Design, Discover, and Decipher: Student-Developed Escape Rooms in the Virtual Ecology Classroom

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There has always been a need for engaging assessments in online learning environments, though the COVID-19 pandemic further emphasized this need. Instructors across science, technology, engineering, and mathematics (STEM) disciplines have begun to implement escape room activities as effective and engaging learning tools in their classrooms. For our virtual introductory ecology course in spring 2021, we developed a student-designed escape room assessment which aligned with several course goals and covered a broad range of ecology concepts. The learning objectives of this assignment asked students to (i) create a themed “room” filled with ecology-based riddles and puzzles that represented a novel virtual escape room for their peers based on an important ecological topic, (ii) summarize and synthesize primary literature into clues and locks to educate their peers about an ecological topic, and (iii) use critical thinking and discussion of ecological topics with peers to solve their peers’ escape rooms. We found that while students generated distinct escape room activities and focused on various ecological topics, student scores on this assessment, as well as student feedback, indicated that the escape rooms were conducive to learning, novel, and accessible in the virtual learning environment. We suggest that student-designed escape room assessments are an effective way for students to learn course material in a fun, engaging, and creative manner, and our spring 2021 implementation suggests that this activity may be an effective assessment for online settings.

KEYWORDS undergraduate, biology, design-based learning, ecology, escape rooms, game-based learning, online classrooms, undergraduate, virtual classrooms

INTRODUCTION

There has always been a need for more effective and engaging assignments in online learning environments, though the COVID-19 pandemic emphasized this need when instructors had to quickly adapt their in-person assignments for the virtual classroom. Online instruction can be just as effective for student learning as in-person instruction (1), but it must incorporate engaging, student-centered activities and open communication with the instructor (2). Kirkwood and Price (3) noted that the quality and validity of online assessments remain areas of concern, though much effort has been allocated to improving and further developing innovative online learning assessments in the past several years (4). While there is no single assessment type that is effective and relevant for all online courses, learner satisfaction in online courses is often higher when multiple unique assessment methods are offered (5).

In recent years, the implementation of escape room activities in undergraduate classrooms has emerged as a novel way of engaging students and promoting deep learning and as an effective online learning tool (6, 7). Nicholson (see p. 1 in reference 8) defines an escape room as “a live-action team-based game where players discover clues, solve puzzles, and accomplish tasks in one or more rooms in order to accomplish a specific goal (usually escaping from the room) in a limited amount of time.” In an educational context, escape rooms allow learners to construct knowledge as they progress with their peers through a series of challenges designed for scaffolded learning (6), which often encompasses multiple rounds of answering questions or solving puzzles related to a particular topic, with the end goal of solving a cumulative or final puzzle. Escape rooms have been used in a variety of courses across science, technology, engineering, and mathematics (STEM) disciplines, many of which have been implemented online, including biology (9), engineering (10), medicine (11–14), physics (15), and chemistry (16). Escape room activities have generally been found to improve students’ motivation, engagement, and academic performance (7).

Game-based learning “takes advantage of gaming technologies and techniques to create a fun, motivating, and interactive virtual learning environment that promotes situated experiential learning” (see p. 1 in reference 6). In most cases, instructors are...
the creators of such games, which are intended to help students learn about or review key concepts from a unit or course. The design elements from an instructor-created escape room benefit students by fostering myriad types of engagement with the content (17). Another form of game-based learning is learning by design, which is more student-centered; during this process, students engage in case-based reasoning and problem-based learning to develop some final product which often aligns with course goals or learning objectives (18). In design-based learning, students, not their instructors, are the creators of these learning games (19).

While game-based learning may be underutilized in undergraduate biology, design-based learning is even less common in such contexts, particularly in online learning environments (20). The majority of design-based learning in STEM courses derive from engineering and computer science (10, 21, 22), with limited examples from biology (19, 23–25). Davis and Lee (10) specifically report on a first-year engineering course in which students collaboratively brainstormed and constructed their own escape rooms containing puzzles using “Arduino hardware, laser cut and [Computer Numerical Control] milled parts, and 3D printed models” (p. 1).

For our virtual introductory ecology course in spring 2021, we aimed to create an assessment focused on constructivist theories (26, 27) that would both measure students’ learning of important ecology topics and allow students to engage in a creative and collaborative project. Thus, we developed a student-designed escape room assignment which aligned with several course goals and covered a broad range of ecology concepts (see below). We posit that this activity advances the field of online education by providing opportunities for authentic collaboration and engagement using a format that can be easily adapted for different courses. Additionally, this escape room assignment offers students the chance to use familiar technology (i.e., Google programs) in a novel way.

**Intended audience**

This assignment was created for an undergraduate introductory ecology course intended for biology majors; however, the materials could easily be modified to align with other biology courses for both majors and nonmajors or for K-12 instruction. The semester of implementation was synchronously online, but this assignment could be used for in-person classes as well.

**Learning time**

Our assignment was designed and implemented as a semester-long project, which was completed entirely in four 3-h labs with some outside-of-class work. We created an “introduction to digital escape rooms” lab (Appendix 1), which was implemented the 4th week of a 16-week semester, that introduced students to the structure and creation of virtual escape rooms (Table I). This first lab was designed to scaffold skills (i.e., navigating a digital escape room, constructing a main slide with clickable objects, and constructing clues and locks in Google products) that will enable them to be successful with their first assessment learning objective (see below).
The lab schedule included three additional full lab periods spaced throughout the semester for students to collaboratively design and develop their projects and ask questions of their teaching assistant. Students were encouraged to work outside of class to complete elements of their project that could not be completed during the lab and to reach out to instructors for additional feedback on their project. Overall, students had 12 weeks to form a group, choose a topic, and develop an ecology-based escape room to share with their peers.

**Prerequisite student knowledge**

This design-based learning assignment is suitable for any course level in biology, though it could also be easily adapted for courses in other STEM disciplines. The prerequisite content knowledge expected of students can be adapted for any course by making the “themes” of the rooms about relevant topics and increasing the complexity. The prerequisite technology skill expected of the students is familiarity with cloud computing service (e.g., Google Docs, Slides, and Forms), which is built upon during the initial lab in which students are introduced to the escape room activity.

**Learning objectives**

The assignment described in this paper represented roughly 20% of the course grade in an undergraduate introductory ecology course. We describe the project-specific learning objectives, in line with the structure and format of an escape room, below. The first two objectives relate to the group’s creation of the product, and the last objective addresses the students’ engagement in the follow-up activity in which they worked to solve one another’s rooms.

Upon completion of the assignment, students should be able to complete the following.

1. Create a themed “room” filled with ecology-based riddles and puzzles that represents a novel virtual escape room for their peers based on an important ecological topic.
2. Summarize and synthesize primary literature into clues and locks to educate their peers about an ecological topic.
3. Use critical thinking and discussion of ecological topics with peers to solve their peers’ escape rooms.

Overall, the goal of this assignment was to replace a field-based group research project which usually comprised a bulk of the laboratory effort in years when the class was in person. To minimize safety concerns associated with COVID, the majority of the lab in spring 2021 was shifted online, and this assignment further provided opportunities for students to collaborate virtually. We aimed for the assignment to allow students to immerse themselves in the literature on a chosen topic, deeply explore concepts related to their topic, and develop a creative and informative virtual escape room. The first two objectives are measurable tasks whose products were assessed with the scoring rubric at the end of the semester. For the third objective, we did not intend to measure a student’s critical thinking; rather, we sought for students to practice critical thinking skills during the activity (i.e., using data and evidence to make decisions), which was assessed through the scoring rubric and peer reviews. To maintain the scholarly dissemination endpoint that students generally enjoy about long-term research projects, the final piece of the assignment was for each group to share their escape room on the final day of the semester so that their peers could learn about other topics using critical and creative thinking to “escape” each other’s rooms.

**PROCEDURE**

**Materials**

The required materials for this assignment were access to a digital device and Internet to use Google software products (e.g., Slides, Docs, Forms). For our implementation, most meetings for class were conducted virtually; therefore, students and instructors needed access to video conferencing and screen sharing capacities, which greatly facilitated effective group work and instructor feedback. We expected our students’ final products to effectively use primary literature as the foundation of their clues and locks (Table 1), which necessitated access to the university library. These materials tend to be freely available to any student, regardless of academic level, which further extends the inclusivity inherent in this assignment.

**Student instructions**

Detailed assignment guidelines are available in Appendix 2. During the first week or two of the semester, students self-selected into groups of 3 to 4 students. While self-selected groups may be more unbalanced (28), Theobald et al. report that working with friends is the single highest predictor of how comfortable students feel in peer groups (29). As a group, students selected an ecology topic among a set of about 15 instructor-created topics which aligned with ecological concepts discussed throughout the semester. Instructors could predetermine these topics, as we did, to ensure that class products represent the range of topics covered in a semester (we stipulated that only one group could use each topic). Alternatively, instructors could encourage students to identify and develop their own topics to promote greater student agency.

The second lab of the semester was dedicated to scaffolding literature searching, discriminating between popular and scientific articles, and developing skills on how to effectively read scientific papers. For courses whose students had this mastery prior to the assignment, this step could be skipped; however, the content amassed and synthesized by students for their escape room is derived from the primary literature, and thus this is a critical skill to establish. In the 4th week of a 16-week semester, students participated in an instructor-led lab which allowed them to experience an escape room.
and familiarize themselves with how to independently build an escape room (see “Faculty instructions” for details on this lab and Appendix 1).

We evaluated our students’ performance on this assignment as four elements in a spaced, scaffolded manner; including a blueprint (due week 6), a main slide (due week 8), one clue-lock set (due week 12), and the final escape room (due week 16) (Appendix 2). We scheduled group work days for the weeks following each scaffolded deadline (i.e., weeks 7, 9, and 13), so the groups could work with and ask questions about instructor feedback on these elements. Students would meet remotely via video conference with their instructors (during a prescheduled time), and the remaining lab work days, they engaged with their groups within a virtual breakout room to develop their own escape rooms.

For the final escape room submission, students were required to email a preview link of their main slide (i.e., a link that allows a participant to view the main slide not as a slideshow but as an active presentation) and an answer key for all their locks to the teaching assistant. The links were compiled into a shared Google spreadsheet and shared with the class on the final day of class. This final day, the escape room share day, was a synchronous online class where the instructor randomly assigned groups to “escape” from each other’s rooms. Groups were put into breakout rooms and worked to escape as many rooms as they could. In our 2.5-h final class period, our groups completed, on average, three other groups’ rooms.

**Faculty instructions**

During this activity, the role of the instructors, including both the lab and lecture instructors, was to provide (i) a foundational knowledge of ecological content from which students may choose their escape room topic, (ii) an opportunity for students to complete a practice escape room, (iii) clear instructions for creating an escape room in a virtual format, and (iv) logistical and technological support for the duration of the project. The second training step for this project, following establishment of literature researching strategies, included the “introduction to digital escape rooms” lab that helped familiarize students with the concept of a digital escape room (i.e., what is the structure of a clue and lock, how does a participant progress through a room, how does a participant “escape”). The first activity in this lab allowed students to complete a short instructor-designed escape room. All elements and links to files used in our implementation are available in Appendix 1. Students worked in groups to complete this first activity, while instructors were available to provide guidance on navigating through the example room. The second activity of this introductory lab allowed students to create their own mini escape room by following detailed written instructions and using provided graphical content and wording for locks and clues. The goal of this second activity was to walk students through the process of building a virtual room, without the creative or technical burden of devising the content themselves. Each student group independently created the same mini escape room. In our implementation, all students created a room focused on facts about our university (e.g., enrollment numbers, facilities on campus), although other instructors may wish to choose a different topic. Among these two activities, our students struggled most with the latter activity.

The written instructions for creating all elements of an escape room (Table 1) are detailed and lengthy; thus, students who skimmed integral parts may get lost, so it is important that the instructor is well-versed on creating all aspects of an escape room and familiar with using Google software products. As Google products are ubiquitous and easily accessible, becoming familiar with such products should generally not be a barrier for instructors implementing this activity, particularly because students are often well-versed in using Google-based tools. However, we do recommend that instructors should prepare their own example escape room—using our institution-specific example as a model—to familiarize themselves with the process.

Upon completion of this lab, our lab instructors allowed students to pick their escape room project group (group size between 3 and 4) and we gave each group 1 week to choose their topic. Instructors can either provide students with a list of approved topics, as we did, or approve group topics individually before students progress with their projects.

The semester-long nature of this project meant that, as instructors, we reviewed portions of student projects every 2 to 3 weeks and provided directed feedback to each student group. Instructor feedback focused on incorporation of ecological topics, correct use of outside sources, and the functionality and creativity of the escape room. This feedback was delivered to students through our learning management system (LMS). This scaffolded approach to the project allowed students to slowly and methodically build their escape room while receiving valuable feedback from the instructor as they progressed. We incorporated an informal peer review of the main slide of each group’s escape room using the entirety of the week-9 lab period (i.e., 3 h of synchronous time). Each group was evaluated on (i) the design of the main slide in accordance with the guidelines and presence of clickable items based on the chosen topic, (ii) the flow and interest of their proposed storyline, and (iii) the use and relevance of ecological information from peer-reviewed sources. Comments were provided in real time to each group using a shared Google slide. This assignment provided valuable feedback to each group beyond that given by the instructor and allowed each group to see other escape room examples outside of their own project. While we implemented this assignment only once during the semester, other instructors may wish to provide multiple opportunities for peer review throughout the semester.

**Suggestions for determining student learning**

We developed a grading rubric to determine if students met the desired learning objectives for this assignment (Appendix 2). The rubric addressed the functionality and aesthetics of the
room, the successful application of ecology content, and how effectively the room encouraged its participants to think critically about the topic. Students were given a copy of this rubric at the beginning of the semester to guide them in their escape room creation. To more objectively evaluate student achievement of the learning objectives, lab instructors graded the escape rooms of students enrolled in lab sections in which they were not the instructor.

To evaluate individual group members’ contributions to the project, a peer review survey was given to students through their LMS after the project was complete. Students evaluated their peers’ quality of work, preparedness, ability to work with others, attitude to project, time management, ability to focus on task, ability to monitor group effectiveness, and overall contribution to the group on a four-point scale (excellent to poor). To ensure full participation, this survey was incorporated as 3% of each student’s final escape room project grade.

We incorporated a scaffolded grading system referred to as “mini goals” in our project guidelines (Appendix 2). This system allowed for frequent student feedback from instructors at several points throughout the semester to verify that students were meeting the expectations of the project and to ensure a higher quality final project.

Sample data

We report on student data from our spring 2021 implementation to robustly evaluate the success of this novel assessment. Data were collected retrospectively and were anonymized and summarized to deidentify participants. These procedures were approved by the University of Northern Colorado IRB (no. 2105026615). The escape rooms that students created during our spring 2021 implementation spanned several ecological topics from biomes to predator-prey dynamics to succession. Clues within these rooms had participants reviewing figures and tables from scientific papers, watching online videos, and reading websites to learn about their topics. This information was subsequently required to answer questions, perform calculations, or solve riddles and puzzles to solve each lock. Each lock provided pieces that would cumulatively contribute to solving the final lock to escape the room. With permission from the student authors, one good example escape room is available at https://docs.google.com/presentation/d/11MUU-AVP5z5iuXQDRGpxUuG8rNQTpAjMxz_blchzusI/view?slide=id.p.

Safety issues

We did not anticipate any safety issues associated with this assignment, as all escape room development and play took place virtually at students’ personal learning environments, and no physical materials beyond a computer and Internet access were needed.

DISCUSSION

Field testing

We implemented this escape room activity in a 300-level undergraduate ecology course in spring 2021. The class had 35 students enrolled that, in groups of three (with one exception), created 12 escape rooms. This activity could be implemented in a class of any size, so long as the instructor had sufficient time to support all the student groups and provide timely feedback. This activity was developed primarily to replace the semester-long collaborative laboratory field project that students usually complete, because the spring 2021 course was taught primarily online.

Evidence of student learning

In designing this escape room assignment, we used backward design to ensure that our learning objectives aligned with the broader learning goals of the course. While formal peer review was not integrated into this assignment due to time constraints, instructors did iteratively provide comments for each student group’s escape room throughout the duration of the course, thus providing a more qualitative, formative mode of feedback.

The mean final escape room score, worth 10% of each student’s total course grade and reflecting only the quality of the final product (Appendix 2), across all project groups was 12.6 (standard deviation [SD] = 1.96) out of a possible 16 points (Table 2). Across nearly all elements of the rubric, the student groups in the 2021 implementation scored around 80% (Table 2). The lowest elements were devising creative lock-clue sets that required their participants to actively use critical thinking skills and inclusion of an adequate source list (i.e., most points were lost by our sample of students for missing citations, incorrect citation format, or citations that were not primary literature). Students tended to earn slightly higher scores on other scaffolded components of the project that were worth fewer points; the blueprint (mean = 9.14; SD = 1.15), storyline (mean = 9.46; SD = 0.73), and clue/lock (mean = 8.11; SD = 1.01) were each worth 2% of each student’s total course grade based on 10 possible points each. These scores, which were all above 75%, lead us to suggest that students broadly achieved the project learning objectives.

Average scores on the functionality, text and media, organization and aesthetics, knowledge and understanding, and application of ecology content sections of the escape room rubric show that students achieved 78.8% or higher proficiency in these areas, suggesting that the first learning objective was supported by the escape room activity. Similarly, the average score on the critical and creative thinking section of the escape room rubric implies that students achieved 72.5% proficiency in this area, indicating that the third learning objective was also supported by our activity. While the average score on the evidence from the primary literature rubric component emphasized that students had an 81.3% proficiency on this aspect and thus supports that the
second learning objective was supported by the escape room activity, the average score for source list on the rubric was only 53.8%. This lower alignment between achievement of the second learning objective and students’ development of source lists for the escape room activity may have been due to a lack of in-class assessments dedicated to proper citational practice, which ultimately led to inconsistent citational format and usage. In future iterations of this project, we recommend that students’ use of primary literature for this activity be further scaffolded by an additional assignment supporting proper citational practice and plagiarism avoidance (e.g., reference 30).

**Student perceptions**

At the conclusion of this project, students were asked to provide open response evaluations regarding their perceptions of the challenges and benefits of engaging in the escape room assignment. This evaluation was not anonymous because it was also part of a survey for students to rate the contributions of their peers to the group project. Of the 35 students in our ecology course, 91.4% completed this feedback survey distributed in Qualtrics/Canvas. Using thematic analysis, we coded emergent themes (identified with capitalization) for both perceived challenges and benefits into categories of (i) Preparation for the assignment, (ii) Process in doing the assignment, or (iii) Product of the escape room assignment. The Process theme was further divided into the types of tasks in which the students were engaging (i.e., noncognitive, cognitive, or affective). Then, subthemes were developed as they emerged in the data set. Sample sizes in parentheses below represent the total number of instances each theme occurred. Themes, types of tasks, and subthemes are presented below and in Table 3 (i.e., challenges) and Table 4 (i.e., benefits), along with the number of references and representative quotes from students.

**Preparation.** We viewed the Preparation theme as the aspects of this project in which students may view challenges or benefits that were not associated with completing the project or the final product they aimed to complete. Rather, the Preparation theme was their perspectives about the assignment itself as they prepared to complete it. While we did not code any benefits in this category, many students cited engaging with a new assignment format (i.e., designing a virtual escape room) as a challenge (e.g., reference 30).

**Process.** We viewed the Process theme as the aspects of this project in which students may cite benefits or challenges that were associated with the act of completing the project with their peers. Among the perceived challenges described by our sample, we noted only two types of tasks: noncognitive tasks, including learning to use new technology (n = 9), the creative demand of developing a novel escape room (n = 7), collaborative work (n = 6), and time management (n = 1), and cognitive tasks, including synthesizing knowledge across an ecology topic (n = 11) and meeting project goals (n = 8). Of the perceived benefits related to the escape room Process described by our students, we identified three types of tasks: noncognitive tasks, such as collaborative work (n = 4) and agency (n = 4), cognitive tasks, including deep learning (n = 21), and affective learning, which incorporated increased creativity and engagement (n = 19), increased fun (n = 9), and less stress in comparison to other assessment types (n = 4).

**Product.** Regarding the final product, we coded a single theme each for perceived benefits and challenges. The primary challenge students cited in this category was being able to understand and effectively play through peers’ escape rooms (n = 1), while the singular benefit noted was not having to do a formal presentation (n = 3) as they might for another type of assignment.

**Summary of student perceptions.** Overall, students perceived slightly more benefits (n = 64 total references) than challenges (n = 56 total references) of engaging in the escape room assignment. The majority of benefits were associated with the process, specifically, cognitive tasks (i.e., deep learning) and affective learning (i.e., increased creativity and engagement).

### Table 2

Average scores of 10 groups from spring 2021 implementation (two groups’ itemized scores could not be recovered) and alignment of rubric elements with learning objectives

| Rubric element                        | Avg % (of 2) | Learning objective (LO) aligned with |
|---------------------------------------|-------------|-------------------------------------|
| Functionality                         | 86.3        | LO1                                 |
| Text and media                        | 81.3        | LO1                                 |
| Organization and aesthetics           | 78.8        | LO1                                 |
| Knowledge and understanding           | 82.5        | LO1                                 |
| Application of ecology content        | 81.3        | LO1                                 |
| Evidence from primary literature      | 81.3        | LO2                                 |
| Source list                           | 53.8        | LO2                                 |
| Critical and creative thinking        | 72.5        | LO3                                 |
| Total                                 | 78.4        |                                     |

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The majority of challenges were related to Preparation (i.e., engaging with a new assignment format) and Process, specifically, cognitive tasks including synthesizing knowledge across an ecology topic and meeting project goals. Further, many of the perceived challenges cited by students were not necessarily negative and may be appreciated retrospectively; for example, though many students reported that synthesizing knowledge across topics was difficult, this is an important skill for students to learn and may have been perceived as a challenge particularly for individuals who were not used to engaging in metacognitive tasks. While students generated distinct escape room activities and focused on various ecological topics, student

### TABLE 3

Perceived challenges of engaging in the escape room assignment, including themes, types of tasks, subthemes, number of references, and representative quotes from students; “NA” reflects themes that either did not exist in our data set or were not parsed into types of tasks or subthemes

| Theme         | Type of task | Subtheme                                           | No. of references | Representative quote                                                                                                                                                                                                 |
|---------------|--------------|----------------------------------------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Preparation   | NA           | NA                                                 | 13                | “Definitely maneuvering around new formats and working with tools that I’m not too used to working with was quite a challenge.”                                                                                       |
| Noncognitive  | Learning to use new technology                    | 9                  | “A major challenge overall that I saw [were] some minor aspects of making sure every piece worked in the escape room . . . it was a little arduous going over every little piece of compiling multiple google docs/forms, where one mistake could ruin the entire escape room.” |
| Process       | Creative demand                                     | 7                  | “The challenges of doing the escape room project is that it was frustrating when we had creative slumps and could not come up with questions for our clues/locks. It was hard to overcome these mental roadblocks and be creative during the whole process.”    |
| Noncognitive  | Collaborative work                                  | 6                  | “With this project we had to think as a group in order to make this project work and setting up meetings outside of class was a bit of a challenge. Initially we had barely met some of our group members, therefore it took us a while to get on the same vibe and start working together as a group whole.” |
| Noncognitive  | Time management                                     | 1                  | “We had only two [in class] work days and sometimes that just wasn't enough time.”                                                                                                                                  |
| Cognitive     | Synthesizing knowledge across an ecology topic      | 11                 | “Some challenges were creating this cohesive, easy to follow storyline from each clue and lock to another. You have all these ideas on the topic that you're trying to correlate together. It requires a lot of creativity to present the factual information in a correct manner.” |
| Cognitive     | Meeting project goals                               | 8                  | “The escape room may have given us too broad of an area to delve into for our project. With such a broad category to focus the escape room on, we added random ideas to the escape room and not all of these ideas quite panned out. We had to refine our project in many ways to keep only the relevant information in the project.” |
| Product       | NA                                                     | 1                  | “If another group’s escape room was overly complicated or had links that didn’t work or articles that couldn’t be accessed, it made us extremely frustrated. This frustration took away from the fun but didn’t ruin the experience.” |

The majority of challenges were related to Preparation (i.e., engaging with a new assignment format) and Process, specifically, cognitive tasks including synthesizing knowledge across an ecology topic and meeting project goals. Further, many of the perceived challenges cited by students were not necessarily negative and may be appreciated retrospectively; for example, though many students reported that synthesizing knowledge across topics was difficult, this is an important skill for students to learn and may have been perceived as a challenge particularly for individuals who were not used to engaging in metacognitive tasks. While students generated distinct escape room activities and focused on various ecological topics, student
scores on this assessment, as well as student feedback, indicated that the escape rooms were conducive to learning, novel, and accessible in the virtual learning environment. We suggest that student-designed escape room assessments are an effective way for students to learn course material in a fun, engaging, and creative manner, particularly when multiple iterations of instructor and peer feedback can be incorporated throughout the duration of this project.

Possible modifications

As described above, we feel that this assignment both serves to engage students in an online environment and challenges them to meet the objectives we set for them. However, through our implementation, we identified four possible modifications that may even further improve the design for instructors and experience and learning for students.

First, integrating more frequent peer review may better support students in receiving regular critical feedback while also providing an opportunity to view a diversity of approaches to the same assignment. While we implemented an informal peer feedback after the main slide was due, more of this type of feedback would have benefited both the creators and the reviewers. We scheduled the escape room share day, which was itself a live peer review, to occur during the final exam period. In retrospect, this experience could have served as critical feedback if we had shifted this share day or a similar experience prior to the final deadline. Having students’ peers participate in their escape room helped “[make] sure all components were addressed . . . as well as making sure all links worked.”

This external run-through prior to final submission would have improved the final products, which not uncommonly had broken links or incorrect codes in their locks preventing successful and easy flow through the room. Further, having an early run-through would have benefited the creators by allowing them to watch another group struggle through their room and identify parts to resolve before finalizing their product. Questions we might suggest that instructors pose to peer reviewers are as follows. (i) Do you know where to start when you enter

### Table 4

Perceived benefits of engaging in the escape room assignment, including themes, types of tasks, subthemes, number of references, and representative quotes from students; “NA” reflects themes that either did not exist in our data set or were not parsed into types of tasks or subthemes

| Theme     | Type of task | Subtheme                          | No. of references | Representative quote                                                                 |
|-----------|--------------|-----------------------------------|-------------------|-------------------------------------------------------------------------------------|
| Preparation | NA           | NA                                | NA                | “Another [benefit] is having been able to share the work, which isn’t always as easy on a term paper, especially since most [term papers] are done individually.” |
|           |              | Noncognitive                      | Collaborative work | 4                                                                                   |
|           |              | Noncognitive                      | Agency            | 4                                                                                   |
| Process   |              | Cognitive                         | Deep learning     | 21                                                                                  |
|           |              | Affective                         | Increased creativity and engagement | 19                                                                                  |
|           |              | Affective                         | Fun               | 9                                                                                   |
|           |              | Affective                         | Less stressful than other assessments | 4                                                                                   |
| Product   | NA           | NA                                | 3                 | “The biggest advantage to me is not having to present it like a poster or oral presentation.” |

Table 4
the room? (ii) Do all the keys make sense and all the locks work? (iii) How does the level of this room (i.e., difficulty of the clue-locks) compare to that of your own room and others you have reviewed?

Second, challenges associated with technology were cited as an issue by our sample of students. While this was not a prevalent idea across all our students (i.e., 9 of 35 students reported it), it may have hindered the success of the students who cited it. A possible modification for future implementations may be to add an extra technology workshop as part of a lab during the development process. Such a workshop could help some students hone skills, ask questions to increase efficiency, and create a safe space to ask about tech issues, which may promote equity among students who might otherwise not feel comfortable asking questions.

Third, a key goal of this assignment was for students to synthesize information across sources about a topic in a meaningful way. The blueprint element of the assignment was designed for students to articulate the “big picture” of their escape room so that they would intentionally develop the clues and locks to weave together into a singular, cohesive story. However, student concerns about developing clues and locks and incorporating variety in these clue-locks (e.g., easy to challenging, interpreting a graph to watching a video, including concepts across the chosen topic) were both reported in our qualitative data and observed by our teaching assistants. To address these concerns, a future modification may be to more clearly explain how the scaffolded elements of the assignment use backward design principles (31) to aim for synthesis objectives throughout. We anticipate that better describing the goal of the blueprint as an overall vision of the topic and how subtopics are independent of one another, rather than just focusing on clue-lock sets as solitary pieces, may shift students’ focus toward synthesis rather than “just repeating information” and “focusing on finding information that [they] could use in [their] questions for each lock.”

Fourth, the most commonly mentioned challenge (Table 2) was in the Preparation as students engaged with a new type of assignment. While the experience of doing an assignment that is “new and different” may induce discomfort, as educators, we feel that exposing our students to a variety of experiences helps prepare them for their future careers. A possible modification to alleviate some of this discomfort may be to create opportunities to discuss this challenge to better understand if students were uncomfortable because it was new or if their concern was rooted in anxiety about content or technology that could be addressed differently. Providing stronger metacognitive tasks may help students better uncover what challenges they were having to provide support to remedy issues early.

SUPPLEMENTAL MATERIAL

Supplemental material is available online only.

SUPPLEMENTAL FILE 1, DOCX file, 0.2 MB.

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