

“The Da Vinci Code for IP research”: Case Study of a Course-Integrated Educational Escape Room for Entrepreneurship Education

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Abstract Educational escape rooms can engage students in the development of information literacy skills while interacting with information formats and environments authentic to their disciplines. In business and entrepreneurship education, escape rooms offer the additional benefit of developing the characteristics of the entrepreneurial mindset, such as adaptive thinking, problem solving, enthusiasm, and decisiveness. This case study explores game-based learning for library instruction in entrepreneurship education. Using Eukel and Morrell’s (2021) escape room design cycle as a framework, it analyzes the development, testing, implementation, and results of an original escape room, *Exfiltration! A Competitive Intelligence Virtual Escape Room*, implemented as a course-integrated information literacy learning activity in an upper-level undergraduate new venture creation course. Limitations of the escape room are identified, and opportunities for iterative improvement are described. Recent scholarship on the application of entrepreneurial mindset, business research competencies, gamification, escape room pedagogy, and escape rooms in library instruction is discussed. This case study responds to the call from Taraldsen et al. (2020) for more small-scale studies of educational escape rooms outside of the STEM and health science disciplines.

Keywords *escape rooms, business research competencies, entrepreneurship education, entrepreneurial mindset, experiential education, game-based learning, library instruction, information literacy, escape room design cycle*

Library instructors are exploring gamification as a pedagogical strategy to engage students in information literacy learning experiences. Virtual escape rooms, in which student-players compete to unlock puzzles by correctly completing challenges, are an emerging format for gamified learning that readily integrates online library research tools and disciplinary information formats. Virtual escape rooms can be tailored to achieve information literacy outcomes while providing students with an engaging, narrative-driven experience with information that is authentic to their discipline. This case study explores game-based learning for library instruction in entrepreneurship education. Using Eukel and Morrell’s (2021) escape room design cycle as a framework, the development, testing, implementation, and results of an original course-integrated educational escape room, *Exfiltration! A Competitive Intelligence Virtual Escape Room*, are presented, and opportunities for improvement are identified. Discussion of *Exfiltration!* is contextualized with recent scholarship on entrepreneurial mindset and its alignment with business research competencies, game-based learning and escape room pedagogy, and the adoption of escape rooms as learning activities in library instruction.

Entrepreneurial Mindset and Business Research Competencies

Entrepreneurial mindset comprises cognitive, affective, and behavioral elements (Kuratko et al., 2020; Robinson & Gough, 2020). Students exhibiting an entrepreneurial mindset are cognitively adaptable, demonstrating metacognition to identify business opportunities, problem-solve, and innovate. Affective coping mechanisms to manage the stress, risk, and disappointment that accompanies new venture creation, such as optimism and enthusiasm, also characterize the entrepreneurial mindset. The “entrepreneurial hustle” enables students to take constructive action amidst uncertainty and emergent opportunities (Kuratko et al., 2020, p. 1685).

Experiential education paired with metacognitive reflection is a leading pedagogy for developing entrepreneurial mindset. Effective experiential entrepreneurship education is best characterized by a clear goal to be accomplished, limited resources, uncertainty, possibility for failure, ambiguity leading to multiple possible strategies for goal accomplishment, affective engagement, and an action imperative which requires students to act in the face of limited information (Robinson & Gough, 2020).

Aspects of the entrepreneurial mindset are reflected in the Business Research Competencies. Listed among traditional business research skills is the cognitive adaptability to adjust a search strategy (RUSA, 2019). This further aligns with the Searching as Strategic Exploration frame of the ACRL Framework (2016). Interestingly, scholars have noted the omission of intellectual property (IP) research from the Business Research Competencies (Howard et al., 2018; Toane & Figueiredo, 2018). While not essential to all business information needs, patent and other IP research skills are in demand among patron-entrepreneurs and are an emerging area of specialization for librarians (Hoppenfeld & Malafi, 2015; Toane & Figueiredo, 2018). Patent search techniques and entrepreneurial thinking are also applicable to information literacy in disciplines outside of the business domain, including chemistry, engineering, law, health sciences, and medicine (Anderberg, 2020; Carroll et al., 2019; Gordon et al., 2018; Hylton et al., 2020; Phillips et al., 2019; Russell-Rose, 2018; and Shin et al., 2020).

Game-based Learning and Escape Room Pedagogy

Game-based learning positively influences entrepreneurial intention and mindset in students as part of experiential entrepreneurship education (Martina & Göksen, 2020). Escape rooms have become popularized as a game-based learning modality in the last five years, especially in STEM and health science programs (Martina & Göksen, 2020; Taraldsen et al., 2020; Veldkamp et al., 2020). Educational escape rooms comprise learning objectives; narrative; a game platform (which can be as simple as a webform); locks, puzzles, or challenges; and a game resolution and reward (Kroski, 2020). The narrative arc of escape rooms allows instructors to integrate educational story into game-based learning, engaging students in the affective domain and facilitating their ability to encode new knowledge from the learning experience (Vossler & Watts, 2017). Escape rooms are said to contribute to learning and retention, provide multiple modes of participation, and increase student engagement, self-efficacy, and motivation (Martina & Göksen, 2020; Plump & Meisel, 2020; Taraldsen et al., 2020; Veldkamp et al., 2020; Waggoner et al., 2019). It is observed that escape rooms appeal particularly to traditional aged, Gen Z college students, who are characterized as multimodal learners with limited attention spans; however, escape rooms also present accessibility challenges, and some students will prefer traditional lecture-based learning experiences (Milkman, 2021; Waggoner et al., 2019). While educational escape rooms are generally completed synchronously in teams, virtual escape rooms that students complete independently and asynchronously have been successfully implemented (Schroeder, 2020).

Like experiential entrepreneurship education, escape room learning design should be framed by a goal to be accomplished (Milkman, 2021; Veldkamp et al., 2020). Instructors are encouraged to employ a design cycle when developing educational escape rooms to ensure that they both achieve pedagogical outcomes and deliver an immersive affective experience (Eukel & Morrell, 2021; Veldkamp et al., 2020). Eukel and Morrell (2021) propose a six-stage escape room design cycle, comprising design, pilot, evaluate, redesign, re-evaluate, and iterate phases, to optimize student learning, achieve curricular alignment, and support continuous improvement. Testing during the pilot and redesign phases is particularly important when an escape room incorporates live, dynamic data in its challenges (Kroski, 2020; Pennucci, 2020). Martina & Göksen (2020) offer complementary design elements for escape rooms in experiential entrepreneurship education, including learning outcomes related to “self-awareness and self-efficacy,” “initiative, motivation, and persistence,” and “financial and economic literacy” (p. 5). To serve as an effective learning activity, course-integrated escape rooms should have clear learning objectives that align with the curriculum and require that students utilize relevant subject knowledge and information skills to solve puzzles (Plump & Meisel, 2020; Veldkamp et al., 2020).

Educational escape rooms can mimic real-world conditions, including those relevant to entrepreneurship education, such as uncertainty, stress, limited information, and time constraints, while delivering fun and a sense of accomplishment to create authentic learning experiences (Plump & Meisel, 2020; Taraldsen et al., 2020; Waggoner et al., 2019). Students should be prepared with effective onboarding materials and experience early wins which motivate them to persist through successively difficult challenges (Davis, 2019). In-game feedback should facilitate student self-assessment and reflection, and some challenges should be designed to target higher-order thinking (Urban, 2019). Students’ affective engagement can be accomplished through their immersion as player-characters in a game narrative (Plump & Meisel, 2020; Veldkamp et al., 2020). Saxena and Mishra (2021) mapped Gen Z characteristics to elements of game-based learning, finding that technology-based games appealed to generational preferences for digital experiences, frequent and instant communication, self-directed and individualized learning, short attention spans and desire for “micro-experiences,” and blending of leisure and academic experiences (p. 13). Their systematic review of twenty-nine studies found that game-based learning correlated with higher rates of engagement, motivation, retention, and better scores on practical assignments (Saxena and Mishra, 2021). Notably, one study resulted in no student teams successfully completing an entrepreneurship education escape room, but observed that all students remained motivated and engaged persistently until gametime expired (Martina & Göksen, 2020). Following any game-based learning experience, debriefing discussions and opportunities for metacognitive reflection are recommended to reinforce learning objectives and guide students in connecting the learning activity to course outcomes. Debriefings are especially helpful for students who are not successful in completing the escape room (Martina & Göksen, 2020; Plump & Meisel, 2020; Schroeder, 2020; Taraldsen et al., 2020; Veldkamp et al., 2020; Waggoner et al., 2019).

Escape Rooms in Library Instruction

Valued for their ability to facilitate critical thinking, inquiry, and search persistence, escape rooms are used as learning activities in library orientations and to enhance information literacy instruction (Davis, 2019; Kroski, 2020; Pennucci, 2020; Pun, 2017, 2020; Urban, 2019). Educational escape rooms in library instruction can incorporate real information artifacts--such as patents and 10-K filings--and may assuage library anxiety (Davis, 2019). Library instructors can look to information literacy models, such as the Business Research Competencies or ACRL Framework, and employ backward design to inform escape room development (Kroski, 2020; Urban, 2019). Comprehensive guidance and resources for creating free

digital escape rooms for library instruction are provided in Kroski (2020). This case study provides updated information on a virtual escape room developed for experiential entrepreneurship education as described by Hartman-Caverly (2021d).

***Exfiltration!*: Educational Escape Room Design, Implementation, and Evaluation**

Exfiltration! A Competitive Intelligence Virtual Escape Room is an original digital escape room developed to teach business and IP research concepts (Hartman-Caverly, 2021b; 2021c). This case study retrospectively applies Eukel and Morrell's (2021) escape room design cycle to analyze the development, implementation, and impact of *Exfiltration!* The case study received an exempt determination from Penn State University (PSU)'s IRB (study number 00017685).

Design

Escape room design includes the context, purpose, and learning objectives, which inform the creation of challenges (Eukel & Morrell, 2021). *Exfiltration!* is the creation of a reference and instruction librarian at a regional campus of an R1 land grant university system who has liaison responsibilities with engineering, information science, business and entrepreneurship programs; a center for entrepreneurship and economic development; and a university-affiliated start-up incubator. Penn State Berks offers baccalaureate business degrees, as well as an entrepreneurship and innovation (ENTI) minor that can be completed with any major program of study ("ENTI minor overview," 2021). The campus is home to the Flemming CEED Center for Creativity, Entrepreneurship, and Economic Development, which hosts the student Entrepreneurship Club ("Academic clubs," 2021; "Flemming CEED Center," 2021). Penn State Berks is also affiliated with the Berks Launchbox (n.d.), an innovation hub serving both university constituents and community members. PSU is also a Patent and Trademark Resource Center (Meier & Lysiak, 2021), and IP research consultations comprise a growing portion of the author's reference portfolio.

Following public health guidelines due to the COVID-19 pandemic, PSU continued primarily remote instruction and programming during fall 2020. When the author was invited to speak about IP at an Entrepreneurship Club event by the CEED Center in October 2020, she endeavored to actively engage club members in a learning experience that was both fun and informative. Given the dual emphasis on gameplay and problem-solving, an IP research-themed virtual escape room provided the ideal format. Additional details about the creation of *Exfiltration!* are described by Hartman-Caverly (2021d).

Exfiltration! was designed to achieve three learning outcomes. By completing the escape room, players would be able to:

- conduct a patent search and analyze the results from a business perspective, in order to identify competing products and entities as well as potential investors.
- identify new avenues of business research from patent search results, in order to seek more information about competing products and entities as well as potential investors.
- describe patents as a form of IP, in order to articulate competitive advantages and risk areas related to IP protection and infringement.

Exfiltration! incorporates patent searching and analysis in Google Patents and public company filings searching and analysis in US SEC EDGAR (EDGAR) in order to solve escape room challenges. Each challenge contains a hint that players can display on-demand, providing step-by-step instructions for

retrieving the needed information. Google Patents is used in lieu of the United States Patent and Trademark Office (USPTO) patent search interface due to unique dynamic indexing and linked data features of the Google Patents environment. These features include the similar patents search feature and summary assignee and cooperative patent classification analysis located on the search results page, which provide links to generate new search results from Google Patents and facilitate seamless gameplay. Google Patents is also a more user-friendly search environment than USPTO for novice patent researchers. Only freely accessible search tools are incorporated to ensure that the *Exfiltration!* experience can be offered to non-university-affiliated community members through the Launchbox, as well as to acquaint students with resources they will have at their disposal after graduation.

Upon accessing the virtual escape room, players are presented with a brief corporate espionage-themed narrative and a product schematic (Hartman-Caverly, 2021c), which they first have to identify as a patent drawing. The narrative and schematic are intended to pique players' interest and to offer an "easy win" to motivate players at the outset of the breakout game. Though some players might accurately guess the image is a patent drawing from the multiple-choice selections, an optional hint encourages them to use reverse image search. This skill becomes necessary when players have to identify the publication (patent) number of the image source in challenge two. Players must then retrieve the patent to identify its assignee using Google Patents. The next few challenges involve patent search analysis tools in Google Patents, including ranking assignees by their share of similar patents owned, locating the primary Cooperative Patent Classification (CPC) assigned to similar patents, and identifying the publicly-traded US company that owns many patents in this CPC. This feeds into an EDGAR search, where players must retrieve and analyze the most recent annual 10-K filing by this major US company to map their competitive landscape. Upon completing the escape room, players see a congratulatory narrative expressing the satisfaction of their corporate espionage client and can download a custom Certificate of Exfiltration.

Pilot

Testing is an important step in the escape room design cycle for revealing technical issues with gameplay and other pain points for players (Eukel & Morell, 2021). The creator recruited two colleagues and a family member to test the virtual escape room. The two colleagues had experience with virtual escape room development and were familiar with the game platform, Springshare's LibWizard, but had no prior knowledge of patent or business research. The family member had experience playing a physical escape room, but no familiarity with LibWizard or patent or business research. The family member and one of two colleagues were able to complete *Exfiltration!* in the twenty minutes allotted; the second colleague ran out of time on the final challenge. All three testers reported that the hints were helpful in solving challenges and the game mechanics behaved as expected; consequently, no changes were made to the escape room for the Entrepreneurship Club event.

The author then piloted *Exfiltration!* with seven undergraduate members of the Entrepreneurship Club, along with two faculty club advisors, via a Zoom meeting in October 2020, as detailed by Hartman-Caverly (2021d). Players were provided a very cursory introduction to the escape room advising them to work together as a team, select a designated "reporter" to input answers, and access the hints if they got stuck (or the Ask for Help feature for technical assistance). Players were informed that they had twenty minutes to complete the game once they accessed the escape room link, and they were randomly assigned to two teams using the Zoom breakout room feature. Following the escape room, players

reconvened as a large group to debrief, and the librarian presented a mini-lecture on IP concepts for entrepreneurs (Hartman-Caverly, 2020).

Evaluate

An escape room pilot generates preliminary data to evaluate the gameplay experience (Eukel & Morrell, 2021). As explained by Hartman-Caverly (2021d), one team successfully completed *Exfiltration!* during the club event, and the other team ran out of time on the final challenge. Only two student-players completed the optional feedback form, but both awarded *Exfiltration!* a perfect score for overall game experience. Players reported a positive gameplay experience during the debrief. No players reported technical issues or unreasonable challenges; some discussion ensued about team dynamics and disagreement over how much time to spend before accessing the hint. Based on this preliminary success, one of the participating faculty advisors proposed adopting *Exfiltration!* to replace a traditional IP lecture and quiz as a required learning experience in her online course. The student president of the Entrepreneurship Club, who was also pursuing the ENTI minor, affirmed that *Exfiltration!* would provide a valuable and engaging learning experience for students.

Redesign

The redesign stage of the escape room design cycle is an opportunity to make improvements based on the pilot results and to develop learning assessments and evaluation instruments for educational escape rooms (Eukel & Morell, 2021). Following the successful pilot with the Entrepreneurship Club, *Exfiltration!* was added as a required learning experience in MGMT 425: New Venture Creation in place of a traditional lecture and quiz about IP concepts. The only change made to gameplay was to extend the timer from twenty to thirty minutes to ensure that students had adequate time to complete *Exfiltration!* as a required learning activity without sacrificing the immersive affective experience invoked by the timer (Nahl, 2005). To preserve the integrity of the learning experience, the instructor also requested that *Exfiltration!* be offered exclusively for her course at Penn State Berks.

One major difference between the delivery of *Exfiltration!* during the Entrepreneurship Club pilot versus the course-integrated activity is that MGMT 425 is an asynchronous online course. As a result, students played the escape room individually, rather than collaboratively in teams, and had no real-time interaction with the librarian-game master. To compensate for the loss of the pregame briefing, a three-minute introductory video was added to the welcome screen of the escape room (Hartman-Caverly, 2021b). Viewing this video did not count against the player's time limit. The introductory video provides an overview of the escape room learning activity and offers students some gameplay tips, including how to contact the librarian for help (Hartman-Caverly, 2021e).

The librarian developed metacognitive reflection questions to guide students in processing gameplay as a learning experience. Reflection questions also serve as formative learning assessments to gauge how students situate IP concepts and competitive intelligence (CI) research skills into their understanding of new venture creation and to identify unmet learning outcomes. The reflection questions were:

1. How can intellectual property (IP) research inform your business strategy?
2. Which competitive intelligence (CI) skill used in the escape room is most useful to your new venture formation? Explain your reasoning.

3. How will information help you establish and maintain your competitive advantage? Think about research skills, information resources, and services that you can use as you develop your new venture. Outline a three-point competitive intelligence (CI) strategy. Example: I will ... in order to ...

Students were required to compose short responses to these three reflection questions in the learning management system (LMS) following completion of *Exfiltration!* Students were also asked to complete the same feedback form used during the pilot to report on their gameplay experience.

Reevaluate

Continuous evaluation of educational escape rooms ensures that they deliver optimal gameplay and learning experiences to students (Eukel & Morell, 2021). Educational escape rooms can be evaluated using data generated by gameplay, as well as feedback solicited from players. Game data includes escape room completion rates, average scores and score distributions, correct answer rates at the individual challenge level, and hint use. Feedback forms can solicit additional information from players about their gameplay experience; and, for educational escape rooms, reflection questions or other methods of assessment can evaluate student mastery of course-related concepts. The reevaluation of *Exfiltration!* revealed a number of opportunities for improvement.

Exfiltration! was played by seventeen students as a required learning experience in a spring 2021 section of MGMT 425: New Venture Creation at Penn State Berks. Nine out of seventeen students (53%) completed the escape room to the final question; eight students (47%) did not complete *Exfiltration!* As each challenge question allowed multiple attempts, students earned an average score of 45%, and a median and mode score of 29%; one student scored 100% on the escape room. Scores were distributed unevenly, as seen in Table 1 and Figure 1.

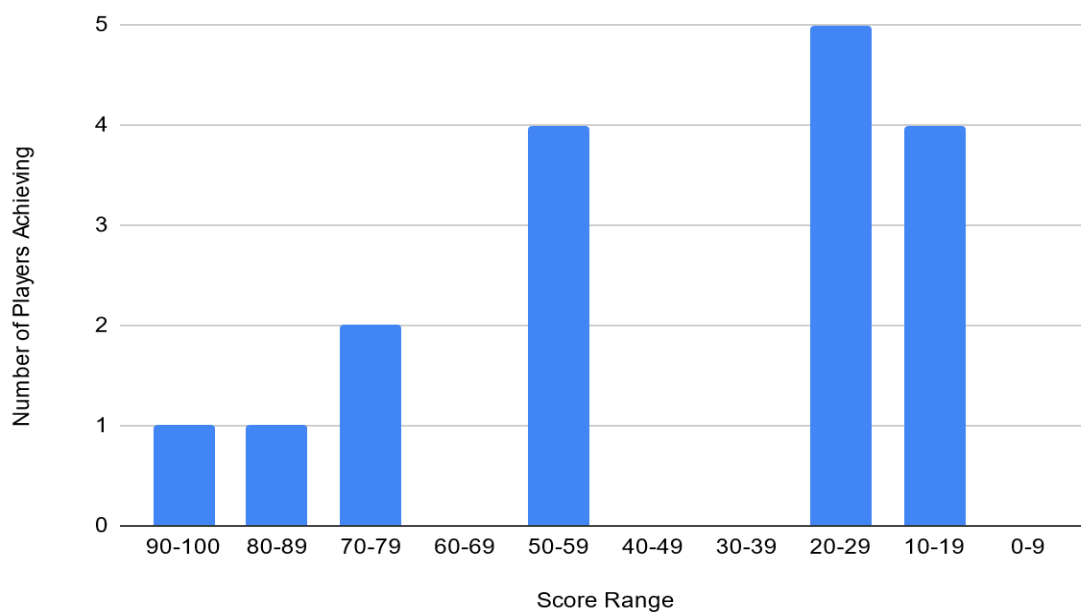


Figure 1. Distribution of *Exfiltration!* scores.

Score Range	Number of Players Achieving this Score Range	Percentage of Players Achieving this Score Range
90-100%	1	6%
80-89%	1	6%
70-79%	2	12%
60-69%	0	0%
50-59%	4	24%
40-49%	0	0%
30-39%	0	0%
20-29%	5	29%
10-19%	4	24%
0-9%	0	0%

Table 1. Distribution of *Exfiltration!* scores.

Exfiltration! features seven challenge questions. The game platform, Springshare's LibWizard, tracks correct responses at first attempt; players could make an unlimited number of attempts at each challenge and were required to input the correct response to advance. Challenge-level completion data is detailed in Table 2 and Figure 2. All students successfully completed the first challenge. For the second challenge, six players (35%) correctly entered the patent number on their first attempt; an additional three students identified the correct patent number but included extraneous punctuation in their response, which was marked incorrect by the automated grading system. One student was not able to correctly identify the patent number, exiting the escape room at challenge two. The remaining sixteen students successfully completed challenge three. Six students (35%) exited the escape room at challenge four. One student exited the escape room at challenge five. The remaining nine students successfully completed the *Exfiltration!* escape room.

N=17 Challenge	Number of correct responses on first attempt	Percentage of correct responses on first attempt	Number of players using the hint	Percentage of players using the hint	Number of players using the hint before first attempt	Percentage of players using the hint before first attempt	Number of players exiting at this challenge	Percentage of players exiting at this challenge
One: Image Source	16	94%	0	0%	0	0%	0	0%
Two: Publication (patent) number	6	35%	13	76%	3	18%	1	6%
Three: IP owner (patent assignee)	10	59%	10	59%	5	29%	0	0%
Four: Assignees of similar IP	5	29%	13	76%	3	18%	6	35%
Five: CPC	9	53%	2	12%	1	6%	1	6%
Six: Competitor controlling patents in CPC	6	35%	8	47%	5	29%	0	0%
Seven: Competitive landscape (10-K analysis)	1	6%	8	47%	1	6%	9	53%

Table 2. *Exfiltration!* Challenge Completion Data, Use of Hints, and Exit Challenge.

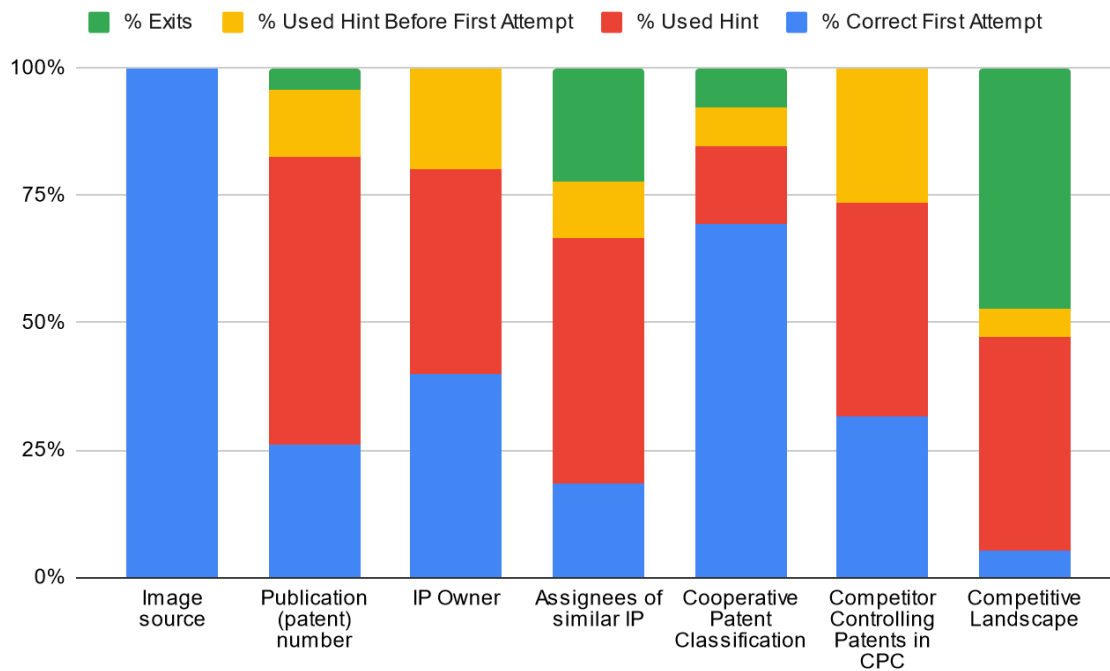


Figure 2. *Exfiltration!* Challenge Completion Data, Use of Hints, and Exit Challenge.

Following their *Exfiltration!* escape room experience, students responded to three metacognitive reflection questions. When asked how IP research can inform their business strategy, eleven students referenced using IP research for competitor analysis and to develop their strategic differentiator; relatedly, five students said that IP research would inform product design, and two students mentioned using IP research to identify competing products. Five students indicated that IP research could help manage the risk of IP infringement, and three students said knowledge of IP could inform their business strategy. Additional responses included finding material inputs for manufacturing, finding sources of venture capital, and conducting business viability analysis. One student described IP research as being “like a literature review of the new venture.” Another student observed:

Intellectual property is what makes a company unique and valuable. Protecting this is important. Researching intellectual property can help a business to find a gap in the marketplace and create a product that is innovative. The business can use this knowledge to create a strategy for competitive advantage.

Asked to identify which CI skill is most relevant to their new venture, a majority of students thought that patent research is useful, with seven students saying it can help identify competitors or one’s strategic differentiator, three citing the ability to determine patentability and/or avoid infringement, and others referencing the ability to locate manufacturing inputs and other capital. Three students said that general research skills would be useful. Two students mentioned the use of reverse image search techniques to pinpoint similar product designs. Other students mentioned planning, ideation, analysis skills, organization, and patience as escape room skills that would transfer to their new venture.

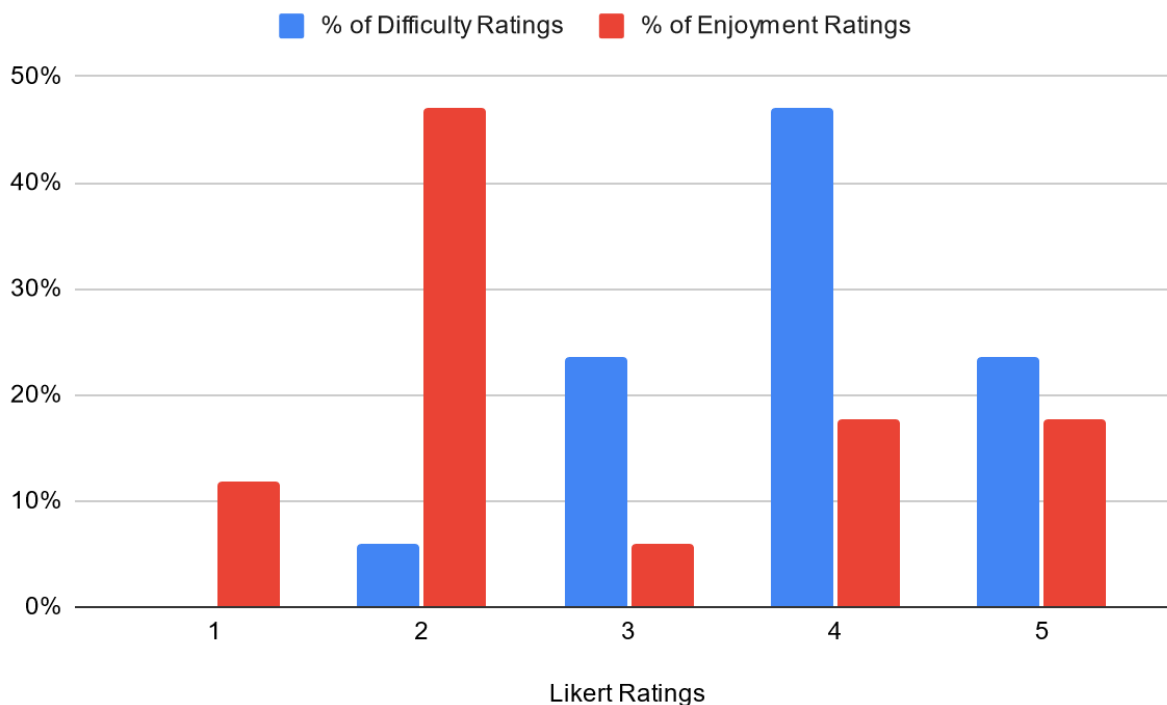
Students concluded the reflection activity with the development of a three-point CI strategy. Nine students indicated their strategy would include researching competitors and competing products, with six students using patent research to do so and two students using SEC filing research. Seven students said

they would conduct research, including using library resources, to improve their business strategy and to manage financial risk. One student commented, “I will use my research skills before I get too invested with the product or service in order to avoid wasting time and money to ensure I am able to move forward with the new venture.” Seven students referenced patent research to determine patentability or to protect IP, and others cited patent research as useful for finding raw materials, determining consumer demands, and conducting product safety assessments. Two students said they would conduct customer and market discovery research. Other responses included using reverse image search to identify competing products, networking with the local business community, and cultivating patience, active listening, open-mindedness, and delegation skills.

Finally, students were invited to complete the same feedback form used by Entrepreneurship Club members during the *Exfiltration!* pilot. The feedback form included two five-point Likert scale questions, one which addressed the difficulty of the escape room (1 = too easy, 5 = too difficult), and one which addressed enjoyment of the escape room (1 = boring, 5 = fun). (The Likert-scale question assessing the overall game experience was inadvertently omitted when migrating the form into the LMS.) Students could also submit free-text responses describing technical difficulties, suggesting additional changes, or highlighting something they enjoyed. The difficulty and enjoyment ratings are summarized in Table 3 and Figure 3.

<i>N</i> =17 Likert rating	Number of difficulty ratings	Percentage of difficulty ratings	Number of enjoyment ratings	Percentage of enjoyment ratings
1	0	0%	2	12%
2	1	6%	8	47%
3	4	24%	1	6%
4	8	47%	3	18%
5	4	24%	3	18%
<i>Note.</i> For the difficulty rating, 1 = too easy and 5 = too difficult; for the enjoyment rating, 1 = boring and 5 = fun.				

Table 3. *Exfiltration!* Difficulty and Enjoyment Ratings.



Note. For the difficulty rating, 1 = too easy and 5 = too difficult; for the enjoyment rating, 1 = boring and 5 = fun.

Figure 3. *Exfiltration!* Difficulty and Enjoyment Ratings.

When asked about technical difficulties they encountered, five students indicated they would benefit from more detailed hints. Two students expressed a need for more time, and two students said unfamiliarity with the LibWizard platform hindered their experience. Two students thought that the instructions were unclear. Students also mentioned challenges with precision requirements in automatically-graded free-text responses, and wanted the ability to move on after so many incorrect attempts. Three students reported encountering no technical difficulties. The individual gameplay experience, in contrast with the team-based experience in the pilot, may account for the diminished persistence, inability to troubleshoot technical problems, failure to solve the challenge questions, and general frustration exhibited by many students.

Students also offered further suggestions for improvement and indicated what they enjoyed about *Exfiltration!*. Three students suggested extending the timer or getting rid of it altogether. One student wanted to see improved hints, while another noted that the hints provided were helpful. One student simply implored: "Make it a little bit more easier!" A few students expressed enjoying *Exfiltration!* One described it as "like the Da Vinci code but for IP research." Another shared that they thought the reason they enjoyed the escape room was because it was difficult. A final student observed, "Overall it was a really great experience and I would love to do more things like this in the future."

Iterate: Next Steps for *Exfiltration!* 2.0

Like other instructional materials, educational escape rooms improve through iteration and evidence-based refinement (Eukel & Morell, 2021). Results and student feedback point to numerous opportunities for improving *Exfiltration!* The instructor is committed to retaining the escape room as a course-integrated learning activity on the condition that improvements to the gamified learning experience are implemented to respond to students' experiences. To better prepare students, the author will extend the onboarding video with brief demonstrations of Google Patents and EDGAR searches and recommend students review relevant CI tutorials (Hartman-Caverly, 2021a) prior to gameplay. Closer coordination with the instructor, including the possibility of locking access to *Exfiltration!* in the LMS until after the game is tested and updated accordingly, will ensure that challenge questions contingent on dynamic data are correctly auto-graded. A new debriefing video that reviews IP concepts and escape room CI techniques and demonstrates correct challenge responses will also be developed for review upon completion of the escape room. Game time will be extended from thirty to forty-five minutes, so that the entire *Exfiltration!* experience (introductory video, gameplay, debriefing video, reflection questions, and feedback form) can be completed in approximately one hour. To enhance enjoyment of the game, the narrative arc will be interspersed throughout the challenge questions. No changes are planned for the metacognitive reflection questions, as they effectively elicited meaningful student responses that demonstrated connections between gameplay and course concepts. Finally, the author recognizes that game-based learning is not effective, appealing, or accessible for all students, so an updated lecture with corresponding tutorial activities covering the same concepts and skills will be developed as an equivalent alternative learning experience. These improvements are planned for the fall 2021 semester.

The *Exfiltration!* virtual escape room extends gamified library instruction at Penn State Berks from first-year seminar programming into curricular instruction (Chisholm et al., 2020). *Exfiltration!* also has potential applications outside of course-integrated learning activities. In fall 2021, the author facilitated an *Exfiltration!* game as part of a workshop on intellectual property during Global Entrepreneurship Week. The escape room can also be used in programming for community entrepreneurs sponsored by the Berks Launchbox or in collaboration with the local public library. Future versions that emphasize the commercialization of new technologies may be developed to focus on particular industries, such as robotics, medical devices, or renewable energy, to teach intellectual property research in programs outside of business, such as mechanical engineering, kinesiology, and occupational therapy.

Conclusion

Escape rooms are an emerging area of gamified learning in library instruction. Virtual escape rooms take the action online, appealing to Gen Z's preferences for technology-enhanced learning and socializing, while also extending the library's instructional reach to remote and asynchronous learners. As a subset of gamification, escape rooms also provide a platform for incorporating educational stories into information literacy instruction, using narrative conventions to engage and motivate students while assisting them in encoding new knowledge. Virtual escape rooms also lend themselves to instruction assessment techniques which respect participant privacy while generating rich data on game completion rates, time-to-completion, and success rates on challenge questions, in addition to potential qualitative feedback.

Library instructors seeking to develop a virtual escape room are encouraged to consider the intersection of learning objectives, disciplinary subject matter, information environments, and thematic elements to develop a game story. Compared to their analog progenitors, virtual escape rooms are particularly well-suited to interacting with dynamic data in real-time; the trade-off is that they require

ongoing testing and updating. Virtual escape rooms also provide a context for engaging students with primary information sources in their discipline. Effective game narratives can help students navigate and make sense of these specialized information formats to deliver an authentic learning experience.

This case study of *Exfiltration!: A Competitive Intelligence Virtual Escape Room* answers the call from Taraldsen et al. (2020) for scholarly communication on the use of educational escape rooms outside of STEM and the health sciences. Eukel and Morrell's (2021) escape room design cycle is used to investigate the development, testing, implementation, and results of an original escape room implemented as a course-integrated information literacy learning activity in an upper-level undergraduate new venture creation course. Limitations of the escape room are identified, and opportunities for iterative improvement are described. Educational escape rooms present compelling instructional strategies for experiential entrepreneurship education, where they can be designed to cultivate the cognitive, affective, and behavioral characteristics of the entrepreneurial mindset. Educational escape rooms also offer opportunities for library instructors to extend information literacy instruction in impactful and curricularly aligned ways.

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References

Academic clubs. (2021). Penn State Berks. Retrieved from <https://berks.psu.edu/academic-clubs>

Anderberg, L. (2020). How to read a photograph, a passport, a product sample, and a patent: Teaching with STEM archives. In A. Borst and R. DiYanni (Eds.), *Critical reading across the curriculum: Volume 2: Social and natural sciences* (pp. 58-80). Wiley. <https://doi.org/10.1002/9781119155317.ch4>

Association of College & Research Libraries [ACRL]. (2016, January 11). Framework for information literacy for higher education. Retrieved from <http://www.ala.org/acrl/standards/ilframework>

Berks Launchbox. (n.d.). Retrieved from <https://berkslaunchbox.psu.edu/>

Carroll, A. J., Hallman, S. J., Umstead, K. A., McCall, J., & DiMeo, A. J. (2019). Using information literacy to teach medical entrepreneurship and health care economics. *Journal of the Medical Library Association*, 107(2), 163-171. <https://dx.doi.org/10.5195%2Fjmla.2019.577>

Chisholm, A., Hartman-Caverly, S., & Spencer, B. (2020). Remodeling library collections: Designing a discovery lab for student engagement. *LOEX Quarterly*, 46(4), 4-6, 9. <https://commons.emich.edu/loexquarterly/vol46/iss4/3>

Davis, R. C. (2019). Introducing first-year and transfer students to a college library with a historical mystery from the special collections. *College & Undergraduate Libraries*, 26(4), 278-300. <https://doi.org/10.1080/10691316.2019.1695034>

ENTI minor overview. (2021). Penn State Berks. Retrieved from <https://berks.psu.edu/enti-minor-overview>

Eukel, H., & Morrell, B. (2021). Ensuring educational escape-room success: The process of designing, piloting, evaluating, redesigning, and re-evaluating educational escape rooms. *Simulation & Gaming*, 52(1), 18-23. <https://doi.org/10.1177/1046878120953453>

Flemming CEED Center, The. (2021). Penn State Berks. Retrieved from <https://berks.psu.edu/flemming-ceed-center>

Gordon, I. A., Meindl, P, White, M., & Szigeti, K. (2018). Information seeking behaviors, attitudes, and choices of academic chemists. *Science & Technology Libraries*, 37(2): 130-151. <https://doi.org/10.1080/0194262X.2018.1445063>

Hartman-Caverly, S. (2020, October 28). Entrepreneurship and intellectual property: A primer [Lecture slides]. Retrieved from <https://docs.google.com/presentation/d/1NcJvIezyG5FRuX74iTiEkDcB1dK82LMr7e7is7560Aw/edit?usp=sharing>

Hartman-Caverly, S. (2021a, February 17). Competitive intelligence: Tools and techniques. Retrieved from <https://guides.libraries.psu.edu/berks/CI>

Hartman-Caverly, S. (2021b, February 19). Exfiltration! A CI virtual escape room for MGMT425 (Berks). Retrieved from https://psu.libwizard.com/f/ExfiltrationEscRoom_BerksMGMT425

Hartman-Caverly, S. (2021c, February 25). Exfiltration! A competitive intelligence virtual escape room. Retrieved from <https://psu.libwizard.com/f/ExfiltrationEscRoom>

Hartman-Caverly, S. (2021d). Exfiltration! Gamifying CI instruction with a virtual escape room. *Ticker: The Academic Business Librarianship Review*, 5(2). <https://doi.org/10.3998/ticker.16481003.0005.213>.

Ticker: The Academic Business Librarianship Review, 7:1 (2022)

<https://doi.org/10.3998/ticker.2931>

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- Hartman-Caverly, S. (2021e). Introduction to *Exfiltration!:* A competitive intelligence (CI) virtual escape room for MGMT 425 [Lecture slides]. Retrieved from <https://docs.google.com/presentation/d/1hKTbXCbY4HNJ2ISINewUykGbSGpcVlwknUZXMxh5e8/edit?usp=sharing>
- Hoppenfeld, J., and Malafi, E. (2015). Engaging with entrepreneurs in academic and public libraries. *Reference Services Review*, 43(3): 379-399. <https://doi.org/10.1108/RSR-02-2015-0011>
- Howard, H. A., Wood, N., & Stonebraker, I. (2018). Mapping information literacy using the business research competencies. *References Services Review* 46(4): 543-564. <https://doi.org/10.1108/RSR-12-2017-0048>
- Hylton, J. B., Mikesell, D., Yoder, J., & LeBlanc, H. (2020). Working to instill the entrepreneurial mindset across the curriculum. *Entrepreneurship Education and Pedagogy*, 3(1), 86-106. <https://doi.org/10.1177/2515127419870266>
- Kroski, E. (2020). How to create free digital breakouts for libraries. *Library Technology Reports* 56(3). <http://doi.org/10.5860/ltr.56n3>
- Kuratko, D. F., Fisher, G., & Audretsch, D. B. (2020). Unraveling the entrepreneurial mindset. *Small Business Economics*, 57, 1681-1691. <https://doi.org/10.1007/s11187-020-00372-6>
- Martina, R. A., & Göksen, S. (2020). Developing educational escape rooms for experiential entrepreneurship education. *Entrepreneurship Education and Pedagogy*, 1-23. <http://dx.doi.org/10.1177/2515127420969957>
- Meier, J., & Lysiak, L. (2021, April 14). Patents. Retrieved from <https://guides.libraries.psu.edu/patents>
- Milkman, K. (2021, May 4). The power and pitfalls of gamification. *Wired*. <https://www.wired.com/story/power-and-pitfalls-gamification/>
- Nahl, D. (2005). Affective load. In K. E. Fisher, S. Erdelez, & L. McKechnie (Eds.), *Theories of information behavior* (pp. 39-43). Medford, NJ: Information Today Inc. Retrieved from <https://books.google.com/books?id=ll6qzqhIj8wC&lpg=PR13&ots=1igNmSXa-q&lr&pg=PA39#v=onepage&q&f=false>
- Pennucci, S. S. (2020). Flip it and break it: Using flipped lessons and breakouts to energize learning. *Pennsylvania Libraries*, 8(2), 115-123. <https://doi.org/10.5195/palrap.2020.220>
- Phillips, M., Fosmire, M., Turner, L., Petersheim, K., & Lu, J. (2019). Comparing the information needs and experiences of undergraduate students and practicing engineers. *The Journal of Academic Librarianship*, 45(1), 39-49. <https://doi.org/10.1016/j.acalib.2018.12.004>
- Plump, C. M., & Meisel, S. I. (2020). Escape the traditional classroom: Using live-action games to engage students and strengthen concept retention. *Management Teaching Review*, 5(3), 202-217. <https://doi.org/10.1177/2379298119837615>
- Pun, R. (2017). Hacking the research library: Wikipedia, Trump, and information literacy in the escape room at Fresno State. *The Library Quarterly*, 87(4), 330-336. <https://doi.org/10.1086/693489>
- Pun, R. (2020, April 30). Experimenting with digital escape rooms. Infobase Blog. Retrieved from <https://www.infobase.com/blog/featured/experimenting-with-digital-escape-rooms/>

- Reference and User Services Association [RUSA]. (2019). Business Research Competencies. Retrieved from www.ala.org/rusa/sites/ala.org.rusa/files/content/resources/guidelines/business-research-competencies.pdf
- Robinson, P. B., & Gough, V. (2020). The right stuff: Defining and influencing the entrepreneurial mindset. *Journal of Entrepreneurship Education*, 23(2), 1-16. <https://www.abacademies.org/articles/the-right-stuff-defining-and-influenceing-the-entrepreneurial-mindset-9044.html>
- Russell-Rose, T., Chamberlain, J., & Azzopardi, L. (2018). Information retrieval in the workplace: A comparison of professional search practices. *Information Processing & Management*, 54(6), 1042-1057. <https://doi.org/10.1016/j.ipm.2018.07.003>
- Saxena, M., & Mishra, D. (2021). Gamification and Gen Z in higher education: A systematic review of literature. *International Journal of Information and Communication Technology Education*, 17(4), 1-22. <http://dx.doi.org/10.4018/IJICTE.20211001.oa10>
- Schroeder, K. T. (2020). Escape room. *Journal of Faculty Development*, 34(3), 82-83.
- Shin, N., Vela, K., & Evans, K. (2020). The research role of the librarian at a community health hackathon – a technical report. *Journal of Medical Systems*, 44(36): 1-3. <https://doi.org/10.1007/s10916-019-1516-x>
- Taraldsen, L. H., Haara, F. O., Lysne, M. S., Jensen, P. R., & Jenssen, E. S. (2020). A review on use of escape rooms in education - touching the void. *Education Enquiry*, 13(2), 169-184. <https://doi.org/10.1080/20004508.2020.1860284>
- Toane, C., & Figueiredo, R. (2018). Toward core competencies for entrepreneurship librarians. *Journal of Business & Finance Librarianship*, 23(1), 35-62. <https://doi.org/10.1080/08963568.2018.1448675>
- Urban, A. C. (2019). Serious games for information literacy: A scoping review and design recommendations. *Library Hi Tech*, 37(4), 679-698. <https://doi.org/10.1108/LHT-01-2019-0010>
- Veldkamp, A., Daemen, J., Teekens, S., Koelewijn, S., Knippels, M.-C.P.J. & van Joolingen, W.R. (2020). Escape boxes: Bringing escape room experience into the classroom. *British Journal of Educational Technology*, 51(4): 1220-1239. <https://doi.org/10.1111/bjet.12935>
- Vossler, J. J. & Watts, J. (2017). Educational story as a tool for addressing the Framework for Information Literacy for Higher Education. *portal: Libraries and the Academy*, 17(3), 529-542. <http://doi.org/10.1353/pla.2017.0033>
- Waggoner, D. R., Martin, S. J., Eads, J. L., & Branson, R. D. (2019, February 1). Using an escape room as gameful training with students. *NACE Journal*. Retrieved from <https://www.naceweb.org/career-readiness/competencies/using-an-escape-room-as-gameful-training-with-students/>