy.

This shift from more basic thinking to critical thinking depends on specific learning experiences (Kuhn & Dean, 2004). Such experiences should be situated within supportive learning environments. When developing a supportive learning environment, it is important to remain flexible to allow for optimal interactions between facilitators-students and students-students. Taking into consideration the requirements for a highly-qualified 21st-century workforce, “an environment should be formed that creates learning ‘opportunities,’ spaces that facilitate investigation, the posing of questions, and the allowing of the construction of knowledge and skills” (Nissim et al., 2016, p. 30). Based on these assertions, constructing learning environments that foster critical thinking, such as the escape room experience described in this paper, could provide opportunities for students to develop the 21st-century skills that are now expected by future employers (Sousa & Rocha, 2019).

Escape Rooms in Higher Education

Escape rooms are being utilized on college campuses in academic programming as a way to teach students creatively (Edson, 2019; Mac Gregor, 2018; Miller et al., 2020). For example, libraries have incorporated these events to reinforce research skills, learn locations of resources, and help students discern fake news through fact-checking puzzles (Cowing et al., 2018; Miller et al., 2020). Miller et al. (2020) report this gamified approach offers students an entertaining way to use their problem-solving skills in a real-world academic context.

There are three ways to organize the clues and puzzles in escape rooms: the linear path, the open path, and the multi-linear path (Nicholson, 2015; Wiemker et al., 2015). The linear pathway presents players with puzzles to solve in a specific order. The answer to the first puzzle solved unlocks the next puzzle in the sequence until players reach the game’s final puzzle, leading to escape. The linear design is considered easier for players to solve, given the built-in structure for a guided experience (Wiemker et al., 2015). The open path puzzle allows players to work on multiple puzzles simultaneously, in any order. As players solve the puzzles, they receive pieces of the final solution, enabling them to escape. The open path design is considered more difficult for players to solve since there is no clear indication of where to start (Wiemker et al., 2015). The multi-linear approach involves a series of linear path puzzles, with each pathway leading to a final result. Each of these results is needed for a meta-puzzle, leading to escape (Nicholson, 2015; Wiemker et al., 2015).

Despite the recent popularity of escape rooms in academia, the literature about the efficacy and usefulness of escape rooms as an educational tool is particularly sparse. A systematic review of educational escape rooms revealed that 78.9% occurred in a classroom (Fotaris & Mastoras, 2019). However, there have been no studies examining the overall design of classroom-based escape room experiences. Determining if overall escape room design makes a difference in students’ collaboration and critical thinking skills can contribute to the absence of research on educational escape room experiences.

In sum, as institutions of higher education transition from outdated instructional models, there is also a need to ensure students receive opportunities to practice and apply 21st-century skills (Lee et al., 2018; Nissim et al., 2016). Moreover, students given a chance to improve their collaboration and critical thinking skills will improve their hireability and ultimate success as they move into the workforce (Brown et al., 2019). Escape rooms are positioned as a possible option for reinforcing these skills as literature points to escape rooms as providing an engaging method to gamify and strengthen 21st-century skills with college students (Edson, 2019; Mac Gregor, 2018; Miller et al., 2020). Understanding the influence escape rooms can have on developing these needed skills may provide those designing campus activities and course curriculum with added strategies to support their students’ development.

METHODOLOGY

The purpose of this study was to investigate students’ perceptions of collaboration and critical thinking skills following an escape room experience. Data collection occurred as an assessment measure for the event. A more in-depth analysis was performed to better understand how escape room design might be utilized to support the 21st-century skills of collaboration and critical thinking in higher education. Specifically, the research questions guiding the analysis were:

- 1) How do students perceive the escape room experience as an opportunity for themselves or others to practice or improve collaboration skills?
- 2) How do students perceive the escape room experience as an opportunity for themselves or others to practice or improve critical thinking skills?
- 3) Are there differences between the ways students report collaboration and critical thinking skills in a linear path and an open path escape room?

Descriptive statistics were used to investigate the first and second research questions, and descriptive comparison analysis and further statistical analysis (e.g., t-tests) were used to respond to the third research question.

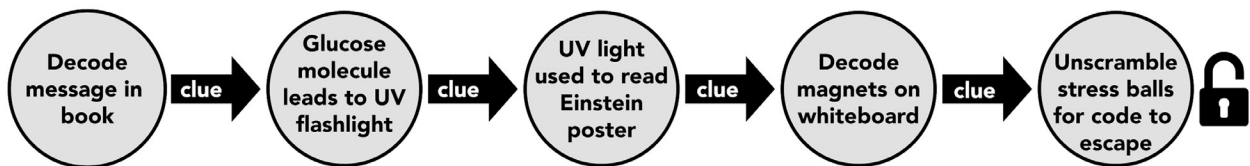
Setting

Data were collected during a Week of Welcome event held by the College of Education in a mid-sized Southeastern university. The annual, campus-wide program takes place each fall and allows students time to meet faculty, staff, and peers through informal activities. These events are created and scheduled by each college and the University-supported Student Activities Committee. During this study, the College of Education hosted two escape rooms designed to offer students a fun afternoon and require them to use collaborative and critical thinking skills. Students were asked to answer a short survey at the end of their escape room experience to analyze their perceptions of collaboration and critical thinking skills.

Description of the Escape Room Experiences

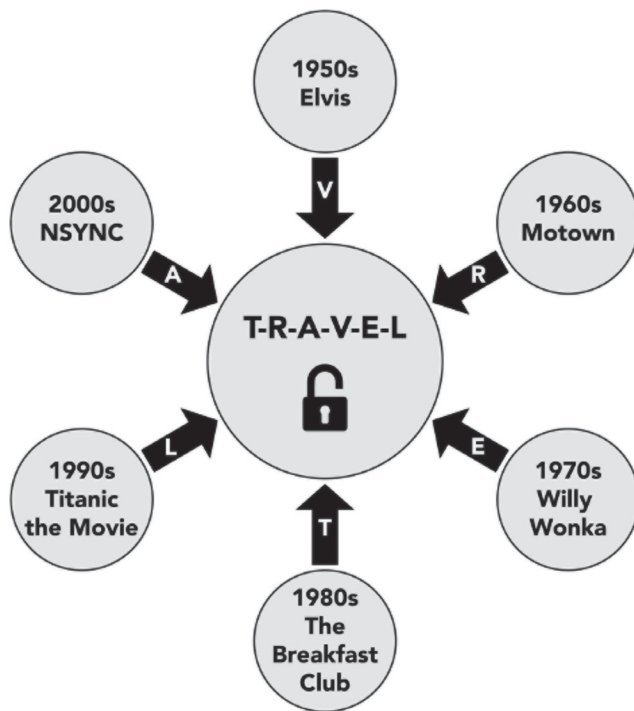
The two escape rooms, staged in two campus classrooms, were intentionally designed to have different solution paths. The storyline for *Escape from School* had participants inadvertently locked in a high school after dismissal, requiring them to solve puzzles and riddles related to various high school subjects/experiences in order to escape. This room was arranged in a linear path, meaning one puzzle had to be completed before moving on to the next. Because each clue led to the subsequent clue, students were required to work as one group to complete the five tasks in this room. Figure 1 displays the linear path design of the *Escape from School* room.

Figure 1. Linear path design of the *Escape from School* escape room.



The second room, *Time Traveler*, transported participants back in time to solve puzzles and riddles in order to return to the present time. This room was designed using an open path structure where, upon entering, participants could branch off into smaller groups to solve decade-themed puzzles. After groups solved each puzzle, they obtained a letter. Once all of the puzzles were solved, participants had the letters: L, A, T, V, R, and E, which they unscrambled to spell the word TRAVEL to answer the last clue and escape. Figure 2 depicts a graphic display of the *Time Traveler* escape room design.

Figure 2. Open path design of the *Time Traveler* escape room.



Upon arrival at the event, students were presented with the two scenarios and could sign up for either or both experiences. As demand grew, there was not enough time for all students to complete both rooms; therefore, students were asked to select which room they wanted to enter. Just prior to their start time, participant groups were escorted to their escape room entrance by a faculty member who read the room instructions before entry. (See Figure 3.) Inside, there was one faculty member to answer questions and provide assistance if needed. Once students completed the experience, they were escorted to an area where they could take pictures and complete the survey.

Figure 3. Escape room instructions read aloud to participants.

Thank you for coming to our escape rooms. There are a few things you need to know before getting started:

- Each escape room experience gives you 20 minutes to try to escape from your room. You will need to collaborate with your peers, groups of 4-6 people, and use critical thinking skills to make that time frame.
- When you enter the room, there is a black box by the door in which your personal belongings (especially your cell phone) should go in. You are not allowed to use your cell phone during the experience and PLEASE don't share any information about the rooms with students waiting to enter. Each room contains everything you need to solve the puzzles and escape.
- There will be a faculty member in the room with you. Ignore them, unless you need a clue. You must ask them for a clue before they will give it to you. They are simply there to answer questions and to approve your "password" in order for you to successfully "beat" the room.
- Once you are finished (either at 20 minutes or before), you will be escorted out and taken to have a group picture made. (Those who are successful in escaping will receive a prize.) There is a very important (but short) survey we need you to fill out at the end of the experience. Please help us by filling out this survey. It is anonymous, unless you wish to provide your information.
- Here is a scenario for your escape room [hand slip of paper]. There is also one inside for reference, if needed. Good luck to everyone!

Participants

Participants, approximately 18-24 years old, were students currently enrolled at the university and attended the escape room experience hosted by the College of Education at the beginning of the 2018 fall semester. The escape room activity was advertised as *Educate2Escape* on the university website with other campus-wide activities for Week of Welcome. The announcement included a description of the two escape room scenarios and also offered free food and t-shirts. A total of 91 participants, a mixture of male and female, completed surveys immediately following their escape room experience, with two participants having completed both escape rooms.

Data Collection

Data were collected through paper-based surveys. Initial questions asked participants to identify the room they experienced and whether they escaped. A Likert scale was incorporated so students could rate their opinions about collaboration and critical thinking skills used during the escape room experience. The scale included: strongly agree, agree, neutral, disagree, and strongly disagree. Specifically, items 1-3 gathered students' perceptions regarding collaboration skills, while items 4-6 collected information about critical thinking skills. (See Figure 4.) Moreover, each set of three items focused on whether the escape room was an opportunity for participants to practice the skill, improve the skill, and whether they felt other participants would improve their skill. Additionally, informal observations were made by Author 1 and Author 2, who supervised the linear path and the open path rooms, respectively.

Data Analysis

Paper surveys were manually compiled in a spreadsheet, and Likert values were assigned, with 5 being "strongly agree," and 1 being "strongly disagree." To address the first and second research questions, descriptive statistics were used to investigate how students report the escape room experience as an opportunity for themselves or others to practice or improve collaboration skills and practice or improve critical thinking skills. Descriptive comparison analysis was employed to respond to the third research question and identify if there were differences between the ways students reported collaboration and critical thinking skills in a linear path or an open path escape room. Further statistical analysis was conducted with t-tests to investigate if any differences between the survey data from each escape room were statistically significant. Although there is debate regarding the use of parametric versus nonparametric tests for analyzing Likert style data, the researchers for this study followed the guidance in deWinter and DoDou (2010). They conducted t-tests since the tool needed was one to investigate fundamental differences. Lastly, informal observations during the escape room experience were used to support the survey findings.

RESULTS

The first section of the survey collected data about each participant's experience in the escape room. Out of the 91 surveys completed by participants, 45 (48%) experienced the *Escape from School* room, and 48 (52%) experienced the *Time Traveler* room, which accounts for the two students who participated in both rooms. The overall success rate of participants escaping from the rooms was 90%, indicating the majority of students were successful in completing the escape room within the required time limit of 20 minutes. Furthermore, an investigation by room revealed the success rate of the linear path and open path rooms were similar, with 91% of participants completing *Escape from School* and 89% of participants completing the *Time Traveler* room.

Escape Rooms Provide Opportunities to Practice and Improve Collaboration and Critical Thinking Skills

To address the first and second research questions, participants' responses to collaboration and critical thinking skill statements (items 1-6) were compiled in Figure 4. Frequency counts display that most participants rated their experiences in the agree and strongly agree categories. In comparison, fewer participants selected neutral, disagree, or strongly disagree.

Figure 4. Frequency counts of participants' Likert scores regarding the escape room experience as an opportunity to practice or improve collaboration and critical thinking skills.

Survey Response Raw Data Disaggregated by Room Type

Items	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree	
	EFS	TT	EFS	TT	EFS	TT	EFS	TT	EFS	TT
1. I had an opportunity to practice collaboration skills in this experience?	19	17	22	24	4	5	0	2	0	0
2. My participation in this experience helped to <i>improve</i> my collaboration skills?	12	14	23	12	9	16	1	6	0	0
3. Students participating in these types of activities in their classrooms would improve their collaboration skills?	21	21	22	19	2	8	0	0	0	0
4. I had an opportunity to practice critical thinking skills in this experience?	20	25	20	17	5	6	0	0	0	0
5. My participation in this experience helped to <i>improve</i> my critical thinking skills?	14	16	16	14	11	13	3	5	0	0
6. Students participating in these types of activities in their classrooms would improve their critical thinking skills?	25	22	16	21	4	4	0	1	0	0

Note. EFS = *Escape from School*, n=45; TT = *Time Traveler*, n=48; Participants who completed both rooms are counted twice.

Table 1 further presents the percentages of total participants who strongly agree, agree, neutral, disagree, and strongly disagree for each item (#1-6) on the survey connected to collaboration and critical thinking skills. Out of the 91 survey responses, the majority of participants perceived the escape room experience as supporting critical thinking and collaboration skills, as displayed by the large percentages of participants who selected “strongly agree” or “agree” for each item. Further comparison across the items illuminates how the participants were more likely to agree that the escape room experience offered them an opportunity to practice these skills (items 1 and 3), than it did to improve their skills (items 2 and 4), as can be noticed in Table 1. Interestingly, while the participants were less likely to say the escape room improved their skills, the majority of participants felt an escape room experience would improve other students’ collaboration and critical thinking skills.

Table 1. *Percentage of Participants' Responses Per Survey Item.*

Items	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I had an opportunity to practice collaboration skills in this experience?	37.0%	51.1%	9.8%	2.2%	0%
2. My participation in this experience helped to improve my collaboration skills?	27.2%	38.0%	27.2%	7.6%	0%
3. Students participating in these types of activities in their classrooms would improve their collaboration skills?	45.1%	44.0%	11.0%	0%	0%
4. I had an opportunity to practice critical thinking skills in this experience?	47.3%	40.7%	12.1%	0%	0%
5. My participation in this experience helped to improve my critical thinking skills?	30.8%	34.1%	26.4%	8.8%	0%
6. Students participating in these types of activities in their classrooms would improve their critical thinking skills.	49.5%	40.7%	8.8%	1.1%	0%

Comparison of Participants' Perceptions on Their Critical Thinking and Collaboration Skills by Room Design

To address the third research question and understand if there were differences in the ways participants reported collaboration and critical thinking skills in the linear path or open path escape room, we began with a comparative analysis of the average scores for the collaboration items (#1-3) with the average scores for the critical thinking items (#4-6) for each student that participated in only one escape room (n = 89). These averages are displayed in Table 2. The range of scores for each indicator in Table 2 are as follows: 5 strongly agree, 4-4.49 agree, 3-3.9 neutral, 2-2.9 disagree, and 1-1.9 strongly disagree. In addition, t-tests were conducted to further explore if any of the differences displayed between the data from the two rooms were statistically significant (see Figure 5).

Table 2. *Participants' Average Scores of Responses to Collaboration Items (#1-3) and Critical Thinking Items (#4-6) Per Escape Room.*

	Collaboration Items (#1-3)		Critical Thinking Items (#4-6)	
	<i>Escape from School</i> (Linear Path)	<i>Time Traveler</i> (Open Path)	<i>Escape from School</i> (Linear Path)	<i>Time Traveler</i> (Open Path)
Strongly Agree	11.6%	25.6%	27.9%	30.4%
Agree	69.8%	48.8%	44.2%	34.8%
Neutral	16.3%	23.3%	25.6%	26.1%
Disagree	2.3%	2.3%	2.3%	8.7%
Strongly Disagree	0%	0%	0%	0%

Linear path design may influence perceptions about collaboration more than open path design. Table 2 displays participants' average perception of collaboration skills during the escape room experience, either practicing and improving their own skills or how they perceived it improving another's collaboration skills. Results of the comparative analysis show in both rooms, the majority of participants responded positively (agree or strongly agree), which suggests linear path and open path room designs were perceived as beneficial for col-

laborative skill development. However, a greater percentage of participants in the linearly designed *Escape from School* room agreed or strongly agreed compared to those in the open path designed *Time Traveler* room. Additionally, a greater percentage of participants' average scores were reported neutral for the *Time Traveler* room (23.3%) versus *Escape from School* (16.3%). Although these differences are noticeable, they were not statistically significant, as demonstrated in Figure 5. The one exception is the comparison of the responses for Item 2, "My participation in this experience helped to improve my collaboration skills," for the linear path versus the open path. There is a statistically significant difference (at the $p=0.1$ level) in favor of the linear path room. This significant difference, paired with the comparative analysis results, suggests linear path escape rooms may encourage more collaboration skills than open path escape rooms. In considering this finding, the researchers noted that participants were required to work together in the linear path escape room since only one clue was revealed at a time, compared to the open path escape room, which offered an opportunity for participants to split off and work at different stations. This difference may have affected perceptions about collaboration.

Both rooms' designs support critical thinking. Table 2 displays participants' average perception of critical thinking skills following the escape room experience, either practicing and improving their own skills or how they perceived it might support others in improving their critical thinking skills. The comparative analysis shows that the majority (*Escape from School* = 72.1% and *Time Traveler* = 65.2%) of participants' averages were in the strongly agree or agree range, indicating both escape rooms were perceived as beneficial for critical thinking skills. However, the cumulative average of critical thinking items in Figure 6 also indicates there were slightly more participants in the open path designed *Time Traveler* room who disagreed that the escape room experience supported critical thinking skills compared to the linearly designed *Escape from School* room. As with the statistical analysis conducted on the collaboration questions, the differences on the critical thinking questions were not statistically significant. While both rooms were perceived as beneficial, our comparative analyses illuminate that a linear path may encourage more critical thinking than an open path structure. The researchers hypothesize this may have occurred because the linear path structure required the participants to complete the clues one by one, encouraging more group discussion for solving riddles and puzzles. Vocalizing their thoughts might have made participants more aware of their critical thinking, compared to the open path room where participants, working alone or with a partner, would not have been privy to everyone's thinking.

Figure 5. T-test results comparing linear structure versus open path structure.

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Collaboration Composite Score	Critical Thinking Composite Score	All Items Composite Score
Group 1 Average (n=43)	4.3	4.0	4.4	4.3	3.9	4.4	4.2	4.2	4.2
Group 2 Average (n=46)	4.1	3.7	4.3	4.4	3.8	4.3	4.0	4.1	4.1
p value (2 tailed t-test)	0.256	0.092	0.268	0.648	0.709	0.354	0.114	0.440	0.290

Group 1 = *Escape from School* (Linear Escape Room)

Group 2 = *Time Traveler* (Open Escape Room)

Informal Observations Supports Survey Findings

Author 1 and Author 2 were observers in the *Escape from School* and *Time Traveler* escape rooms, respectively. They were responsible for providing the students with a hint if needed, evaluating the NSYNC dance (a performance required to solve the 2000s themed puzzle in the *Time Traveler* room), and helping to re-stage the rooms between groups of participants. Both Author 1's and Author 2's informal observations described participants engaging in critical thinking skills as they collaborated to determine (a) what each puzzle was asking; (b) the best procedure for solving the puzzle; (c) how to implement the procedure; (d) the next steps to take depending on success of the first attempt; and (e) what to do with the results once the puzzle was solved. For example, participants were observed collaborating by directing their peers to look at other boxes and asking whether a certain combination had already been attempted. Also, comments were made soliciting peer involvement, questioning who wanted to do particular tasks, and providing words of encouragement when something did not work.

Author 1 and Author 2 also noted participants celebrated successful escapes as a team and that groups tended to discuss what they might have done differently if they had time to attempt it again. This further showcases how the participants continued to work collaboratively and think critically about the puzzles and their escape strategy and further supports the findings of the survey data, indicating an escape room experience provides an opportunity for participants to practice or improve collaboration skills.

DISCUSSION AND IMPLICATIONS

New models of education supporting the use of collaboration and critical thinking are needed in higher education in order to prepare students for employment in the 21st century (Brown et al., 2019; Franco & DeLuca, 2019). Therefore, this study explored incorporating escape room experiences into campus programming to encourage students' collaboration and critical thinking skills. In response to the first and second research questions, survey data revealed the majority of participants reported being able to practice and improve collaboration and critical thinking skills in the escape room experience. Participants tended to agree more strongly that the escape room experience would improve other students' collaboration and critical thinking skills (items 3 and 6) than improving their own (items 2 and 5). This may be because the post-secondary participants did not feel the puzzles or riddles in the escape rooms were challenging enough to cause improvement for themselves since the majority of groups completed the rooms in time to escape. However, participants may have felt escaping those rooms might be difficult for other students and would have improved their skills. Since the goals of Week of Welcome campus programming are to encourage students to make connections with others and have fun on campus, these rooms were designed to be challenging yet achievable, hence the rooms' high success rate in this study. Thus, for others considering the use of escape rooms in higher education programming, room design's difficulty should be considered based on the event's overall purpose.

In response to the third research question addressing if students' perceptions regarding collaboration and critical thinking skills were influenced by the design of an escape room experience, the data of averages showed the majority of participants responded positively regarding collaboration and critical thinking skills whether they completed *Escape from School* (linear path design) or *Time Traveler* (open path design). The *Time Traveler* room did exhibit slightly greater scores of neutral or negative for the three collaboration items and three critical thinking items. Thus, results suggest linear path escape rooms may influence perceptions of collaboration and critical thinking more than open path escape rooms. The clues' linear nature encourages all participants to work together on a task and allows participants to hear each other's problem solving regarding the clues.

While examining the data, a new question emerged regarding if the familiarity between teammates influenced their perceptions of their collaboration and critical thinking skills. Future studies investigating room design and perhaps interviewing students about their perceptions may shed further light on how structure and participant familiarity influences critical thinking and collaboration.

Limitations of Study

Minor limitations in the study occurred in connection to the survey and population. First, the survey was not validated and only contained a small set of items regarding collaboration and critical thinking since the survey was initially created as a short evaluation of the program. Also, the potential for social desirability bias could have impacted students' responses to the survey. Students might have positive perceptions of collaboration and critical thinking skills and therefore be more likely to claim they had the opportunity to practice or improve these skills. A third limitation stems from the lack of participants completing both rooms. Due to time constraints, all students but two completed only one room. However, had students been able to participate in both rooms, their survey data could have provided more comparative information. The two participants who completed both rooms each completed one survey, providing data on the overall experience and not a specific room. Further insights on the design of escape rooms and students' perceptions about collaboration and critical thinking might have occurred if more participants had completed both rooms and a survey for each.

Finally, most participants were successful in their attempts to escape. This success may have influenced their pos-

itive perceptions of their collaboration and critical thinking skills. Perhaps if students had not escaped the room, they would not have perceived a strong use of these 21st-century skills. This, in turn, poses the question of whether the rooms' difficulty levels influenced the students' perceptions, another interesting topic for future studies.

CONCLUSION

Employers desire college graduates who have proficient 21st-century skills, in addition to career-specific knowledge (Cevik & Senturk, 2019). Concurrently, escape rooms offer students a gamified approach to reinforce collaboration and critical thinking skills (Edson, 2019; Miller et al., 2020). Therefore, to develop highly desirable graduates, colleges and universities may want to consider ways to leverage campus programming to support the continuous development of these skills through activities such as escape rooms. This study provides initial insight into how escape rooms could be enjoyed by students while also being perceived as an opportunity to practice collaboration and critical thinking skills. Evidence from this study suggests that escape rooms can be a campus event that supports critical thinking and collaboration skills among students. An escape room experience was selected for this study because it focused on the two specific skills; however, campus programming leaders and organizers might consider investigating current programming to see what skills are being addressed by, or would naturally align with, events already occurring on campus. If some 21st-century skills are incorporated into highly attended events, and others are not, leaders might seek additional programming to address these needs.

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