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PROJECT ADMIRAL AND SINKING SHIP: A DETAILED ANALYSIS FROM DEVELOPING TWO RAPID GAME PROTOTYPES

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December 2022

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The purpose of this research is to study and document the process of creating educational procurement games, with the goal being to expand the lexicon of knowledge for Air Force (AF) contracting. We advise two game development teams through the process of integrating contracting learning objectives into virtual games. Working alongside North Carolina State University (NC State), we help develop a tower defense game (Project Admiral) and a digital escape room game (Sinking Ship). We meticulously document our experiences advising student game developers on which contracting elements to employ and how to properly design the game. We also document what we discover about the game development process to inform future research. Our documentation utilizes engaged scholarship methods, treating these games as case studies to provide insights into the process of developing educational procurement games. We evaluate our successes, failures, and lessons learned to inform future educational game development projects. Ultimately, we aim to provide useful guidance for educators and researchers interested in developing their own educational procurement games. Our findings are beneficial both to those newly introduced to the field as well as experienced professionals who desire an update on the current state of contracting game development.

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The purpose of this research is to study and document the process of creating educational procurement games, with the goal being to expand the lexicon of knowledge for Air Force (AF) contracting. We advise two game development teams through the process of integrating contracting learning objectives into virtual games. Working alongside North Carolina State University (NC State), we help develop a tower defense game (Project Admiral) and a digital escape room game (Sinking Ship). We meticulously document our experiences advising student game developers on which contracting elements to employ and how to properly design the game. We also document what we discover about the game development process to inform future research. Our documentation utilizes engaged scholarship methods, treating these games as case studies to provide insights into the process of developing educational procurement games. We evaluate our successes, failures, and lessons learned to inform future educational game development projects. Ultimately, we aim to provide useful guidance for educators and researchers interested in developing their own educational procurement games. Our findings are beneficial both to those newly introduced to the field as well as experienced professionals who desire an update on the current state of contracting game development.

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LIST OF ACRONYMS AND ABBREVIATIONS

AF	Air Force
AFB	Air Force Base
AFICC	Air Force Installation Contracting Center
AIRC	Acquisition Innovation Research Center
BtB	Back to Basics
CCO	Contingency Contracting Officer
CLC	Continuous Learning Center
CI	Computational Intelligence
CO	Contracting Officer
COA	Courses of Action
COT	Contracting Officer Test
CS	Contracting Specialist
DA	Defense Acquisition
DAU	Defense Acquisition University
DCS World	Digital Combat Simulator World
DDM	Department of Defense Management
DdSG	Data-driven Security Game
DOD	Department of Defense
DSL	Domain Specific Language
ERG	Escape Room Game
FAR	Federal Acquisition Regulation
FPS	First Person Shooter
GAO	Government Accountability Office
IDIQ	Indefinite Delivery Indefinite Quantity
K/D	Kill-Death
LD	Liver Defense
MD	Mage Duel

MDA	Mechanics, Dynamics, and Aesthetics
MDE	Model-Driven Engineering
MIT	Massachusetts Institute of Technology
MVP	Minimum Viable Product
NCO	Noncommissioned Officer
NDS	National Defense Strategy
NPC	Non-Player Characters
NPS	Naval Postgraduate School
NC State	North Carolina State University
OCS	Operational Contracting Support
PSC	Private Security Contractors
RPG	Role-Playing Games
SAF/AQC	Deputy Assistant Secretary of the AF for Acquisition (Contracting)
SDT	Self-Determination Theory
SF44	Standard Form 44
SF/CC	Security Forces commander
SG	Serious Games
TD	Tower Defense
TRG	Training Group
USAF	United States Air Force
VR	Virtual Reality
W/L	Win-Loss

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—Captain Jordan "J$" Lindley

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—Captain Gage "G^3" Wright

I. INTRODUCTION

If we're going to take America's best and brightest, and put them directly into harm's way, then we need to be absolutely sure we're investing in the right resources to make them successful. That's especially important today as we prepare to engage peer threats in the contested realms of air, space, and cyber.

—Maj Gen (Ret.) Doug L. Raaberg

(*Warfighter Training and Readiness*, 2022)

A. PROBLEM STATEMENT

Gamification is the process of adding game elements to an otherwise mundane task to make it more fun and engaging. The USAF is not taking full advantage of the use of gamification to train its contracting professionals. Even though the USAF is at the leading edge of many gamification efforts, there is a massive gap between contracting training and training for the USAF's more idolized career fields, such as pilots. The Chief of Staff of the Air Force (CSAF), Gen. Charles Q. Brown Jr., stated the overarching problem perfectly during his confirmation hearing: "New Airmen are smart, tech savvy, and ready to learn, but USAF's classroom model has some catching up to do" (Hudson, 2020, para. 4). In the same breath, Gen. Brown also highlighted an example of applied gamification specifically: "That's why I'm excited about the initiatives like [the] Pilot Training NEXT experiment, it is showing us how to move from a classroom-centered to a learner-centered model of training, and I think it has far-reaching implications."[1] If the USAF decides to fully invest in gamification methods for acquisition training, then perhaps contracting will also see similar gains.

Contracting in the United States Air Force (USAF) is a career field which would certainly benefit from the use of gamified training. Contracting professionals operate in a risk averse, highly regulated, and performance-driven environment which has truly little tolerance for mistakes (Finkenstadt et al., 2022). As Prof. Kapp outlined in his article

[1] We call more attention to the Pilot Training NEXT experiment in our later section on military use cases but in essence, the program capitalized on a commercial flight simulation game to effectively cut 2 months from the traditional pilot training schedule (Everstine, 2019).

"Games, Gamification and the Freedom to Fail," people often learn far more from their failures than their successes (Kapp, 2015). He went on to outline that video games provide the perfect environment for learning because they engage people by allowing them to explore different ways to solve difficult problems without the intimidating fear of actual consequences. Unfortunately, the DOD is headed in the opposite direction with regards to contracting training. Instead of granting future COs more opportunities to learn from their mistakes in a simulated environment, the latest Back-to-Basics (BtB) initiative for DOD acquisition has trainees "…spend more time "doing" and getting job experience" ("Back-to-basics," n.d., para. 7). The addition of gamified training would provide a much-needed climate for contracting professionals to learn from mistakes without the fear of significant and potentially career altering consequences.

If acquisition professionals are not given a training environment in which they are allowed to make mistakes, they will be ill equipped to design creative acquisition strategies which provide solutions to the warfighter at the speed of relevance. Games which simulate work related tasks often result in higher declarative and procedural knowledge as well as higher retention when compared to other learning modalities (Sitzmann, 2011). Additionally, Kapp (2012) found that simulation games have shown a great deal of promise with increasing users' problem-solving skills provided the appropriate game mechanics are used. He also demonstrated that the gamification of traditional learning environments effectively incentivizes out-of-box thinking by giving users the courage to fail. Giving acquisition professionals a mock environment in which to practice worst case scenarios freely will give them the confidence and knowledge to devise solutions to problems as they arise in real life without incurring the cost of on-the-job errors.

The USAF has shown a high level of interest in capitalizing on gamified contracting training in recent years, but more research is needed to home in on the correct game type to captivate contracting professionals. Without utilizing the correct game type, it is likely that contracting professionals will lack the motivation to engage with the game. The previous contracting gamification research team in reference to their Minimum Viable Product (MVP), stated, "…a first-person shooter was probably not the best format to use for an early adoption of gamified learning" (Larsson et al., 2021, p. 95). Further, during our own

development of a contracting tower-defense game with NC State, we found that it was extremely challenging to effectively communicate contracting content to game developers who had zero experience in the field of DOD acquisition. The USAF will need to ensure that future game developing teams have the baseline acquisition knowledge necessary to create a valuable gamified training experience.

This capstone project provides crucial insights into how the USAF should pursue gamified contracting training in the future. Through our own engaged scholarship our research uses a case study methodology to gain a better understanding of the complex topic of applying gamification principles to contracting-specific games by reflecting on our experiences as part of the development team for the Acquisition Innovation Research Center's (AIRC's) *Project Admiral* and *Sinking Ship*. This study makes recommendations based on qualitative data to help USAF leadership, and other defense leaders, make informed decisions as they develop new contracting training in the future.

B. PURPOSE

The purpose of this research is to further the literature on defense acquisition gamification as it relates to Air Force Contracting. We created two case studies to help us better understand the process of developing games that use gamification to make contracting procedures easier to learn. From our experience assisting in the creation of multiple games, we aim to improve the process for future game creation. This research is being done to assist the Office of the Assistant Secretary for Defense (Acquisition), Defense Pricing and Contracting, the Deputy Assistant Secretary of the Air Force for Acquisition (Contracting) (SAF/AQC), the Air Force Installation Contracting Center (AFICC), the SILAS Lab at Naval Postgraduate School, and the Air Force contracting training program as a whole.

Our research falls in line with the National Defense Strategy (NDS) as developing effective gamification is a further investment in the contracting workforce. The 2022 NDS released in March emphasizes the need to build enduring advantages ("Fact Sheet: 2022 National Defense Strategy," 2022). This "involves undertaking reforms to accelerate force development, getting the technology we need more quickly, and making investments in the extraordinary people of the Department, who remain our most valuable resource" ("Fact

Sheet: 2022 National Defense Strategy," 2022). By developing additional pathways to learning for the contracting workforce, the DOD stands to actualize substantial gains not only now, but for many years in the future.

The use of game elements to grasp difficult concepts has been a time-honored tradition for military tacticians. Games have been used by the military to train personnel since the stone age (Smith, 2010). Today, there's a wide variety of game types which are used to teach military practitioners everything from tactics and strategy to hand-eye coordination and teamwork. With the help of these tools, people can think of problems more creatively and work together toward a shared goal (Smith, 2010). The video games we worked on during this research are in early development but have the potential to change the way we train in a positive way.

The method of research used for this study is a case study approach through engaged scholarship. The value of this approach is that it allows an in-depth exploration of complex issues in real-life settings (Crowe et al., 2011). For our research, the "issue" being explored is the development of games for contracting. We witnessed this process first-hand as we guided game development teams through their process of game creation for two separate games. This approach was useful in highlighting the advantages and disadvantages of utilizing various gamification concepts in the creation of future games for Air Force contracting.

C. RESEARCH QUESTIONS

1. Primary Questions

A. What are the largest hurdles in developing a video game centered around contracting?

B. How could this development process be improved for future games?

2. Secondary Questions

A. What game type is the most applicable for Air Force contracting?

B. What content areas in Air Force contracting translate best to games?

II. BACKGROUND

Chapter II of this paper–provides background information on general topics of gamification. Definitions of gamification and sub-topics are provided as they relate to the area of research. The MDA (Mechanics, Dynamics, and Aesthetics) are discussed in detail as a means to explore and understand future games. Next, basic aspects of game design are researched in order to understand the different paths a development or functional advisory team can follow. Lastly, examples of use cases in military and commercial contexts are examined.

A. DEFINITION OF GAMIFICATION

Before understanding the attributes of game designs for specific types of games it is important to understand what gamification is. Additional concepts related to gamification as it applies to education and training are also explored.

"Gamification is the use of game elements and game-design techniques in non-game contexts" (Werbach & Hunter, 2012). While there are many different variations of this definition out there, they mainly hold the same meaning. Gamification is the addition of game elements and game design into real life applications. This definition is used in this research as it is widely accepted and is most suited to the study. Understanding these various game elements and game design techniques aids us in recognizing how these features can improve gamification in Air Force contracting.

B. DEFINITION OF SERIOUS GAMES

Serious games (SGs) are a classification of game type which can be easily differentiated from other games (Cody et al., 2009). SGs are designed to teach players specific skills or knowledge while also providing an engaging and fun experience. By providing a safe and controlled environment in which to practice, SGs can help people learn how to handle real-life challenges. Minecraft is a famous example of a SG. This game allows players to be creative and construct whatever they can imagine using an assortment of different blocks in a three-dimensional space. According to Denny (2019), a study

discovered that frequently playing Minecraft can be an excellent method of teaching kids the basics of computer programming. According to Cody et al. (2009), SGs were initially criticized for being an oxymoron as many believed games to be "inherently fun and not serious." Since then, the term has become widely accepted in reference to games intended to educate, motivate, or change behavior. All of the games that we highlight in this research can be considered SGs due to their educational objectives. We use this term throughout our research and having a basic understanding of its definition and meaning is imperative for future researchers within this topic.

C. GAME ELEMENTS

Like any complex subject, the concept of gamification can be best understood by being broken down into its basic components. Werbach and Hunter (2012) state that "a game manifests itself as an integrated experience, but that it is built from smaller pieces — we call those game elements" (Werbach & Hunter, 2012). Game elements can be thought of as a toolkit for building a game. Good game design requires an understanding of how to cultivate the desired outcome through various elements. "Gamification, like many other educational innovations, is not intrinsically good or bad. A lot depends on how it is designed and used" (Hung, 2017). Game elements should provide meaningful feedback to users that allow students to understand how well they grasp the desired knowledge (Hung, 2017). When game elements are designed with the end objective in mind, they enable developers to create games that allow for highly effective learning.

The MDA (Mechanics, Dynamics, and Aesthetics) framework is widely used as a means of understanding games and game development. This framework can be used to understand the strengths and weaknesses of a game. Outlined in Figure 1 and Figure 2, the purpose of the MDA framework is to provide a direct connection between game design, game production, and specialized game research (Hunicke et al., 2004). The MDA Framework divides the game into three elements and proposes an order of influence between them (Junior & Silva, 2021). Hunicke et al. (2004) provide detailed descriptions of each element in their work. **Mechanics** are defined as the various algorithms and ways that data is represented within a game, in other words, they are the game's inner workings.

Examples of this in a game could be the game's basic controls or how the player interacts with the game. These mechanics allow the player to control their character and are the foundation on which all other elements of the game are built upon. **Dynamics** are the result of the player's interactions with the mechanics of the game over time. For example, this can be observed in video games when the player gains more choices as the game progresses, or when a character's abilities grow after completing certain tasks. **Aesthetics** are emotional responses the player receives when they are interacting with the game. Aesthetics can be the feeling of being challenged or the feeling of community within the game (Hunicke et al., 2004). Game designers tend to envision game Mechanics first, then Dynamics, and finally Aesthetics, while players will typically experience games in the reverse order (Kusuma et al., 2018). Other frameworks and models have been created but Umar Ruhi "found various commonalities in the strategic requirements, system design, and user-experience elements that characterize enterprise gamification initiatives, and the MDA framework facilitates our discussion of these concepts." (Ruhi, 2016, p. 8). The remainder of this section is dedicated to further expounding on the many features that fall under Mechanics, Dynamics, and Aesthetics elements and how this can be applied to contracting training.

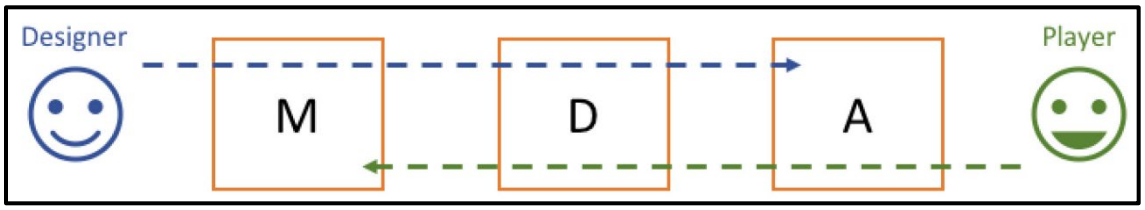

Figure 1. The MDA framework and order of influence. Source: Junior and Silva (2021).

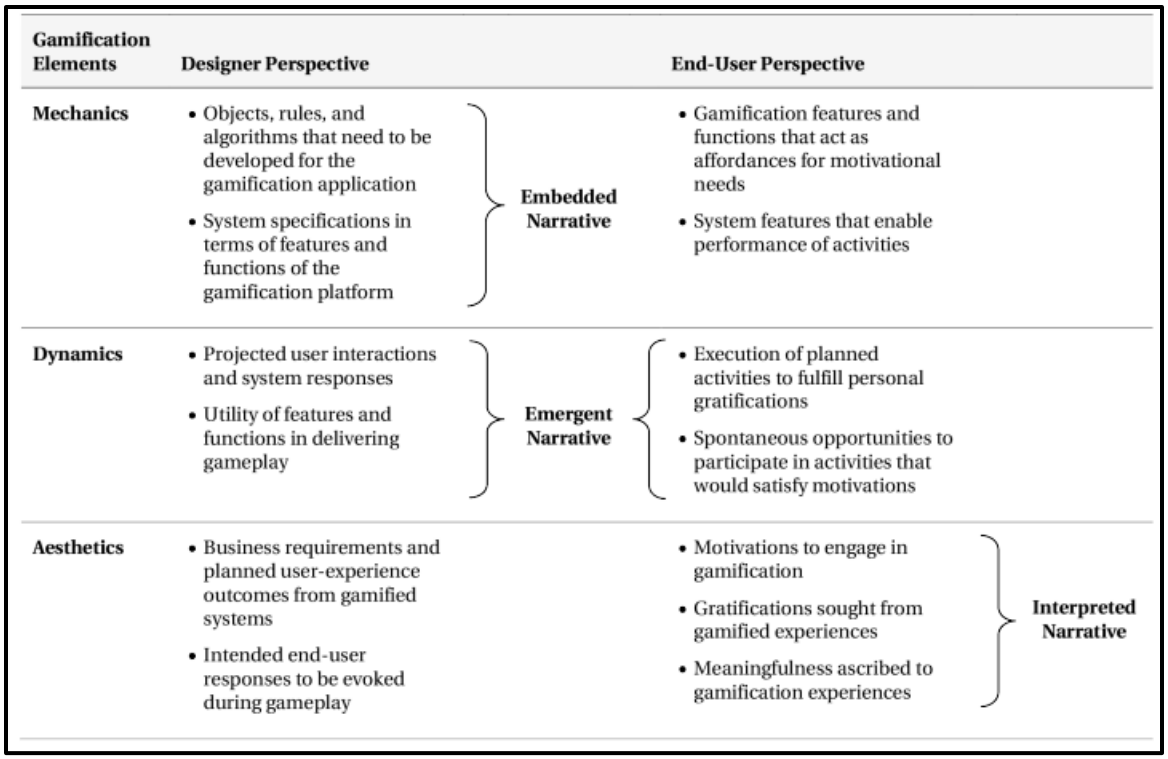

Figure 2. Gamification elements from designer and end-user perspectives
Source: Ruhi (2016).

1. Mechanics

The first step toward the emotional goals of the end user is the game's mechanics. Components typically are points or badges or another representation of basic achievement within the game (Ruhi, 2016). These allow the player to see their progress and also enable the use of leaderboards where players can compare themselves to others playing within the game. The mechanics of a game are critical to define because they can be directly manipulated by the designer to achieve the desired psychological effects (Junior & Silva, 2021). While it is crucial to identify these mechanics in game design, the process should not be more complicated than necessary (Junior & Silva, 2021). Non-required complexities and an excess of defined mechanics can lengthen the amount of time needed without adding value. To build successful future contracting games the concept and importance of mechanics must be understood. Additionally, understanding the perspectives of end users (see Figure 1) will allow the game designer to achieve their goals.

2. Dynamics

How players engage with the game's mechanics directly influences the dynamics they can participate in. In the context of video games, Ruhi (2016) refers to game dynamics as a psychological framework. This means that it provides players with a frame of reference to identify what kinds of activities they can participate in within the game. In some games, dynamics can be seen as specific rules players need to adhere to contingent on how many points they've scored or what level they're on (Ruhi, 2016). Dynamics are what link the game designer to the player as shown in Figure 2. A development team will be more likely to achieve their emotional objectives if they have a firm grasp of how mechanics form the basis for dynamics (Junior & Silva, 2021). If the development team understands the emotional objectives of the game, they will be able to work smarter and faster toward achieving the game's goals (Junior & Silva, 2021). A comprehensive understanding of game dynamics will allow future contracting game development teams to incorporate the correct choices and constraints to meet the needs of the end user.

3. Aesthetics

The final component of the MDA framework is aesthetics. Game aesthetics are represented in the emotional outcomes felt by end users as they participate in the activities within the game (Ruhi, 2016). This is typically referred to as the types of "fun" players experience. As Junior (2021) found, it is difficult to say what exactly makes a game fun. "In contrast to traditional games where players typically seek hedonic (entertainment or pleasure-related) gratifications, our research revealed that, in the context of enterprise gamification, end users mostly sought instrumental gratifications geared towards achieving specific valued outcomes such as learning and recognition" (Ruhi, 2016, p. 10). Air Force contracting game development must understand game aesthetics and what end users' desired outcomes are to correctly design future games. Games do not directly invoke emotions—they only offer tools and constraints in a virtual setting that will allow the player to experience their own emotions (Junior & Silva, 2021). To achieve the desired goals for the players, the MDA Framework is important to understand.

D. GAME DESIGN

The next step in creating a game is to apply the game elements in a game design. Hunter and Werbach (2012) describe game design as the process of deciding which elements to put where and how to make your overall gamified experience better. There have been hundreds of millions of dollars spent on games that have failed (Werbach & Hunter, 2012). It is crucial to understand effective game design in order to avoid such failures. There is a wealth of knowledge concerning game design available through time-tested techniques that must be researched to set future game development up for success (Werbach & Hunter, 2012). With the proper game design, gamification becomes a highly effective training method. Gallego-Duran et al. (2019) point out that most of the literature shows gamification improves retention when compared to traditional methods and even though not all studies reach the same conclusion, gamification certainly has a promising future. Gamification is a useful technique for training people because it employs game-like elements to maintain engagement in learning. Only a few "well designed games will achieve this level of engagement" (Gallego-Duran et al., 2019, p. 1). The following section defines and elaborates on game design concepts we find to be key. Game design information is critical for the future games developed for Air Force contracting.

Goals: In order to be persuaded to pursue the result desired by the game developer, users must have a target in which to focus their ambitions. In every game, players should have some goal to work towards (Goethe, 2019). According to Goethe (2019), goal-setting theory can be used to increase work performance by motivating people through setting and keeping track of specific goals. Goals provide the light at the end of the tunnel to players which motivates them to continue engaging with the content of the game. "For effective gamification, it's critical to have a well-developed understanding of your goals" (Werbach & Hunter, 2012, p. 64). In their research, Werbach and Hunter (2012) say this goal must be a specific performance goal such as building brand loyalty or improving employee productivity. These examples are both specific for what the game wants to achieve and can easily be measured. This information must be at the forefront of the conversation for the future of developing games in contracting. Just like in contracting where defining the requirement is critical, so is setting a solid goal for your gamification program.

Success Criteria: It is essential to any game that players clearly know when they have reached the desired outcome. There must be a way of knowing when the objective is achieved and, like the goals, this must be clearly defined (Goethe, 2019). "It has also been predicted that a majority of gamification implementations are doomed to fail due to poor understanding of how to successfully design gamification" (Goethe, 2019, p. 75). One of the greatest errors a game can make is to have ill-defined success criteria that leave a player guessing. A player must know what their goal is in the game and when they have met that goal (i.e., have achieved success). Air Force contracting must keep this in mind while developing future games

Rewards: Incentives matter, and to maximize player engagement games must utilize effective reward structures. Rewards can vary from being outcomes of the game in the form of results and recognition, embedded in the game in the form of getting more points or badges, or external recognition in the form of prizes that the winner may receive (Goethe, 2019). It is critical for the development team to know what rewards its players are seeking and how to distribute these rewards most effectively throughout the game. Games created with this consideration can keep the trainees motivated and help them learn the desired outcomes.

E. USE CASES: MILITARY

The motivational structures which underpin modern gamification are by no means new to militaries around the globe. The great French General Napoleon Bonaparte once said, "A soldier will fight long and hard for a piece of colored ribbon." (Pennington, 2017). In fact, the missions long performed by the armed forces lend themselves very well to the concept of gamified methods because they commonly have rank structures, differing levels of knowledge, and an unspoken point system for determining success (Dudfield, 2020). One could look to the earliest days of American history and see that the concepts supporting gamification today (such as competition, reward systems, and ranks) lie at the foundational core of its military culture. For example, the U.S. military has widely awarded decorations to its service members since 1782 to visually recognize those who distinguish themselves and go beyond the call of duty (Callander, 2003). Such medals are still used today and

differentiate service members for continued rank progression as well as selective opportunities.

Today, the discussion of gamification in the military is often grounded in education and training. Gamified learning in this sense often allows military members to simulate work tasks in a more immersive way when compared to previous methods which required either in-person training or career specific simulators. Since military members tend to operate in environments in which failure would result in unrecoverable consequences, a game provides a space in which members can actively learn from previous mistakes without real world ramifications. In this section we explore several modern use cases which highlight the range in which gamification has had an impact on military training.

1. America's Army

Developed at the Naval Postgraduate School and released to the public in 2002, America's Army is perhaps the most well-known and viral example of gamification in the military (Davis & Bossant, 2004). America's Army (see Figure 3) was a recruitment tool aimed at capturing the imagination of young recruits whilst simultaneously cutting down boot camp attrition rate by providing a realistic representation of what challenges new soldiers would face while training. Even though the free game faced a lot of scrutiny over its life from the media for combining war, entertainment, and recruiting into one addictive medium, it clearly exceeded all expectations. According to an MIT study "30 percent of all Americans aged 16 to 24 had a more positive impression of the Army because of the game and, even more amazingly, the game had more impact on recruits than all other forms of Army advertising combined." (Singer, 2016, para. 11). Singer (2016) also added that this game reflected the greatest impact on Army recruits even though it only made up a miniscule .041% of the Army's annual advertising budget.

America's Army has been the longest running military example of modern gamification and opened the floodgates to future gamification efforts. With many different iterations of the game, it was able to evolve over time to feature realistic missions and give prospective recruits an understanding of what would be expected of them before they sign the dotted line. Over 20 million players, 180 million successful missions, and 20 years

later, America's Army ultimately shut down its online operations on 5 May 2022 due to a declining number of active accounts following the latest iteration of the game released in 2013 (Gault, 2022).

Figure 3. America's Army screen capture. Source: Gault (2022).

2. Digital Combat Simulator World

The USAF recently started leveraging a commercial combat simulator game to train its A-10 Warthog fighter pilots as part of its Pilot Training NEXT experiment (Trevithick, 2021). Digital Combat Simulator World (DCS World) (see Figure 4) is a free-to-play and extremely realistic virtual reality (VR) combat simulator game that allows up to 64 players to engage in online aerial combat and operation design (Eagle Dynamics, 2021). The game separates itself from traditional flight simulators because it allows for a competitive multiplayer environment featuring statistics like kill-death (KD) and win-loss (W/L) ratios. Another benefit is that trainees can easily bring the game home with them for repeated play since the game is commercially available. Trevithick (2021) also highlighted DCS World is particularly useful because it allows for the 355th Training Squadron to supplement its meager 4 traditional full-motion simulators, which require an instructor, with over 22 VR driven cockpits that trainees can use either with an instructor or by themselves.

Figure 4. Simulated flight training session at Sheppard AFB. Source: Trevithick (2021).

3. Mage Duel

The DOD hasn't limited its utilization of educational games to traditionally straight-forward kinetic functions either. The USAF's 517th Training Group's (TRG's) Linguistic Next Program recently partnered with TUTORWORKS Inc. and the University of Arizona to create a visually stunning language training game. In Mage Duel (MD) (see Figure 5) players are sent to the mythical land of Degom where they play as a young sorcerer as she learns the art of word magic (TUTORWORKS Inc., 2022). Tasked to go on a reconnaissance mission to learn more about the Northern Warlord in a foreign land, players must develop their language skills to gain magical abilities and spells so they can survive against combatant mages. MD is particularly innovative because it employs a Semantic Similarity Engine which enables learning based on meaning as opposed to traditional evaluation methods which rely on near verbatim sentence structure to test proficiency (TUTORWORKS Inc., 2022).

Figure 5. Mage Duel—thread collection source: TUTORWORKS Inc. (2022).

4. Contingency Contracting Simulation: The Barda Bridge

DOD Contracting isn't new to the idea of gamified learning either. Many contracting professionals fondly remember the 2007 release of *The Barda Bridge* (see Figure 6) where players prepare to deploy overseas as a contingency contracting officer (CCO) (Weatherford, 2010). The film provided gamified training to personnel in deployable contracting positions, and it featured branching story paths which allowed the player to make challenging pre-deployment and deployment decisions similar to what CCOs might expect to face in a real-life scenario. *The Barda Bridge* was often played in a classroom environment where students could work as a team to decide which choices would result in the best outcomes. Classes were provided feedback on how they did once they reached the end of the video. Additionally, students also had the opportunity to experience the game individually through the Defense Acquisition University's (DAU's) Continuous Learning Center (CLC). Unfortunately, with DAU's choice to remove Adobe Flash ™ from their platform, the individual experience is no longer available on the CLC website, but the team is hard at work developing a new iteration on the classic "Choose Your Own Adventure" style CCO game.

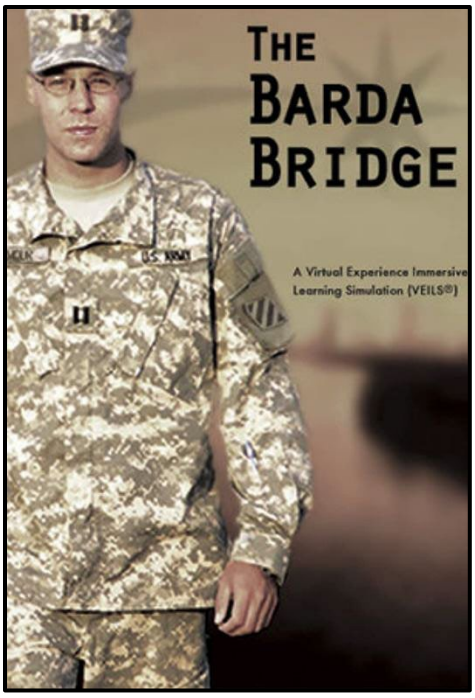

Figure 6. The Barda Bridge movie poster. Source: IMDb (2007).

5. SandBox Contracting

The most recent iteration of gamified contracting training came from applied research in the Department of Defense Management (DDM) at the Naval Postgraduate School (NPS). In their research, Larsson et al. (2021) created a first-person shooter (FPS) called Sandbox Contracting (see Figure 7), which threw players directly into the action as they defended an objective from wave after wave of enemy non-player characters (NPCs). Once players defended the objective, they were required to answer a randomized contracting question to defuse an enemy bomb. Should the player succeed, they would then be rewarded with in-game currency, which they could use to upgrade their weapons in future levels. In their study, Larsson et al. (2021) tested the game's efficacy compared to traditional training methods at the enlisted contracting training schoolhouse at Lackland AFB, Texas. While the researchers found that gamified training methods performed just as well, not necessarily better than traditional methods in many areas when used as a complete replacement, they made critical discoveries about how game design and mechanics affected student reactions. They found that, generally, students were very interested in gamified

learning. They concluded that gamified education and training could be a potent learning enhancement method alongside traditional methods of instruction. Larsson et al. (2021) demonstrated the edge of possibility by building a rapid game prototype entirely in-house and fielding that prototype at the enlisted contracting training schoolhouse in a short timeframe.

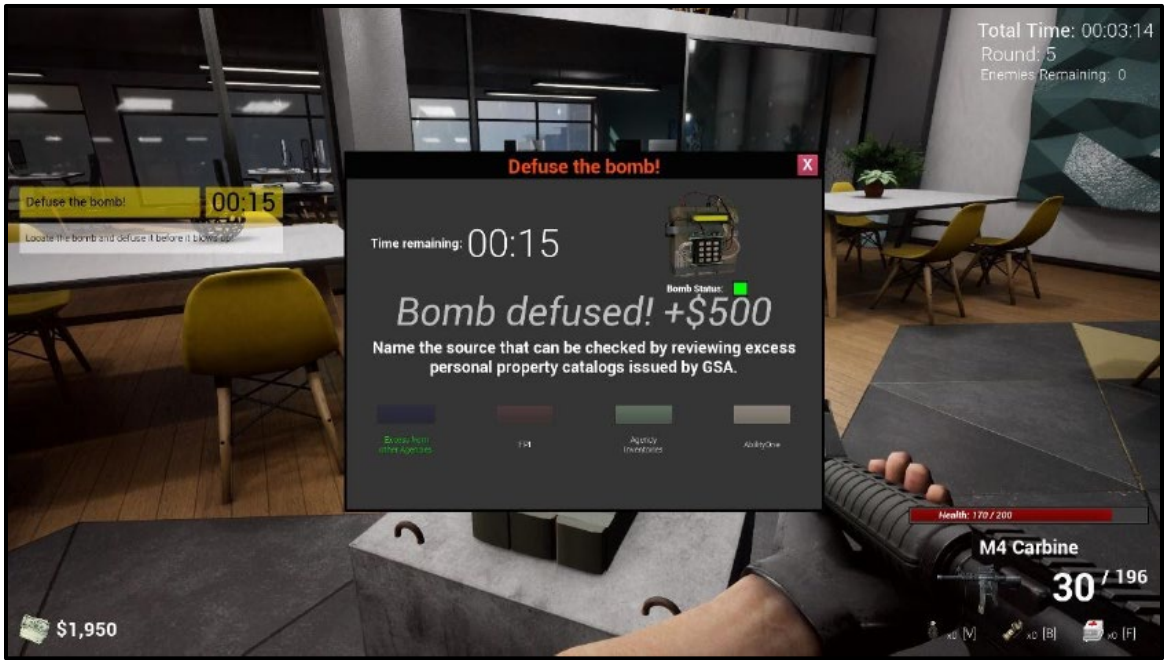

Figure 7. Sandbox contracting—feedback example. Source: Larsson et al. (2021).

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III. LITERATURE REVIEW

Chapter III of this paper examines literature related to gamification of education and learning. We examine the case study approach and engaged scholarship as suitable research methods. Then, we discuss the motivation that drives why games can be used in learning environments. Next, we explore research studies on game types including tower defense and escape room game types respectively. Last, we discuss recent relevant research in the defense acquisition and contracting realms for gamification.

A. RESEARCH METHODS

In this section, we review both the case study approach as well as engaged scholarship and how we leverage each methodology for our research. Both methods provide a solid foundation for our research which we use to develop the subsequent sections. By examining both game prototypes in this way we are able to provide relevant and timely information about game development and gamification strategies in both the defense acquisition and contracting domains.

1. The Case Study Approach

The case study approach is a research methodology that involves intensive, detailed analysis of a single unit of study, such as a company, government agency, or public policy. We used the case study approach in our gamification research to obtain relevant insights on the development of games for defense acquisition and contracting. Crowe et al. (2011) defines a case study approach as "a research technique that is used to generate an in-depth, multi-faceted understanding of a complex issue in a real-life context" (p. 1). We use this process firsthand through our guidance of the game development of two separate rapid prototype games, Project Admiral and Sinking Ship. Of the three main types of case studies discussed by Crowe et al. (2011), we implemented the collective approach which "involves studying multiple cases simultaneously or sequentially in an attempt to generate a broader appreciation of a particular issue" (p. 2). Using the collective approach allows researchers to identify patterns and trends which otherwise would not be apparent by studying each case individually. Additionally, it allows for an easy examination of the similarities and

differences between cases. In their work, Crowe et al. (2011) and Rashid et al. (2019) outlined the process for conducting a collective case study analysis and we were able to utilize these steps as the backbone of our research. Below are the steps in Crowe et al.'s (2011) & Rashid et al.'s (2019) research which detail how to effectively perform a collective case study analysis.

a. Defining the case/Foundation Phase

One of the most critical steps in a collective case study approach is defining the case. All cases should be generally defined in concrete terms such as their purpose, scope, and phenomena of interest so that meaningful conclusions can be drawn across case boundaries. Without a clear definition of each case, it would be impossible to accurately compare data across multiple case studies or replicate similar findings later on. Crowe et al. (2011) explained that defining the case involves carefully formulating research questions informed from previously existing literature. They also stated that case definition should involve a pre-defined boundary that clarifies the time and nature in which the case study will be performed. Rashid et al. (2019) adds that any ambiguity in this early stage would surely result in chaos in the following stages. Therefore, defining each case early on in the process, is a critical first step in conducting a collective case study analysis.

b. Selecting the case(s)/Pre-field Phase

Deciding on the cases to be selected in a collective study is a very important task which should not be taken lightly. For a collective case study approach, one of the main benefits includes the ability to compare and contrast across several cases. As such, multiple cases should be chosen based on the goals of the research and the phenomena of interest. Further, the cases selected should be similar enough to merit a reasonable comparison, yet not so similar that they negate the ability to make worthwhile conclusions. Additionally, Rashid et al. (2019) states that during this stage, researchers should decide if the case study approach is indeed the best methodology to conduct the research. Although the collective case study approach allows researchers to gain valuable insights it is not always the best choice, particularly when the cases in question are unique but not particularly observation rich. Rashid et al. (2019) also gave valuable advice, stating that researchers leveraging this

approach should focus on describing real-life phenomena instead of trying to craft statements which handwave the "why" behind the occurrence. If researchers focus solely on the traditional goal of generating reasons behind why case subjects exhibit the behavior they do, then it is very likely that they will miss out on documenting key insights behind how such behaviors occur in the first place.

c. Collecting the data/Field Phase

Before data collection begins, understanding the research questions and ensuring the research goals align with the data which will be collected is key. Crowe et al., (2011) points out that in a collective case study approach, the cases being analyzed need to be described in a detailed enough manner as to allow for adequate cross-case comparisons. If collective cases are lacking in depth, then it will often be difficult to make the broad comparisons necessary between unique cases. One of the best ways to ensure this adequate depth is to collect multiple kinds of data (e.g., interviews, surveys, reports, etc.) for each case being examined. As mentioned by both Crowe et al.(2011) and Rashid et al.(2019) data triangulation is a method of collecting data from multiple sources in order to confirm findings and increase validity. When conducting a case study using a collective approach, data triangulation is essential in order to gather accurate and rich data. For example, if conducting interviews, the researcher might interview multiple people about the same case and also compare those interviews to other sources of data such as observations or documented accounts. Using data triangulation helps to ensure that the case is comprehensive and accurate, making it an essential part of the collective case study approach.

d. Analyzing, interpreting, and reporting/Reporting Phase

The final step of a collective case study approach is ensuring that you have a coherent interpretation of your findings from the collective sources of data. Not only did Crowe et al. (2011) report their findings, but they also emphasized how imperative it is to give the reader adequate context so that they can grasp how the conclusions were reached. Rashid et al. (2019) adds that the following points should be taken into consideration when utilizing a case study approach: case descriptions, relationship descriptions, participant

descriptions, details of field protocols, empirical material interpretations, and analysis. In balancing all of these elements, researchers are able to provide a more comprehensive case study analysis.

2. Engaged Scholarship

We also utilize engaged scholarship throughout this research endeavor. In academia, engaged scholarship is thought of as a participative form of analysis wherein researchers utilize the advice and perspectives of mission partners (practitioners) to understand complex problems (Van de Ven, 2007). By directly engaging with key stakeholders, researchers are able to obtain a more in-depth understanding of the subject and are able to inform more relevant research. Where more traditional forms of inquiry rely very heavily on secondary sources, engaged scholarship involves on-the-ground collaborative work which often brings in a whole new set of perspectives that would otherwise remain untapped.

McIsaac and Riley (2020) analyzed over 11 different studies which utilized an engaged scholarship approach and they found that frequent interactions between researchers and stakeholders led to a collaborative environment which bridged the gap between theory and practice. They found that the best engaged scholarship partnerships were characterized by several essential actions and contextual factors. The most essential actions were frequent interactions with key stakeholders along with collective planning and joint execution of research tasks. By developing a good working relationship, both researcher and stakeholder are able to make inferences which would otherwise be impossible in a traditional compartmentalized approach. Further, McIsaac and Riley (2020) noted that the most important contextual factors were making sure each participant had a clear understanding of the tasks they were responsible for along with a collective mutual respect for the other team members' own priorities and perspectives. Through the melding of both theory and practice, research teams are able to make recommendations and discoveries which have a much higher likelihood of producing consequential results.

Engaged scholarship bolsters the research process by involving key stakeholders at each step. Van de Ven (2007) outlined these steps as a. **Problem formulation**, b. **Theory**

building, c. **Research design**, and d. **Problem solving**. Van de Ven (2007) illustrated how each of these steps interact in Figure 8. By leveraging the operational community throughout the entire research effort, engaged scholarship ensures that the research is focused on addressing real-world problems, and that the findings will be applicable to those who need them most.

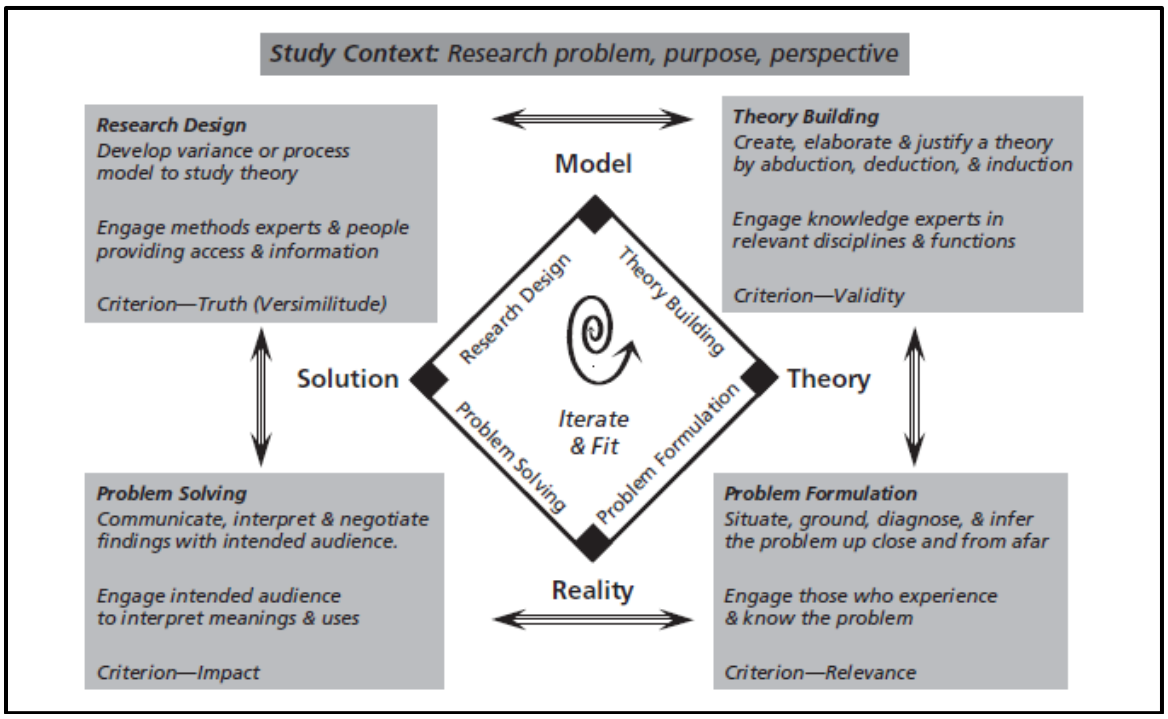

Figure 8. Engaged scholarship diamond model. Source: Van de Ven (2007, p. 10).

a. Problem formulation

When practicing engaged scholarship, problem formulation focuses on ensuring that the research problem is grounded in the real world. In other words, it must accurately represent the reality of both the situation on the ground and to inquiring outsiders. The team must garner an in-depth understanding of the problem by engaging subject matter experts as well as researchers. The more complex the problem, the more the team will need to engage with stakeholders in order to understand it. Engaged scholarship is contingent on

the realization that interacting with people from diverse perspectives greatly advances academic analysis.

Throughout our studies at NPS we use engaged scholarship as the backbone of our research. We began by grounding our research problem in the real world based on the research demonstrated by Finkenstadt et al. (2022). Their study provided a notional application matrix for understanding how game types can best be utilized to address real-world defense acquisition educational needs. Subsequently, our partners at NC State were in the early stages of developing two games which aligned well with Finkenstadt et al.'s (2022) educational game matrix. The first game was a tower defense (TD) game titled "Project Admiral." It planned to educate contracting personnel about considerations when acting in a contingency environment where there is a great deal of uncertainty. The second game in development was a virtual escape room game (ERG) titled "Sinking Ship," which was planned to educate the acquisition workforce about FAR 33 Protests, Disputes, and Appeals lesson content. Our advisor recognized this opportunity and gave us the information we needed to engage with the subject matter experts at NC State. By formulating the problem based on relevant and timely research, along with communicating with real-world stakeholders early on we were able to set the stage for research that could have a real benefit to the operational community.

b. Theory building

Similar to the main research problem, derivative theories must also consider all plausible alternatives. Exploring other theories that mirror different perspectives enables research teams to filter down to the most probable explanation. Effective engaged scholarship seeks objective validity rather than one's own limited conceptualization of complex topics. Subsequently, more objective and significant takeaways can be produced when more than just one hypothesis is investigated. This process of cross-examination enables researchers to better select a theoretical model that precisely reflects the problem within its own unique setting.

Theory building is an essential part of any research project. Without a solid theory to guide your work, it can be difficult to draw meaningful conclusions from your data. We

apply theory building in our research by considering multiple game types and seeking to uncover the objective reality behind what key factors lead to an effective educational game. By choosing to research multiple game types we were able to explore a variety of alternatives and the impacts that different game types would have on the development process. Further, we consistently consulted with experts in both gamification and educational fields to ensure that the features we created would be beneficial for the end users. Then we were able to effectively measure student experience with different modalities of educational games (e.g., ERG, and TD games) by using carefully thought-out curriculum evaluations. As part of a larger group of contracting professionals researching gamification, we add to the literature on the topic and allow future research teams to consider other plausible options that can be compared to those we developed.

c. Research design

In engaged scholarship, research design is all about collectively exploring and incorporating methods which allow researchers and practitioners alike to parse out which theory or set of theories most accurately represent reality. In this step, the team develops operational models which empirically test key aspects of each theory in pursuit of the truth. These models or "tests" can take the form of experiments, case studies, surveys, longitudinal studies, etc., with the end goal being the expansion of existing knowledge around the subject. As with the previous three steps, continued communication between the researchers and practitioners (particularly methods experts) remains of the utmost importance.

Achieving a successful research design is essential for any study and our team was very mindful of this throughout our work on this project. Our applied research design included examining both game types as case studies and carefully documenting our team's development decisions along the way. Additionally, we were able to collaborate with key stakeholders to come up with purposeful metrics for use by both game developers and educators. We then were able to use multiple curriculum evaluations which helped us observe the objective truth about games as an educational modality. Once we collected the

data, we were then able to establish our findings in a way that would be useful to both future contracting gamification researchers and developers alike.

d. Problem solving

During problem solving, the team ties their research findings back to the problems identified by practitioners in their respective communities. In a traditional approach, if the research is good enough then it is assumed that the community will of course incorporate that research, but this is rarely what is observed. "It is one thing to write a research paper, and quite another to transfer, interpret, and implement study findings at the communication boundaries of both scientific and practitioner communities" (Van de Ven, 2007, p. 25). Engaged scholarship tends to shatter this boundary as practitioners and researchers foster a relationship which allows for a free flow of communication between communities instead of the top-down researcher to practitioner flow often characterized by traditional approaches

When solving problems, it is important to consider the context in which those problems exist. Engaged scholarship problem solving was ever-present in our research because we ingrained ourselves into both the operational gamification research community and the Acquisition Innovation Research Center's (AIRC's) incubator study which led to the creation of both Project Admiral and Sinking Ship. By injecting ourselves into the game creation process as advisors and communicating constantly with prior research teams, we were able to consistently communicate, interpret, and negotiate our findings with the end users who needed them most. This process built a relationship between both researcher and game developer which made our findings unique when compared to previous gamification research.

As we will further discuss in future chapters, our research capitalized on the engaged scholarship approach by injecting ourselves directly into a game development team as they were creating contracting specific training. We were able to experience the game development process first-hand by frequently interacting with game development practitioners and students alike to hone applied knowledge of gamified contracting training. Studying the concept of gamification in this way provides us with an opportunity

which has yet to be explored and allows us to make more qualified recommendations to both contracting and practitioners alike.

B. MOTIVATION FOR GAMIFICATION TRAINING AND LEARNING

Motivation is defined as "the reason or reasons one has for acting or behaving in a particular way" (Merriam-Webster.com 2022). When applied to gamification, this would mean the reasons one has for choosing to play or continue playing a game. As stated in For the Win, people experience inertia in the sense that they tend to have a predefined internal resistance that needs to be overcome for them to act a certain way (Werbach & Hunter, 2012). Understanding the "why" is important for comprehending how to get people motivated to play a game. This is especially important for our research because our audience may have the preconceived notion that our games are homework with a clever disguise. By understanding the underlying theories behind player motivation, we will be better able to overcome this inertia in the future. Further, by applying the MDA Framework in conjunction with motivational theory, we will be able to focus on the mechanics, dynamics, and aesthetics involved in the game which make users motivated to play. This section examines different theories that can aid game developers in achieving their goals in motivation for their player base.

1. Self-Determination Theory

According to Self-Determination Theory (SDT), which was devised by Edward Deci and Richard Ryan, individuals are naturally inclined to grow, but this internal motivation can be suppressed if the surrounding environment is not supportive (Werbach & Hunter, 2012). SDT discusses three psychological needs: autonomy, competence, and relatedness. **Competence**, or mastery, means the need to experience our behaviors as effectively enacted, or to feel like we have done a good job as we progress through the game (Werbach & Hunter, 2012). To apply this to a game would mean to give the player the ability to feel as if they are accomplishing something through play. This could be through achievement, badges, or leaderboards as described in the MDA Framework. **Autonomy** is the need to experience a behavior as voluntary and self-endorsed, or as to have control over what we do (Werbach & Hunter, 2012). This concept would be

applicable to games as users should not be forced to play the game. If done incorrectly, "mandatory play" (Larsson et al., 2021) could cause users to have a negative opinion of the game even though they may have otherwise enjoyed playing the game on their own. **Relatedness** entails the need to feel like we belong. This manifests itself in interacting and feeling close to others or having meaningful interactions with other people (Werbach & Hunter, 2012). This applied to gamification would ensure users feel they are experiencing meaningful interactions with other users in the game. The psychological need of relatedness may be incorporated through an in-game leaderboard where users can compare their skills in relation to others.

SDT also outlines two types of motivation: intrinsic and extrinsic (Werbach & Hunter, 2012). Werbach and Hunter (2012) state that **intrinsic motivation** exists when you find enjoyment in the act itself. In simpler terms, you are doing something simply because you want to do it, rather than because you will get a materialistic payout. On the other side of the spectrum lies **extrinsic motivation.** This type of motivation is described by the researchers as being inclined to perform a behavior or activity because we want to earn a reward or avoid a punishment (Werbach & Hunter, 2012). Depending on how future contracting games are developed and employed, the balance between both types of motivation will likely play a pivotal role in players' willingness to play. By understanding the motivation types which drive SDT, we will be able to design games which not only captivate our audience but simultaneously increase the likelihood that players will be intrinsically and extrinsically motivated enough to effectively benefit from the experience.

2. Hierarchies of Needs

Abraham Maslow was one of the first to develop a theory of human motivation. Maslow classified five types of needs that would fuel human actions, starting with physiological requirements and building up to the necessity for self-actualization (Maslow, 1943). This theory explains that individuals must satisfy needs starting from the bottom and then working upwards through subsequent levels on the pyramid (see Figure 9a). Based on this theory of needs, Siang and Rao (2003) developed a similar pyramid which applies Maslow's hierarchy of needs and translates it specifically to the needs of players within a

game **(**see Figure 9b**)**. Similar to Maslow's pyramid, players would need to progress through the pyramid by Siang and Rao in the same manner, i.e., from the bottom up.

Beginning at the bottom level of the pyramid, players tend to start a game by trying to fulfill the **rules need**. Players cannot move forward or accomplish anything without the ability to interact with a game. Often players prefer to learn game rules organically through trial and error rather than reading the game's manual. For example, a player may need to learn that they can jump over a chasm to reach the other side of a level and avoid losing a life. However, after falling in and starting over at the beginning, they can try again and experiment with different approaches until she finally succeeds and grasps the rules of the game. Once players understand the rules, they then try to find safety (**safety need**) by looking for guidance or clues within the game so that they can avoid losing long enough to sustain play. The third level describes how players need to feel a sense of belonging (**belongingness need**), or as Siang and Rao (2003) describe, becoming comfortable in the game and believing that they can ultimately succeed. Players need to feel connected to the game, its characters, and the game's environment. In other words, it is imperative for players to understand how their actions affect the world around them, as well as how their actions can influence the game's outcome. Players who believe winning is possible also want to play the game to cultivate a sense of self-esteem (**esteem need**) through learning and mastering the mechanics of the game. Once players believe they have full control of the game, they then feel a strong desire to fully understand it (**need to know or understand**). At this level of the pyramid, the player is actively engaged in uncovering all the game's secrets in the pursuit of further challenge, looking to discover more within the game such as unique strategies, hidden treasure, or unseen locations. After players feel that they have begun to master the game, they then start to enter the level of **aesthetic need**. At this level of Siang and Rao's pyramid, players desire aesthetically pleasing things in a game like immersive sound effects, graphical fidelity, and game physics. The final level of the player motivation pyramid is self-actualization (**self-actualization need**), where players strive to do whatever they want and fully test the limits within the rules of the game and its boundaries. At this stage, players adopt almost a completionism mindset wherein they feel like they have mastered all aspects of the game and want to feel all the power which comes

with that accomplishment. Put another way, "They want to play God in the virtual world." (Siang & Rao, 2003, p. 6)

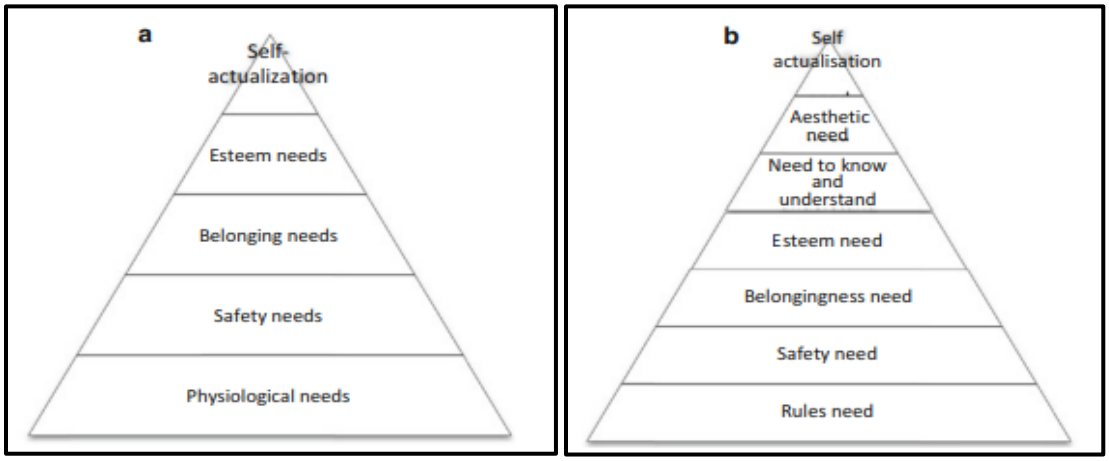

Figure 9. Hierarchy of needs pyramid (a) and hierarchy of players' needs (b) Source: Siang and Rao (2003).

Understanding player motivation is vital for game developers who determine which mechanics, dynamics, and aesthetics are added to a game. The theories described above can be used as steppingstones into further research concerning how games work and the motivation factors that will ultimately affect players. These ideas assisted us and can assist future functional advisors when applying the MDA framework through the process of developing a game. When applied correctly, the underlying theories which describe human motivation can be used as an aid not only for developers, but for education professionals as they work toward their gamified training objectives.

C. GAME TYPE AND ITS IMPACT

1. Tower Defense Games

In Tower Defense (TD) games, the objective is to use barricades and other obstructions to stop invaders from accessing your territory (Dodge, 2022). This is usually done by placing fortifications or countermeasures in the path of the invader's advance. Rewards are typically earned for destroying enemies and surviving subsequent waves of enemy attackers. Some common examples of TD games are Kingdom Rush, Fieldrunners,

and Over the Top Tower Defense. According to Brich et al.'s (2015) research, this genre is popular among researchers because it is easy to learn and yet still demanding and addictive. Furthermore, TD games can be used to teach everything from resource management to strategic planning. As Avery et al. mentioned in their 2011 article on *Computational Intelligence and Tower Defence Games*, this game type is fully engrossing and provides hours of entertainment. TD games are also useful as research subjects because they are relatively computationally and graphically simple, thus making them easy to program. Having a strong understanding of the various aspects of this game type will provide researchers with a strong foundational knowledge before delving into the development of impactful TD games.

TD games enjoy relative ease of development. When compared to other games where the development team needs to painstakingly craft each level individually, TD games often use the same maps, resources, and textures (in the form of buildings/mazes/ enemies) for many subsequent waves of attackers. As Sanchez and Casallas (2015) demonstrated in their work, TD game development can be automated with relative ease through the use of Domain Specific Language (DSL) combined with Model-Driven Engineering (MDE), even for smaller development teams. Through this innovative approach, they were able to create a code generation tool which could drastically reduce the amount of time it took to produce a rapid TD prototype. Similarly, Avery et al. (2011) identified how computational intelligence (CI) could be used to develop procedurally generated content for TD games in the form of maps and enemy strategies. Further, CI could enable TD games to adapt to the player by generating new paths and enemy strategies based on player performance (Avery et al., 2011). If future TD games can be made using similar code generation methods which substantially decrease production time and adapt to individual player needs, then it stands to reason that such games could rapidly be adapted to create effective learning content.

TD games have effectively been used to help teach a very wide range of topics such as mathematics, health, information security, and software maintenance techniques. In Liver Defense (LD) (see Figure 10), students are intuitively taught about human liver function through how the game's use of liver cells (defense nodes) can be specialized to

combat certain waste materials like ammonia, alcohol, and pharmaceuticals (Brich et al., 2015). In that game, players defend a healthy liver from enemy waste cells by managing blood sugar levels and upgrading liver cells to perform realistic liver functions. Players gain points for defeating waves of enemy waste cells and lose points for waste cells which make it all the way through the liver without being metabolized. The simple interface in LD allowed players who had no previous experience to develop a working knowledge about challenging concepts like Kupffer cells, blood sugar, and metabolization. Some contracting concepts are similarly difficult for new specialists to learn. By incorporating gaming elements into the learning process, it may be possible to make these concepts more accessible to novice learners. In addition, as demonstrated by LD, tower defense games offer an immersive experience that can help to keep players engaged while they learn about new and otherwise complicated topics which makes them a modality worth studying for future contracting training.

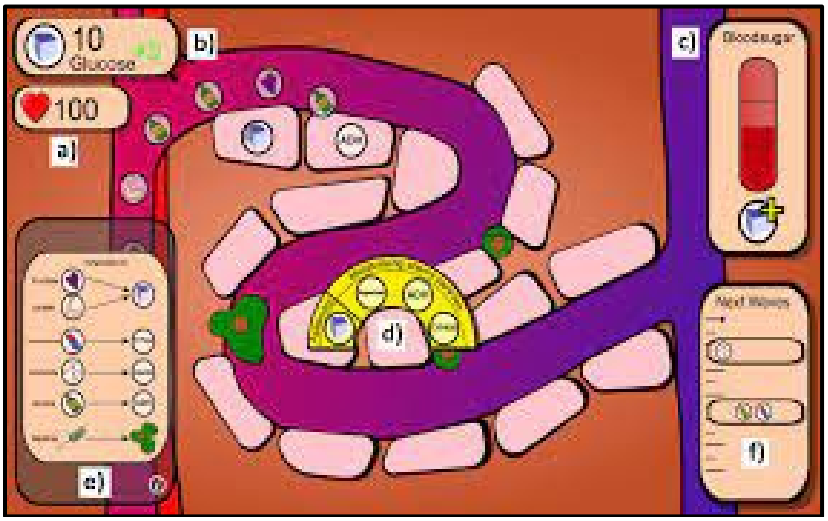

Figure 10. LiverDefense gameplay screenshot

The difficulty with developing effective serious TD games lies in adequately integrating the educational concepts such that they don't take away from the challenging and addictive nature of the underlying game mechanics that would encourage students to spend time in the game, thus learning more and more. As Løvgren and Oyetoyan (2019)

found while developing and testing a TD game prototype called Data-driven Security Game (DdSG) (see Figure 11), this harmony between education and fun are paramount and finding the right balance is no easy task. DdSG was designed to teach software developers (who often lack proper security training) the mitigation strategies and patterns necessary to defend against a wide range of security attacks (Løvgren & Oyetoyan, 2019). As they reported when testing DdSG on students, the game scored high amongst the users in terms of intuitive gameplay and educational content but relatively low in terms of actual fun. In other words, the game exhibited what we often see in serious educational games — a great educational tool disguised as a game. Without the fundamental hook of fun, educational games will continue to struggle at motivating users to engage with the game beyond the classroom.

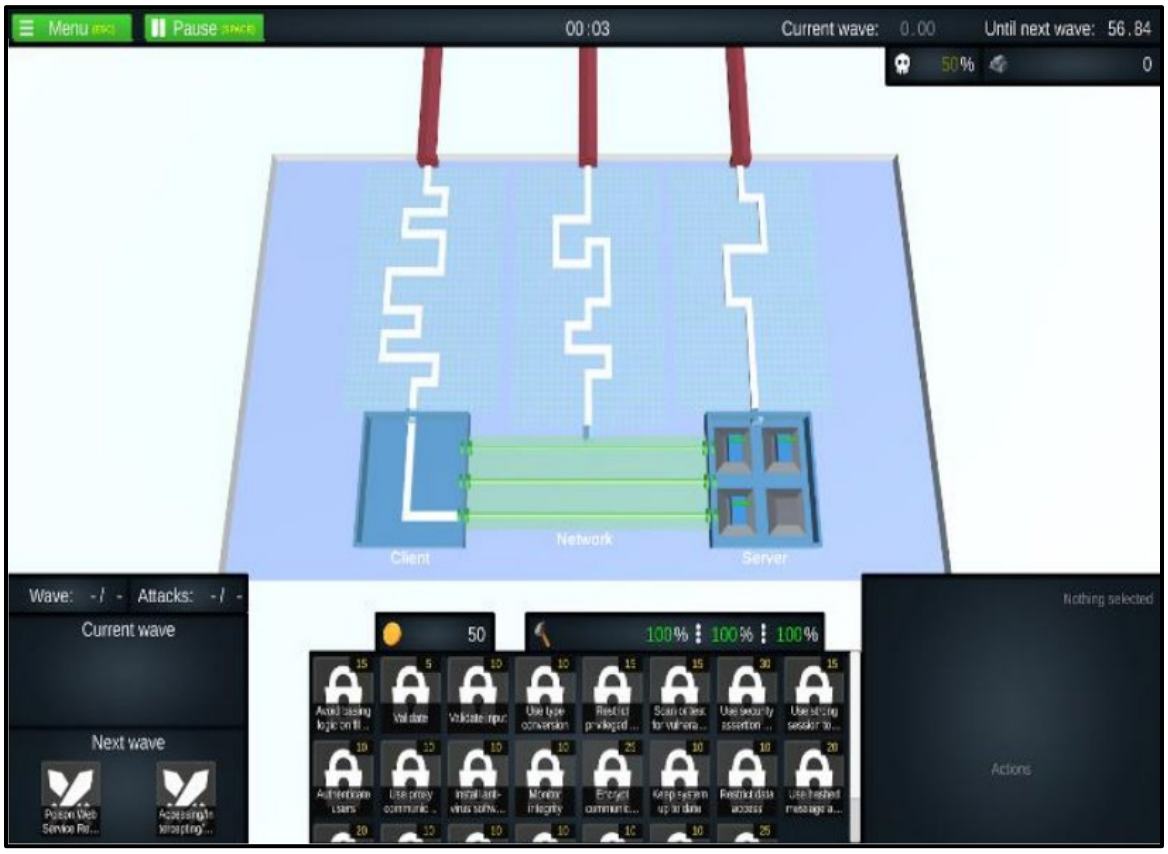

Figure 11. Initial game view of DdSG, Source: Løvgren and Oyetoyan (2019).

One of the greatest takeaways surrounding the literature of the educational TD games we examined is the addictive sense of achievement players feel upon surviving wave after wave of enemy attackers (Avery et al. 2011; Bassilious et al., 2011; Brich et al., 2015; Løvgren & Oyetoyan, 2019). It's a combination of this sense of personal achievement and ease of development that makes TD games such a prime catalyst for future gamification research. Accordingly, if the contracting community could find a way to take advantage of such a game, it could stand to sustain a more diverse set of educational tools and potentially a more knowledgeable workforce. Moreover, due to the relative ease of development, a TD game may even present an opportunity for contracting professionals (who otherwise are not well versed in game development) to design educational TD games for their specialists.

2. Escape Room Games

The goal of an ERG is for the teammates to cooperate, discover hints, and unravel puzzles in order to achieve their objective within the allocated time limit. The traditional goal for an ERG is to simply "escape" its confines, but now there is variation in the types of missions players can experience, ranging from murder mystery to breaking into a vault (Veldkamp et al., 2020). Similarly, the researchers noted that the popularity of ERGs is increasing. This is because schools, colleges, universities, and continuing education programs have begun utilizing this game type as a learning tool. Although the research we found surrounding ERGs refers to in-person escape rooms, most of the principles involved still apply to a virtual setting as the underlying game mechanics are nearly identical and the overall objective of the game remains the same.

Nicholson (2015) found a wide range of ERG types to be possible, noting over 175 unique types in their study. Even though there is a vast range in the types of ERGs, one thing is consistent throughout. In order to get the most out of an ERG, players need to believe that they are an active participant in the game's world. For example, if the escape room's environment suggests that they are trapped in a haunted mansion, then the aesthetics need to be detailed enough to allow the player to break free of the real world and imagine themselves where the game takes place. According to Nicholson (2015), this concept is called immersion, and it occurs when a person (usually a player) is fully

absorbed into the scenario or task at hand. It is essential for educational games to achieve immersion, as it gets the learner engaged and excited to finish the challenge (Veldkamp et al., 2020). As stated by Nicholson (2015), there are four approaches to structuring puzzles when creating an escape room. Figure 12 shows how there are four distinct paths in which a room, or a puzzle can be presented. The puzzles can be presented individually, where each one feeds directly into a larger, more complex puzzle, or sequentially, where one puzzle must be solved in order to unlock what is needed for the next puzzle (Nicholson, 2015). In Figure 12, the squares represent puzzles, and the rectangles represent locks, meta-puzzles, or other victory conditions for that particular escape room. It is important to understand the array of options for escape rooms so that educational developers can figure out what best suits their learning goals. Further, understanding the paths or orders in which ERGs can be presented will help researchers create a more exciting and immersive virtual escape room experience.

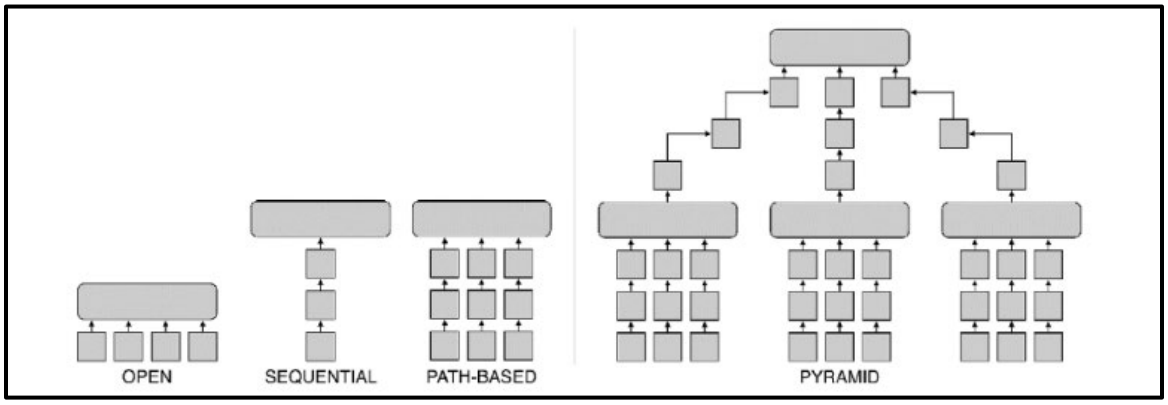

Figure 12. Puzzle structure of escape rooms. Source: Nicholson (2015).

Veldkamp et al. (2020) reviewed the educational aspect of escape rooms and they found positive results for learning. They noted that unlike recreational ERGs, educational ERGs are created with specific learning goals in mind. Educational ERGs are most effective when they are able to seamlessly weave the challenge of aligning the game's puzzles with the learning objectives in the curriculum. To make the right development decisions with an ERG it is important to understand the different elements that the game

type implements. Some key aspects found throughout the Veldkamp et al. (2020) study are examined as this information is essential in understanding the educational benefits that escape rooms can provide.

The players in an escape room game have limited **play time**, which makes the urgency of their actions even greater. As Veldkamp et al. (2020) found, for educational purposes, this mechanic in an escape room game is important because educators need to maximize the number of students who can make it through all the goals in time. The researchers also noted that if adequate play time is not given, then players will likely experience frustration, the desire to quit, or exhibit trial and error behavior which is often not conducive to deep learning. When developing a game of this type, researchers must define a realistic play time for the players in order to reap maximum educational benefits.

Increasing students' **motivation and engagement** in a learning environment was a goal of 92% of escape rooms evaluated by this systematic review (Veldkamp et al., 2020). However, they found no basis to assume that students are intrinsically motivated by playing escape rooms; instead, they found that extrinsic motivation factors such as competition, time constraints, and grading are very important. Knowing that extrinsic motivation is so important for ERGs can be useful for developers because they must understand the underlying factors which motivate players to complete an ERG. If developers understand that extrinsic motivational factors are the primary catalyst for getting students to complete an escape room, then they will be able to design ERGs which can engage a larger audience. For example, choosing to add time constraints and a leaderboard can help achieve the extrinsic motivation necessary to successfully engage more players.

The ultimate goal of any educational ERG should be to **increase learning**. The review by Veldkamp et al. (2020) found that 94.7% of students preferred the escape room modality for learning, however those same students indicated that they learned better from the activity only 58% of the time. Additionally, they found three studies which measured ERG learning effectiveness through use of a pre and post-learning test and noted that two of the three concluded that most students experienced significant learning. The last study they observed found disputable improvement in content retention so they could not conclude that escape rooms had a positive impact on learning compared to traditional

methods. This information reveals that ERGs might have a positive impact on learning objectives. If ERG games can potentially increase learning outcomes, then they are worthy of future research in contracting game development, adding to the existing literature and informing future game development teams about a wider array of game types that can be useful for teaching students. Furthermore, if we can increase learner outcomes in the contracting community by leveraging virtual ERGs, we will nurture a more competent acquisition workforce that is better equipped for an ever-evolving battle space.

Another study on ERGs focused on creating educational escape rooms and interactive games for higher and further education. In their research about the future development of ERGs, Clark et al. (2019) developed the escapED Framework (see Figure 13). This theoretical framework outlines a way to develop educational escape rooms and interactive games that promote comprehension and positive behavioral changes (Clarke et al., 2019). The six steps that they outlined are in the sequential order of when they should be accomplished.

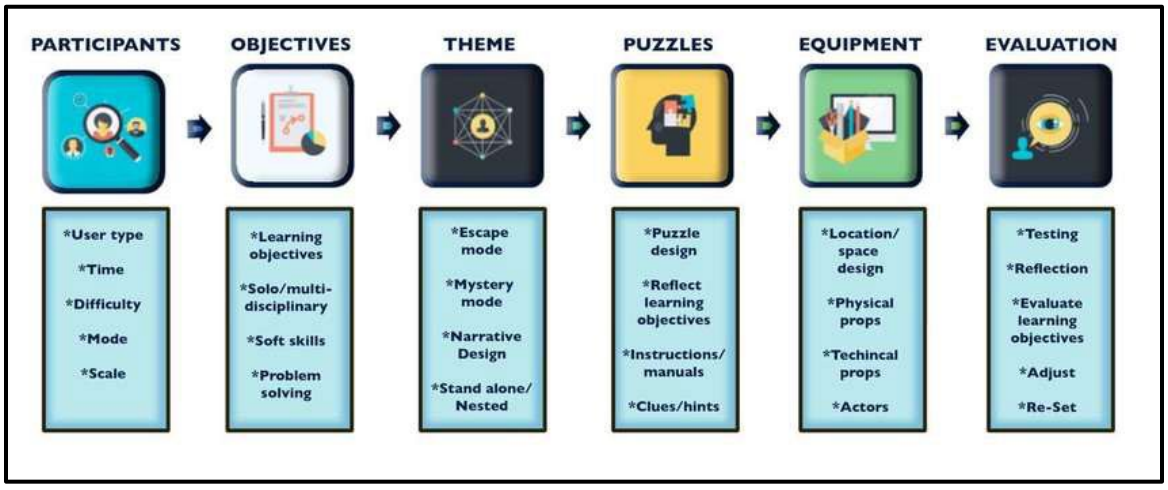

Figure 13. EscapED framework. Source: Clarke et al. (2019).

According to Clarke et al. (2019), six main areas should be considered while making an educational ERG:

a. Participants

First, developers must consider their participants. This can be done in a number of ways but essentially the development team should conduct a needs-based analysis of who the game experience will be aimed toward. As Clark et al. (2019) explains, developers have five sub-categories to consider at the onset of developing an educational escape room. **User-type** considers the user's needs to figure out what type of player they are and what learning objectives they have. **Time** is the duration of the experience or determining what is the optimal amount of time that should be spent trying to solve the ERG. **Difficulty** is aligning the ERG's puzzles or challenges to different levels of player skill sets. For example, an escape room aimed at teaching basic geometric problem-solving skills to elementary students will likely be very different in terms of difficulty when compared to one created to teach high school students. **Mode** is choosing between different game styles of play such as cooperative team-based play or competitive solo play and **scale** is the number of participants the game should be designed for. By considering participants, game developers can better tailor their ERG to the users' needs.

b. Objectives

The second step for developers is to consider the game's objectives. Clark et al. (2019) noted that game objectives can be broken down into four categories. First, developers should concentrate on crafting tangible **learning objectives** so an assessment plan can be employed to evaluate players' learning process and development. Next, developers should decide if the game should use a **solo or multi-disciplinary** approach. For example, if the ERG focuses only on teaching fire evacuation drills to the students, it could be considered solo-disciplinary. Whereas a game teaching geography combined with foreign language retention could be considered multi-disciplinary. Developers should also consider whether or not the game can hone the player's **soft skills** through play such as communication, collaboration, and time management. Finally, players find the game appealing because of its **problem-solving** components. By developing a diverse range of problem-solving scenarios, ERG developers can create engaging experiences for different types of players.

c. Theme

Next, ERG developers should consider the game's theme. The game's theme immerses players into the game's universe by using player motivation, the game's plot, and its material to create an engaging gaming experience (Clark et al., 2019). The theme sets the tone for the entire game and can be used to create an immersive and exciting experience for players. A good theme can make an escape room game more challenging and engaging, while a poorly chosen theme can make the game feel confusing and disjointed. Clark et al. (2019) explains that there are four main areas that developers should consider when designing ERG themes. First, developers should consider designing their theme around one of the two major game modes. The most common game mode for ERGs is the **escape mode** where players are placed in a locked room and required to escape in a set amount of time. Similarly, the **mystery mode** requires players to solve a mystery before time runs out such as a murder mystery or famous detective story. In order to create a feeling of immersion for the players, designers need to be skilled in **narrative design.** A well-crafted narrative will give players a clear goal to focus on and a reason to care about the game world. Lastly, ERG designers should consider whether their game will be a one-off (**stand-alone**) experience or a part of a larger (**nested**) experience. A nested experience might require more complex systems and gameplay mechanics to keep players engaged, while a stand-alone game can be simpler in design. By considering the composition and narrative structure of an ERG, developers can create captivating stories for their players.

d. Puzzles

When it comes to designing an escape room, one of the most important aspects is creating puzzles that are simultaneously engaging and challenging. The fourth step for developers to consider when designing an ERG is the game's puzzles and activities. As Clark et al. (2019) point out, a game's **puzzle design** is key to keeping players engaged. It is possible to modify these puzzles in such a way that they encourage a variety of learning outcomes. As developers design these puzzles it is important that they **reflect on the learning objectives** that were set in the objectives phase so that they do not lose sight of their overall goals. Additionally, these puzzles should have clear and easily understood

instructions/manuals or rules which help players understand the boundaries of the game. Finally, developers should have a plan to provide **clues/hints** for the puzzles in a way which doesn't break the immersion or unduly take all of the challenge out of the game. If players get too frustrated, they may give up before solving the game and learning the lesson objectives. Conversely, if players are supplied with too many hints, making the game too easy or breaking the immersion, they will likely become bored and disconnected from the game entirely.

e. Equipment

The equipment used in an educational escape room can have a significant impact on the overall experience. ERG developers should create a believable and life-like setting for players to interact with. As Clark et al. (2019) outlined, there are four sub-categories which educational ERG developers should consider when determining the equipment to include in their games. Firstly, the room itself can be considered part of the ERG's equipment; developers need to consider the room's **location/space design**. To do this, developers need to answer questions like "Does this room encapsulate the overall theme?" and "Do players have enough space within each room to not only enjoy its aesthetics but perform the tasks required to escape?" An escape room's appearance can have a great amount of decoration and thematic appeal, but all of that will go to waste if players are not able to effectively maneuver within the room's available space. The **physical props** within a room should also cleverly add to the challenge of a game and subtly coerce players to think outside of the box. Some ERGs include a mix of items required to solve the puzzle and red-herring items which may look important on the surface but will be of no use in the long run. **Technical props** have also become increasingly popular in ERGs as they can potentially add a lot to the game's experience. Augmented and virtual reality (VR) are examples of technical props which allow developers to make large changes to the game's design and layout on the fly with relative ease. Developers need to weigh the value of technical props cautiously however, as they can also pull the players out of the game should they crash, disconnect, or fail in some way. Finally, live **actors** in the escape room can add a lot of value as they can skillfully keep players on task and even dole out verbal cues if they perceive player frustration. Just like in a theater production, attention to detail with

regards to the equipment used is essential in creating an engaging experience for players. Players need to feel like they are in the game, and the best way to do this is by choosing the right combination of equipment to bring out the most from the ERGs overall aesthetic.

f. Evaluation

Finally, the evaluation step of the escapED framework involves assessing the game as a whole. Evaluation is important in order to identify any areas that need improvement, as well as to assess whether the game is achieving its intended objectives. **Testing** means making sure that you perform multiple dry runs of the game before administering the room to live players. By taking the time to test and iterate the game experience, you can ensure that your live session goes smoothly and that everyone is able to accomplish the learning objectives. Once players do play the game, it is important that developers collect user feedback and **reflect** with the players about how they experienced the game and whether or not the game affected their knowledge in relation to the training topic. From there, developers should analyze that feedback and establish a formal plan to **evaluate the learning objectives** they outlined in step two. Developers should then collect more feedback from users and **adjust** the game based on their input. This will help developers get closer to optimal learning outcomes, which are ultimately the goal for any educational ERG. Once the game has been polished, Clark et al. (2019) recommends developing a **re-set** sheet which outlines all of the steps that actors/ERG administrators need to accomplish in order to reset the physical ERGs for subsequent playthroughs.

The escapED framework outlined by Clark et al. (2019) proved to be a pivotal design concept which served as a theoretical compass of sorts that we frequently recalled as we advised the design of Sinking Ship. Similarly, the foundational knowledge presented by Veldkamp et al., (2020) and Nicholson (2015) allowed us to make informed decisions with a goal towards creating an immersive experience for players. Even though none of the studies we outlined in this section dealt exclusively with virtual ERGs, the concepts which underlie physical ERGs in our experience translated very cleanly to our virtual setting.

D. LESSONS FROM THE FIELD OF DEFENSE ACQUISITION AND CONTRACTING IN GAMIFICATION

Applying the knowledge garnered from the Sandbox Contracting study (Larsson et al., 2021), Finkenstadt et al. (2022) expanded on a previous working essay (Finkenstadt & Helzer, 2022) and conveyed a strong case for the use of gamified learning in defense acquisition (DA) training. Since DA professionals serve as the sole executors of the DOD's roughly $750 billion budget, taxpayers rightly demand near perfection and pay an inordinate amount of attention to even the appearance of a mistake in the DA field. Noting this, Finkenstadt and Helzer (2022) identified that gamified methods could serve as the useful medium for DA training as it effectively separates DA specialists from the zero-tolerance environments they operate in. Free of the otherwise career altering consequences of real life, DA professionals could be allowed to experiment and benefit from the deeper learning one experiences by learning from their mistakes (Finkenstadt et al., 2022).

One particularly valuable finding from the Finkenstadt and Helzer (2022) initial research was the connections between gamified learning environment features and DA operating environment features (see Figure 14). They were able to visually map out how a gamified learning environment can effectively reinforce the positive operational learning features whilst simultaneously reducing the effect of on-the-job learning detractors such as the intense regulatory environment and occupational decision risks. This kind of visual representation backed up by the hands-on experience of the team will undoubtedly inform future DA gamification efforts.

Features of Gamified Learning Environment	Interaction	Features of DA Operating Environment
Fantasy	Reduces	Objective realities with real consequences in litigious environments.
Challenges/ Goals	Reinforces	Complex problems, levels of professional achievement, varied levels of problem difficulties
Representation	Reinforces	Evolving problems in highly variable environments.
Curiosity/ Mystery	Reinforces	Heterogeneous requirements that require customer discovery and market research and intelligence gathering.
Feedback	Reinforces	Communications across networks. Interactions with public and private entities. Adverse consequences for poor performance or conflicts of interest.
Rules	Reinforces	Strong regulatory environment tha, in many cases, is based on procedural rules.
Voluntary Participation and Mulligans	Reduces	All decisions have consequences for one or more DA parties (costs, schedule, performance, reputation etc.). DA member roles are constrained by regulatory authorities and agency rules (only the contracting officer may obligate fiscal funds, etc.)

Figure 14. Alignment of gamified learning environment with features of DA operating environment. Source: Finkenstadt and Helzer (2022).

Expounding on the Sandbox Contracting study (Larsson et al., 2022), Finkenstadt et al. (2022) recognized that the modality through which players experience the virtual content plays a vital role in how players will not only perceive the effectiveness of the game but also their own enjoyment. If players are required to experience the game through relatively low powered computer hardware then many games will struggle to run and users will become frustrated as loading times and visual glitches continuously pull them out of the virtual immersion. Since the 344th Training Squadron was limited to playing the graphically intensive Sandbox Contracting game on Chromebooks with low computational power, many of the students said that the game's inability to run smoothly had a negative effect on their ability to experience the game (Finkenstadt et al., 2022). Conversely, Finkenstadt et al. (2022) noted that the cohort who was able to play the game through gaming computers reported a higher level of enjoyment and overall had fewer complaints. If future DA games are going to be expected to run on DOD hardware (which traditionally is not designed for gaming), either unit computational capabilities need to be improved to support such games or developers need to ensure that future games are designed with existing DOD hardware and software constraints in mind.

Additionally, as shown in Figure 15, the research team articulated that perhaps one of their most critical findings was the importance of matching DA professionals to the most

appropriate game type (Finkenstadt et al., 2022). In the event that players are able to experience teachings in a way which caters to their particular personality, then it stands to reason that they will likely be drawn to a specific type of game (e.g., role-playing games (RPGs), puzzle games, or FPS games). If large scale patterns can be discovered about the personality of a prototypical DA professional, then future game developers will be able to sufficiently captivate the attention of their target audience.

	Game Types					
Subject	First Person Shooter	Escape Rooms	Arcade-style	Role-playing	Puzzles	Tycoon
Requirements Development						
Systems Engineering						
Mandatory Sources	x					
Market Research/ Intelligence		x				
Category Management	x					
Acquisition Plans						
Solicitation Development						
Contractor Evaluations						
Negotiations						
Intellectual Property						
Contract Protests			x			
Contract Quality Management						
Contract Changes and Mods						
Closing Contracts						
Contingency Contracting/ OCS						
DevSecOps / Software Acq						x
Subject	Game Types					
	Action-adventure	Sandbox	Real-time Strategy	Tower Defense	Base build	Simulation
Requirements Development						
Systems Engineering						
Mandatory Sources						
Market Research/ Intelligence						
Category Management						
Acquisition Plans						
Solicitation Development						
Contractor Evaluations						x
Negotiations						
Intellectual Property						
Contract Protests						
Contract Quality Management						
Contract Changes and Mods						
Closing Contracts						
Contingency Contracting/ OCS				x	x	
DevSecOps / Software Acq		x				

Figure 15. Notional application matrix for defense acquisition subjects and game types. Source: Finkenstadt et al. (2022).

Finally, the research team recommended that future DA gamification studies need to be carried out to explore which types of games cultivate the maximum amount of educational retention (Finkenstadt et al., 2022). Perhaps it is the case that DA specialists prefer more fantasy centric games like RPGs instead of adrenaline provoking FPS games. Should this be the case, it seems plausible that undesirable games to a particular community

will likely reap far fewer benefits when compared to traditional alternatives. Finkenstadt et al. (2022) applied their expansive knowledge about both DA subjects and game types to create a notional matrix which best matches each subject to what likely will be the most suitable game type (see Figure 15). The "x"s within the matrix cells represent current game design efforts that have been completed or are in the process of being completed within the defense acquisition network of game developers (Finkenstadt et al., 2022). Of particular note for our study, the researchers mapped operational contracting support (OCS) and protests to TD and ERG types respectively which are two combinations that we explore in the next chapter.

E. IMPLICATIONS AND SUMMARY

In this chapter, we explore a large variety of topics ranging from research methods like the case study approach and engaged scholarship to theories of human motivation which underline why gamification works. We then look at tower defense and escape room game types and how developers can leverage them to improve learning outcomes for a wide range of skill sets. Finally, we review current lessons from the field of DOD acquisition gamification research which led us to explore both TD games and ERGs as a way to bolster contracting training. By applying the research present in this chapter, we were able to effectively equip ourselves with the knowledge necessary for our joint research with NC State.

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IV. METHODS AND FINDINGS

A. METHODOLOGY

1. Introduction

Our study leverages engaged scholarship methods across comparative cases to assist in the development of two new rapid prototype contracting games alongside a game-development team at NC State. Through this approach, we were able to fully immerse ourselves into the game development process and expand our working knowledge about how contracting concepts could be not only translated into a game but also adequately capture the attention of similarly developed contracting personnel. This chapter serves as a formalized documentation of our methods employed, experiences and lessons learned with the goal of creating a streamlined approach for future contracting game development teams.

Throughout our study, we were able to assist in developing two very different types of serious games. Project Admiral is a tower defense (TD) game used to teach contingency contracting and OCS contracting principles. Sinking Ship is an ERG that focuses on protests and FAR part 33 lesson material. Over the course of this chapter, we analyze both games as case studies using the MDA framework. The MDA framework is particularly useful in examining both games because each case is complex and multi-dimensional. By using the MDA framework, we are able to break down each game into its basic components which game developers and educators alike will easily understand. Further, the MDA framework serves to bring powerful context to the game development process sections we outline for each game. Lastly, we document curriculum evaluations for Sinking Ship to inform other gamification experts. These evaluations will be valuable for the gamification community as they provide insight into the effectiveness of the game in teaching specific concepts.

2. Case 1: Project Admiral

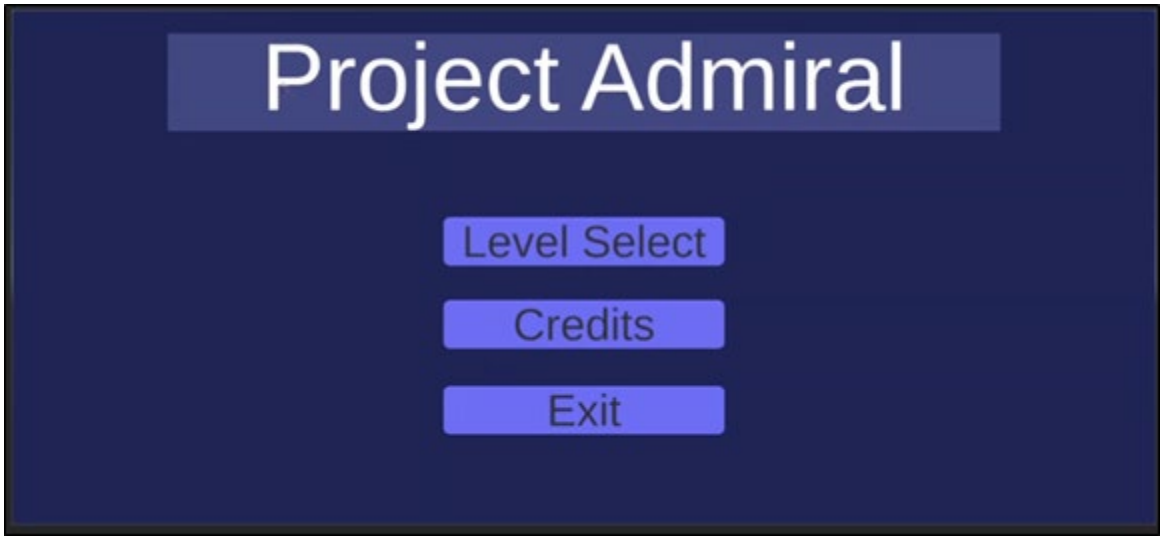


Figure 16. Project Admiral title screen

a. Background

Project Admiral had a development window of approximately five months. This development timeline was restricted due to the fact that Project Admiral began as an undergraduate capstone project, with students at NC State graduating by the end of the first development phase. The team for this consisted of two contracting professionals as functional advisors, four NC State game development students, and three senior advisors who specialized in contingency contracting training, enterprise sourcing, and game development respectively. Developing this game involved weekly meetings along with establishing and maintaining a Discord channel (Discord is a gamer-centric voice and instant messaging platform) where team members could easily request additional inputs from others on the fly while progressing through the project. As the two contracting functional advisors, our task was to assist the NC State team in creating a refined capstone project before the deadline and to help them implement as many contracting elements as possible within the allotted time frame. Our role was mainly to vector the development team as they developed a game centered around contracting. We did not assist in any

technical aspect of the game, but rather our focus was on idea creation, content, narratives, and contracting elements to game mechanic implementation.

Much of the project was coordinated through weekly team meetings which consisted of reviewing the current progress along with any ideas or adjustments we had along the way. Many ideas were suggested through this process that would not be implementable due to the time constraints. In fact, many of the contracting elements we had planned for in the initial version would need to be postponed for later phases or revisions to this rapid prototype. For this project, our intent was not to create the perfect game, but rather to record the process of how game creation is accomplished in order to improve on contracting game development in the future. We aided the developers through additions of any contracting elements they were unfamiliar with, but a large part of the upfront development was behind the scenes programming that did not involve the contracting team's active assistance. This was one of the first games the development team had created which resulted in a slower process and led to the inability to include every suggested aspect. Regardless, the advising throughout this process was useful as it allowed us to document our experiences and create relevant recommendations for future Air Force contracting game development teams.

b. MDA Framework

Mechanics, as discussed previously, are the rules and systems that govern how a game works. They're the most basic interactions that the player and non-player characters (NPCs) engage in throughout the game. In TD games, these mechanics typically revolve around the player placing towers in strategic positions to defend against waves of enemies. In Project Admiral, the player is set on an island with the goal of trying to defend their home-base from invading enemies as they spawn from a glowing orange portal on the opposite side of the island. This is illustrated in Figure 17; the portal can be seen as the glowing orange circle and the base is shown as the only building on the island on level start. Players are able to place a number of different defense nodes in an effort to protect their base from spawning enemies. After a short period of initial base defense buildup, the enemies then begin to spawn from the orange portal and attempt to attack the player's home

base, choosing to either attack the defense nodes in their way or sprint directly towards the base with the intent to destroy it.

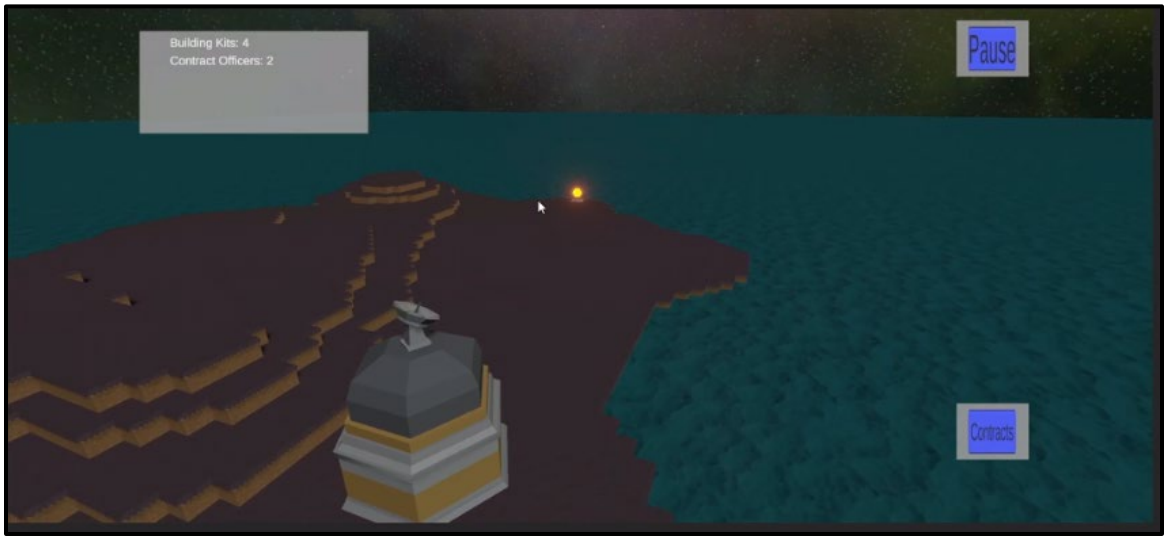


Figure 17. Project Admiral Island and enemy portal

Dynamics refers to the run-time behavior of mechanics over time, which are affected by player inputs (Hunicke et al., 2004). Game dynamics in TD games challenge the player to anticipate the movements of the enemy units and place their towers in strategic positions. Similarly, the enemy units must have strategies which are varied enough to keep the player on their toes. Each level should present the player with new challenges, forcing them to adapt their strategies. In this game, the player is tasked with defending the base with the use of the defense tower, walls, barracks, and air strips as seen in Figure 18. The player is able to place these building options on the squares, and they are purchased with building kits. The defense tower takes up one block and costs one building kit and it targets enemy units as they approach your base. The wall costs one building kit and is used to slow the pace at which the enemies are approaching the base as they will need to get around or through the wall(s) first. The barracks are what house your contracting officers and the air strips allow you to increase the rate of building kits you can earn throughout future waves.

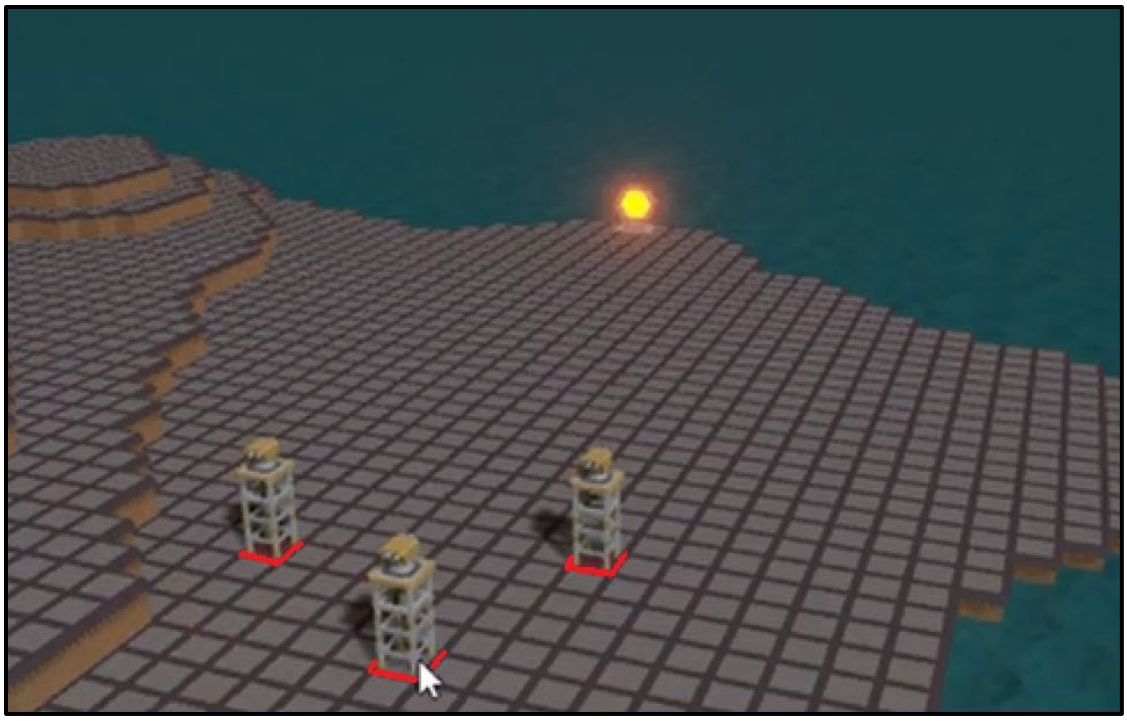


Figure 18. Project Admiral defense tower placement

Once the game starts, the player learns what to expect and is given time to place their first defenses. The enemies come in waves that increase in difficulty resulting in the need for more defense structures and rewarding the player for developing proper defense strategies. The player can acquire more building kits through the use of different contract options as seen in Figure 19. The contract options represent real-world contract vehicles, with rapid contract types awarding immediate resources and long-duration contract types requiring more effort up front but saving resources in the long run. These varied durations add strategy and complexity to the traditional TD model as the player must be able to withstand many waves of enemies without having the additional building materials in the meantime. The barracks can be built to allow the player to have more contracting officers which might lead to more building kits and therefore more defenses.

The contract selection element was one of the most important aspects of this game because it effectively mapped contracting lessons to the game's mechanics and strategy. The various contracts available limited the amount and type of resources that players could use, which in turn affected what kinds of strategies they could employ. For example, a

player could choose to satisfy a base's needs immediately with a Standard Form 44 (SF44) but could risk other factors such as poor performance or needing to refill orders over and over. They could also choose a Blanket Purchase Order (BPA) instead and get multiple vendors which would not need to have orders refilled manually every time the need is required. This process, while not fully developed at the time of writing, was intended to bring real world concerns into the game that operational contracting officers could face. Just like in the real world, all of these contract options have their costs and benefits, and this implementation strategy would allow players to learn about the trade-offs involved in contract selection and how those decisions can impact the overall success of an operation.

Figure 19. Project Admiral contract selection options

Aesthetics are emotional responses the player receives when they are interacting with the game. Aesthetics can be the feeling of being challenged or the feeling of community within the game (Hunicke et al., 2004). TD games rely heavily on visuals to convey information to the player; therefore, the game aesthetics play a big role in how enjoyable and immersive the game is. Good aesthetics can make a game more visually appealing and easier to understand, while bad aesthetics can make it more difficult to follow what is going on. When done well, the aesthetics can add another layer of strategy to the game as the player must pay attention not only to the gameplay but also to the way

the game looks and sounds. Done poorly, however, the aesthetics can be nothing more than a distraction.

In Project Admiral, the game's aesthetics involved the fantasy of being stranded on an alien planet, defending against the attackers, and the challenge of accomplishing this task. The fantasy of being stranded on an aquatic alien planet served to pull the student player out of their day to day office environments. It enabled them to disconnect with the otherwise drab cubicle farms and envision themselves supporting a military base while it was under threat of attack by aquatic alien creatures. Although time constraints limited the depth of Project Admiral's aesthetics, the game still managed to create an aesthetic which has never been attempted in a contracting video game. Figure 20 shows a picture of the game in action. In this image, the player has chosen to spend all of their resources on defense towers to both block the path of encroaching enemies and annihilate them at the same time. With future iterations of Project Admiral solidifying the existing game aesthetics, developers will be able to create a more engaging and enjoyable experience for players.

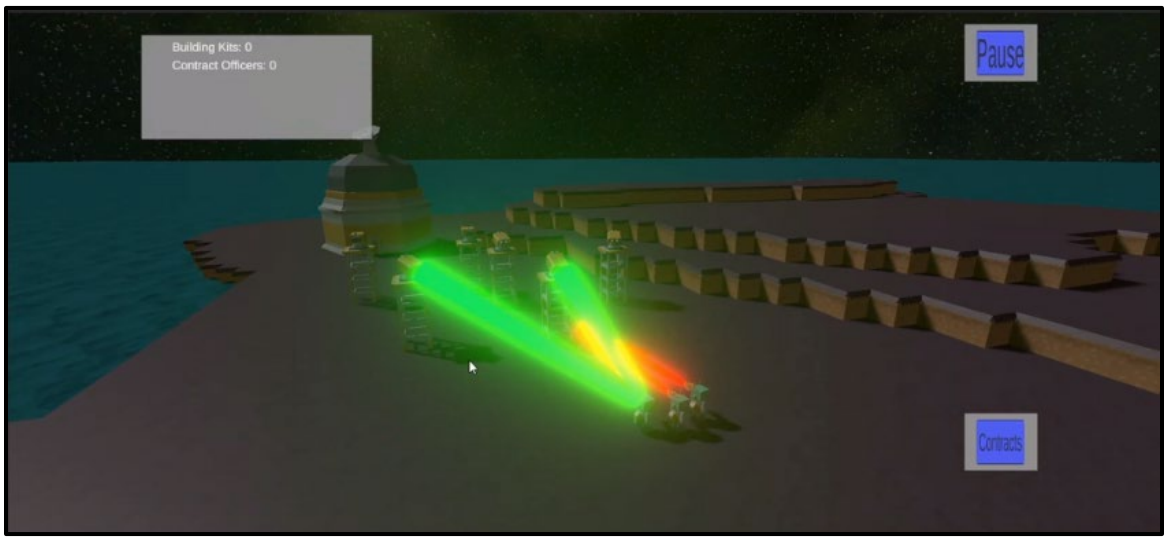


Figure 20. Project Admiral enemy interactions with defense towers

c. Game Development Process

Including contingency and OCS contracting material and balancing that material within a TD game proved to be a very daunting task. After all, most TD games are enjoyable precisely because of their ability to coerce users into a state of flow by leaning on the game's mechanics and the pending danger of enemy attackers. Extracting players from that experience could potentially detract from the future students' engagement and finding the right balance between lesson content and fun is perhaps the greatest challenge that developers of serious games will always struggle with. Another difficulty for the contracting career field in particular is the barrier that seems to exist between those within and outside of the contracting profession. Although many people benefit from the outputs of contracting to some extent, relatively few understand what exactly a CO or CS actually does and crossing this barrier, even as seasoned contracting professionals, was enlightening to say the least.

Many of our earliest meetings centered around foundational subjects. One of the main subjects discussed was what the aesthetics of the game should represent. Would it make more sense to pursue a more realistic deployed or contingency environment, or would the game benefit more from a less realistic roleplaying setting? After considering several different game worlds, we decided that a blend between realism and fantasy would be the best choice. In Project Admiral, players would be cast into a water world where they would be tasked with setting up and defending an Air Force base (AFB) on an alien planet. The water world environment of Project Admiral would add a level of fantasy to what many would consider an otherwise somewhat dry set of lesson materials whilst still having players assist in establishing and maintaining an AFB. By extracting players out of the mundane office environment and building up an aesthetic which required a heightened amount of imagination, we would be passively priming the student to consider potential courses of action (COAs) which they may not be willing to experiment with in real life. Subsequently, our enemies, defense towers, and level maps would coalesce to have players defending their base from waves of aquatic enemies.

For the in-game resource system we deliberated on what would serve as the most relevant potential resource for a contracting office supporting a contingency setting. The

team's initial impression was that money would be the best resource as it is often what many customers prioritize when carrying out contracts. However, upon further reflection, we decided to create a more contracting-centric resource management system to better represent the game's target audience. Instead of allocating money in exchange for defensive nodes and upgrades, students could allocate a combination of COs and CSs for those improvements. At the start of each level players would be given a set amount of contracting personnel (COs and CSs) and much like any contingency environment, the number of personnel could increase or decrease as the game went on. The player could then assign those personnel resources to execute contracts which represented different resources such as water or base security. Each contract type for a specific commodity or service would require a defined number of COs and CSs in order to execute that contract. Once the player has allocated those personnel, they would then be unavailable for a set number of rounds while the personnel executed the chosen contract. For example, a player executing an SF44 to acquire something would dedicate one CO resource for one turn whereas larger contracting efforts, such as an Indefinite Delivery Indefinite Quantity (IDIQ) contract would require one CO and two CS resources for two turns. An SF44 would deliver a small quantity of defense nodes or upgrades at the end of the execution period whereas an IDIQ would deliver a larger quantity and make future purchases from that IDIQ require less resources in the future for the same level. Giving players the ability to make relevant decisions in the contracting career field using the in-game resource system would allow future students to observe how those actions might play out when faced with similar choices in real life.

Once we had conceptualized how the Project Admiral's resource system would work, the team then began thinking about additional ways to incorporate OCS lesson materials into the game. Luckily, one of the team's senior advisors proved to be an incredible wealth of knowledge with regard to contingency and OCS contracting concepts. He supplied the team with a great deal of insights which had been honed over his vast experience in USAF contracting. He was also able to direct the team to the Air Force Installation Contracting Center's (AFICC) OCS portal that contained an abundance of OCS and contingency contracting scenarios which have been used in countless training

exercises. Using this expertise, we were able to filter out which scenarios could be employed throughout the game as not only your typical sustainment purchases but also more detailed virtual exercise scenarios. We compiled common sustainment activities which could be added to the game including procuring water, barriers, defense towers, and security personnel and also began formulating more complicated "inject" scenarios. The more perplexing missions could see a student having to assist a less informed customer acquire something by choosing the best contract vehicle for the commodity or service. It was when the design team went to begin programming the more contracting specific tasks where we realized that both sides of the team seemingly spoke two very different languages.

As the content development phase began to ramp up, it became apparent that the game developers did not have an understanding of what government contracting entails and similarly our contracting professionals didn't fully understand what was within the realm of possibility on the programming side. To counteract this issue, we decided that it would be necessary to drastically increase the number of touchpoints we had between both sides. These touchpoints took place formally in the shape of set meetings which we increased from once every other week to two-three times weekly, and informally by opening communication on the game development side's Discord channel. Instead of meeting in a formal setting every couple of weeks for an hour, both sides of the team were able to see their counterparts multiple times per week and reach each other immediately with any questions they had in the interim. This made it possible for the programmers to articulate what was possible from a game development perspective and allowed our contracting professionals to provide guidance about all things relating to contracting actions in the game. It was through this engaged scholarship that we were able to bridge the gap between our communities and map out how the different contract choices would affect the player and how the more in-depth inject scenarios would play out.

Figure 21 is a flow chart representation of one of the inject scenarios the team developed. This chart demonstrates a potential interaction between a customer organization and the contracting office which goes beyond the basic defense upgrade and sustainment purchases throughout the game. These inject scenarios could pop up during a level to add

an additional layer of training and walk students through a more complicated situation that takes place alongside defending their base. In the example above, a pop-up dialogue with the Security Forces commander (SF/CC) could take place where they require immediate assistance with procuring three additional private security contractors (PSCs) to help sustain their forces. The player would then have the decision to choose between several different contract vehicles, each with their own branching paths and rates of success along with contracting resource requirements. Should the player choose the best contract option, their likelihood of success would be much higher and the scenario could resolve without further action from the player. Multiple injects could be added to the game based on the level of difficulty and provide a realistic representation of managing multiple fires at once whilst having the freedom to experiment and see how each COA plays out. Even though these more difficult inject scenarios didn't make it into the first phase of Project Admiral, giving players this level of complexity along with freedom of movement without danger would certainly give users the ability to make deeper connections between lesson material and the real world.

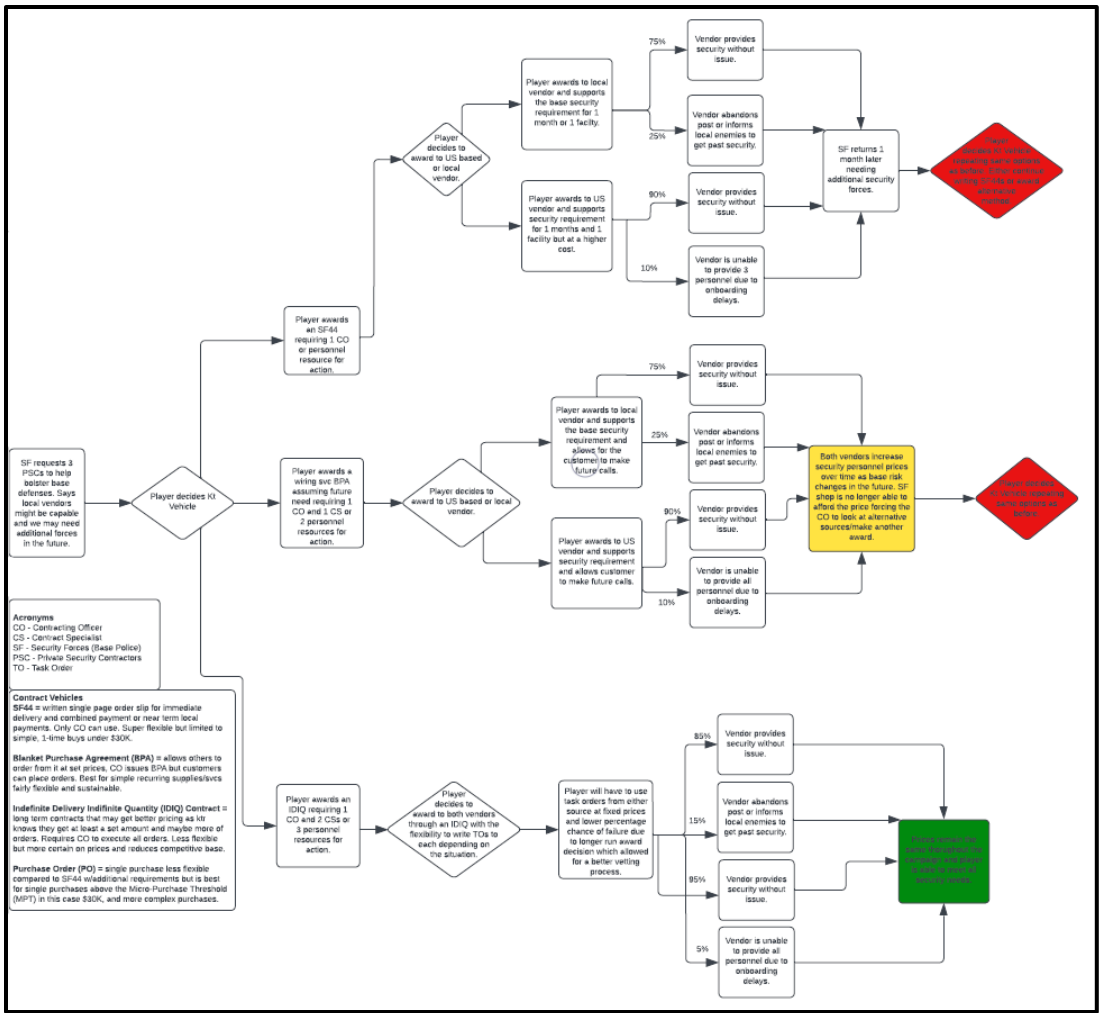


Figure 21. Project Admiral base security inject flowchart (See Appendix for full size of all injects)

Although bridging the gap between contracting and programming communities proved to be a formidable challenge, engaged scholarship allowed us to conceptualize a rapid game prototype which, with further development, has the potential to impact the future education of contracting professionals. Getting to practice OCS and contingency contracting principles within a TD game is especially unique because the underlying game mechanics can be creatively blended to not only bolster a student's education but retain the game's aspect of fun simultaneously. Furthermore, acting cohesively as a unit allowed us as contracting and game development students to identify new ways to leverage TD games for learning without detracting from the mechanics which make TD games addicting. If

future contracting centric games are to be made, it will be imperative that the contracting experts fully ingrain themselves in the process alongside the programmers in order to make impactful games.

3. Case 2: Sinking Ship

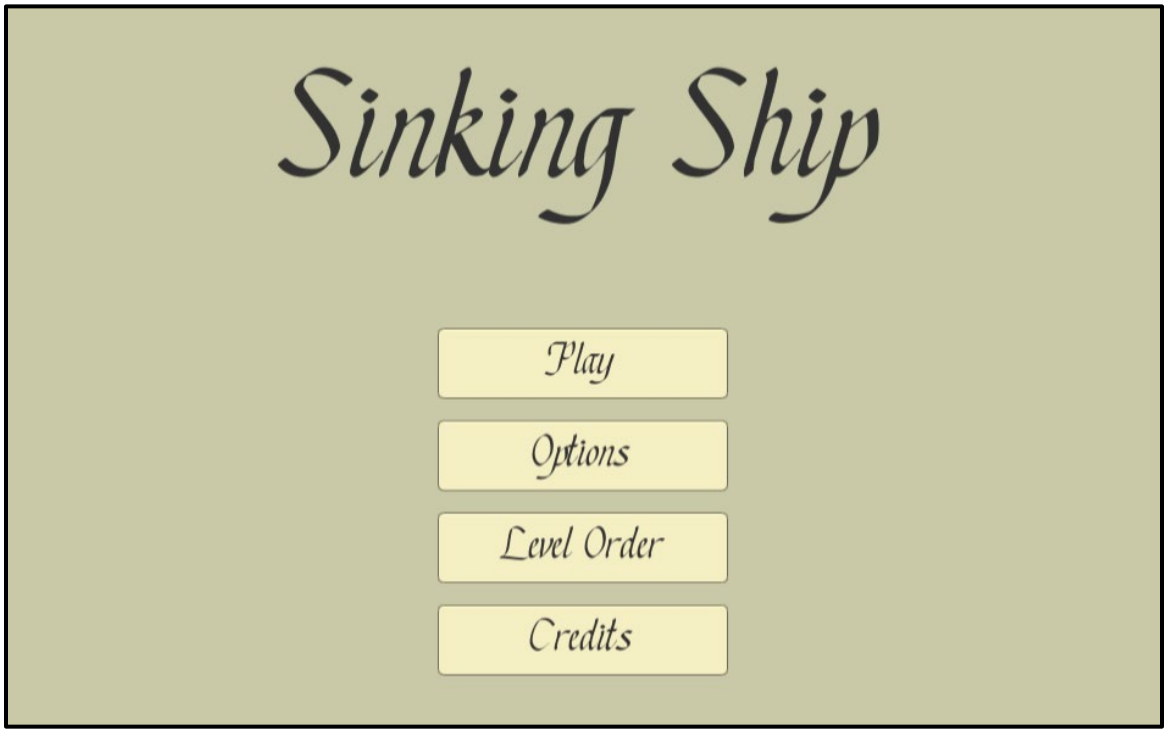


Figure 22. Sinking Ship title screen

a. Background

Compared to Project Admiral, Sinking Ship had a slightly longer development window of approximately seven months. This somewhat longer timeline paid extraordinary dividends because several of the team members carried over to continue work on this new game allowing the relationships between team members to grow over time. Additionally, since this game was already a completed capstone project, the team was able to project much more effort towards incorporating expansive content using previously developed systems. The team for Sinking Ship consisted of the same two contracting professionals as functional expert advisors and engaged scholars, two NC State game development students

(one of whom worked on Project Admiral), and two senior advisors from the previous game. Similar to Project Admiral, this game's development initially consisted of weekly status meetings along with maintaining the previously established Discord channel. The weekly meetings consisted of reviews of the current work along with any ideas or adjustments we had. As consultants, our plan was similar to the TD game in that we were to assist the NC State team in creating an effective educational contracting game. However, since this game was no longer a capstone project and was now being funded by the government, we had far more creative freedom to incorporate innovative content. Just like the previous game, our role was to guide the development team through assimilating contracting specific content. Unlike Project Admiral, however, we were given a much more engaged task of assisting in creating many of the game's puzzles and underlying mechanics and aesthetics. The combination of a longer development window, continuity between development teams, and having a more involved role in the game's design and development for this ERG allowed us to provide a more in-depth account of our experiences and glean critical recommendations to assist future Air Force contracting game teams.

b. MDA Framework

Mechanics in virtual ERGs place players in a digital recreation of a physical space, such as a room or building, and they must use their observations and deductive skills to solve a series of puzzles and escape the space before time runs out. As we discussed previously, since virtual ERGs attempt to mimic the basic structure of a real-life escape room, their mechanics are nearly identical. Typically, players are given a limited amount of time to explore their environment and find clues that will help them solve puzzles and ultimately escape the space. In Sinking Ship, players do not lose the game if they fail to escape within a certain amount of time, but they are tasked with escaping a series of rooms to get off of a sinking ship. Once the player hits start, they are given a prompt for the first room with additional prompts appearing for all subsequent rooms. There are five unique puzzles and contracting challenges in total for the player to get through, each having a keypad near the door where the correct code must be entered to complete the room. The controls are simple in that the player uses the E key to interact with objects in the room and

the W, A, S, and D keys to move around. The player interacts with these objects in order to solve puzzles and answer contracting questions to figure out the code for all five levels. Although the mechanics are simple, they effectively allow the player to mimic the experience of a real-life escape room.

Dynamics can be used in virtual ERGs to create an engaging and challenging experience for players that are high in variety. As we discussed in the literature review, some common dynamics for physical ERGs include puzzles, riddles, and logic problems. By incorporating these dynamics into the game, players must use their problem-solving skills to progress through the rooms. Sinking Ship involves the player using the game's mechanics to correctly answer puzzles in order to unlock the door code to escape that room. For example, Figure 23 shows the puzzle for the first room. The player is given a multiple-choice question and must answer it correctly in order to adjust the cipher. If students select the right answer, they will be able to decode the message on the far right panel. Once the student decodes the message using the middle panel, the correct answer can be entered, and the player is able to turn around to see the code has been revealed behind one of the paintings. The main input the player will use in this game is the E key or interact button. The player will be able to explore and experiment with different aspects of the room to see what they can manipulate and use in order to escape the ship.

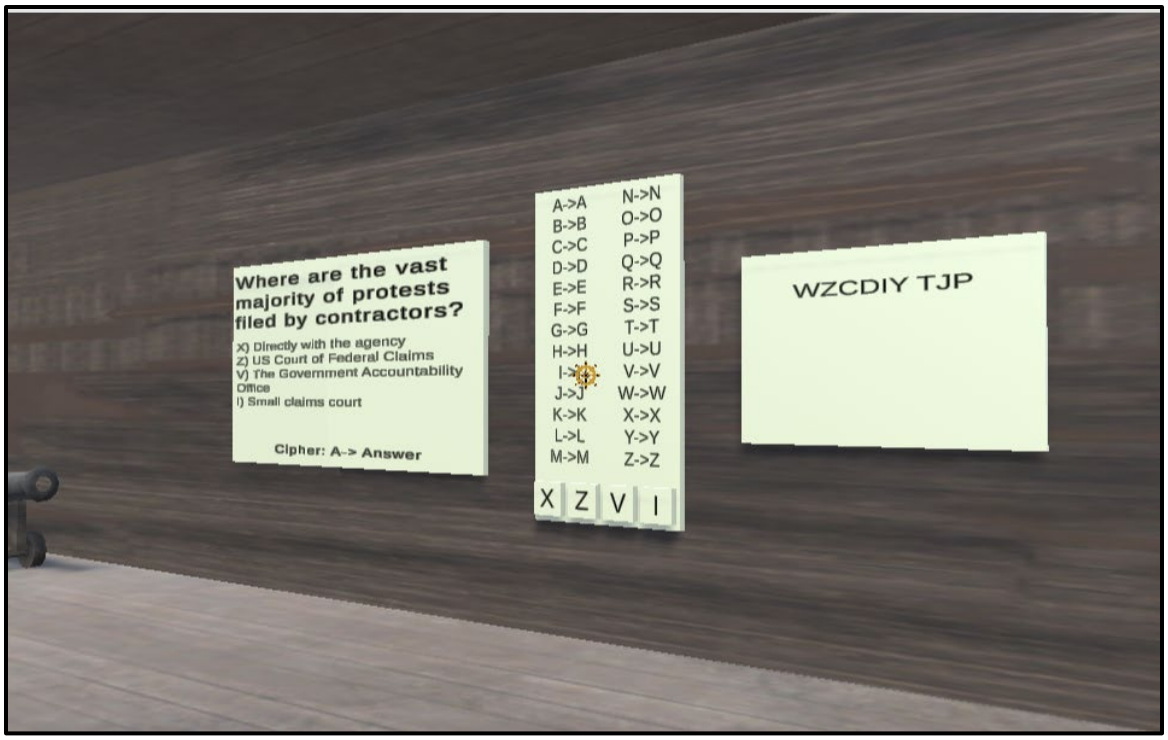


Figure 23. Sinking Ship cipher room puzzle

Aesthetics in virtual ERGs can be used to strengthen the perception of tension and urgency that add to the sense of challenge posed by the puzzles themselves as they serve to make the virtual world more believable. Aesthetically, the theme in Sinking Ship is one of fantasy wherein the player is a character on a sinking pirate ship. This evokes the fantasy aesthetic because it pulls the player out of the standard, seemingly dull, office or classroom environment and places them in a thematic alternative reality. The game also enriches this experience by including narratives, such as the one seen in Figure 24, which aid the player in imagining the banter that they might have when trying to escape the ship alongside a fellow pirate and drive the game's overall story. Further, there is an ever-present challenge as the player must figure out how to escape the room and hone their skills in order to master the content and get a better score than their classmates. By having rich aesthetics in Sinking Ship, the game exponentially increases the impact of its mechanics and dynamics because it effectively captures the mind of the player.

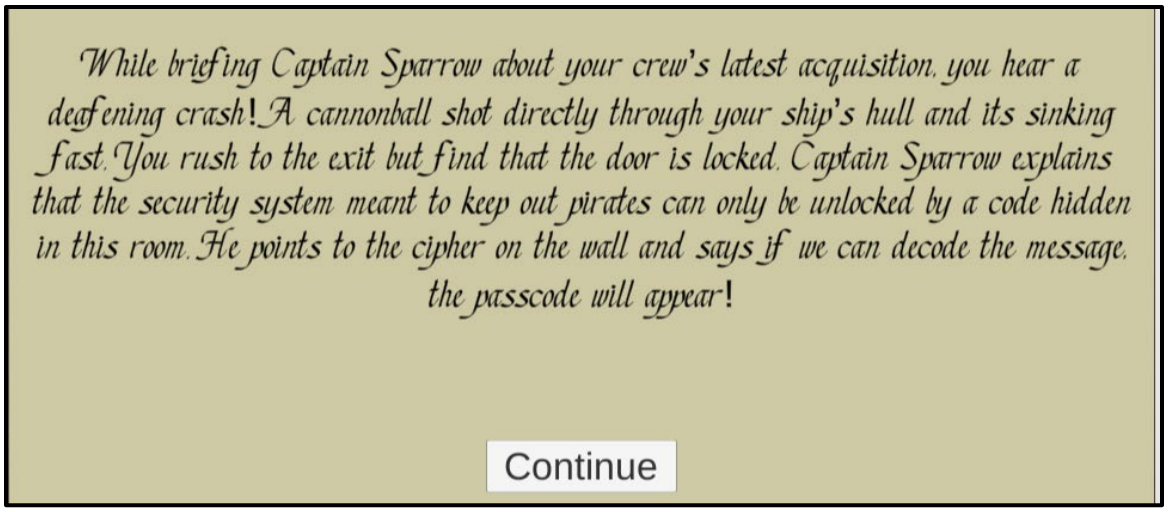


Figure 24. Sinking Ship narrative cipher room

c. Game Development Process

Incorporating FAR part 33, Protests, Disputes and Appeals, lesson content into an ERG proved to be demanding in different ways when compared to the challenges we experienced with Project Admiral. In a TD game, the game design is more straightforward whereas an escape room's design can be extremely broad. The level of flexibility we had with puzzle design in Sinking Ship made each room seem like its own separate mini game. Aside from the start and finish points, Sinking Ship was limited only by the team's imagination. Additionally, the balance between gameplay and lesson content with Sinking Ship was clearly understood because the player could easily identify when they were being required to use their imagination to understand the room versus being required to recall content relating to protests. For example, in Project Admiral, the contract choices and personnel management systems were nearly inseparable from the underlying mechanics and dynamics of the game, but in Sinking Ship, you could easily replace FAR part 33 lesson content with any other subject matter and only be required to make subtle changes to the narratives and aesthetics of the game. In other words, both gameplay and lesson material needed to build upon one another in both games, but in Sinking Ship, there was more compartmentalization between each element which required the contracting side of the team to develop a better understanding of the underlying room interaction which would traditionally be more of a game developer role. Luckily, the engaged scholarship practiced

in Project Admiral primed the team to work cohesively in creating Sinking Ship despite the difference in community and this allowed the game to progress much further in development when compared to its predecessor.

Given the five distinct level segments of Sinking Ship, the development schedule progressed in a very linear fashion. The introductory cutscene and many of the environmental assets of Sinking Ship blossomed from an NC-State capstone project which was inherited by our team. The game would see a player trying to escape from a sinking pirate ship which had just been hit by a volley of cannonballs. To get out of the ship, they would need to explore five diverse rooms, solve a number of engaging puzzles, and answer various questions to make it to the deck and escape via a life raft. Since the lesson content and gameplay are so neatly compartmentalized for each individual room and since the level design so often drove the contracting content, a large amount of this section will be broken out by its game design and lesson material.

d. Cipher Room Game Design

In the first room, the player needs to decipher an encrypted message in order to unlock a key code which they can use to progress to the next room. Fortunately, the assets for this room such as the cipher wheel, doors, keypads, paintings, and animations already existed so the team was able to focus all of their efforts towards refining those assets such that they could be utilized in an intuitive way. Refining the assets proved to be a rather difficult upfront task because the new developers were not involved in the previous design of the game. This made what would have likely been easy tasks for the creators of the initial code nearly impossible to solve for the new team. For example, our primary interaction asset — the cipher wheel — worked very well for multiple choice questions which had an answer of either a or b, but the further you progressed down the alphabet, the more unaligned the asset would become, making the task of deciphering the intended message quite difficult if not impossible. To remedy this, the team decided that it would be far easier to simply create a cipher board (see Figure 25) where each letter would easily align to the correct corresponding letter should players choose the correct answer. From there, players

could easily and accurately decipher the randomized, scrambled message which would direct the player to look behind them where the exit's key code would appear.

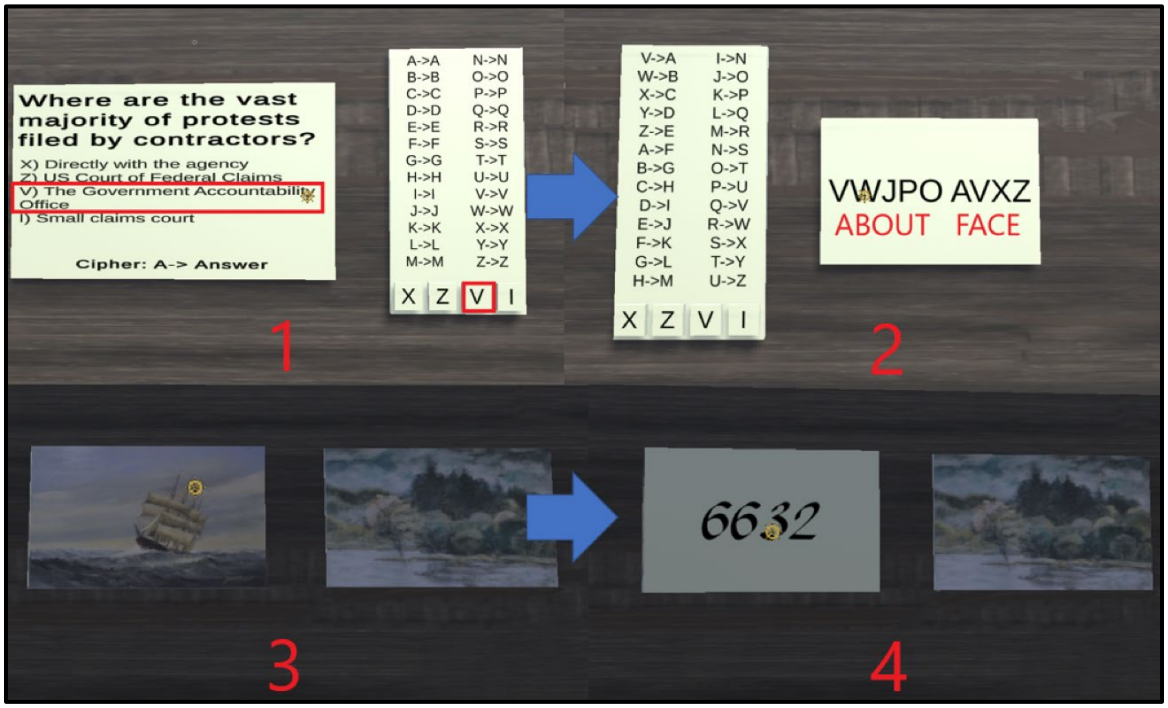


Figure 25. Sinking Ship cipher room puzzle diagram

e. Cipher Room Lesson Content

Considering that the room and puzzle designs were already configured for multiple-choice question sets, developing lesson content to fit the room proved to be relatively straightforward. Although the contracting team members had not experienced an actual protest before, both of them were able to recall their previous training and become subject-matter experts for the design team in a relatively short time frame. They were able to effectively leverage FAR 33 Protests, Disputes, and Appeals as well as the MITRE Contract Diagnostic Protest Tool (CDPT) to pinpoint the most valuable questions surrounding the topic. The CDPT was especially timely because its overall aim is to assist acquisition professionals on bid protest case law and minimize protest risks when building contracts (Staresina, 2022). The primary challenge became how best to balance the question set to match the relative difficulty of the room's decoding puzzle whilst also

creating enough questions to encourage repeat playthroughs. If lesson content challenge and puzzle difficulty were to be highly uncorrelated or out of sync, or if players were only required to answer the same question for each subsequent playthrough, then player engagement and lesson retention would certainly suffer. Since the purpose of the game at this stage was to develop a rapid prototype and conceptual case, we decided that approximately nine questions would ensure that players would likely not run into the same question more than once given the relatively short amount of time they would have available for testing. The team forecasted that players would likely only have time for 2–3 playthroughs with the game in its current state, but future design will likely require much larger pools of questions to ensure that players continue to learn new material surrounding the topic. Figure 26 shows a sample of the multiple-choice questions (the full question set can be found in appendix D) which players would be expected to learn and understand after playing the game (correct answers highlighted in green). These questions were created primarily from FAR 2.101 and FAR part 33. Considering that the end goal will be to have the game utilized as a tool to bolster in-class teaching methods, future iterations of the question banks will need to work in tandem with professors and teachers as they craft their lesson plan.

Multiple Choice

1. What action(s) can be protested?
    a. A solicitation or other request by an agency for a contract for the procurement of property or services.
    b. The cancellation of the solicitation or other request.
    c. An award or proposed award of the contract.
    d. All of the above.
2. All of the following are procedures established to resolve agency protests effectively, to build confidence in the Government's acquisition systems and to reduce protests outside the agency except:
    a. Protests shall be concise and logically presented to facilitate review by the agency
    b. All protests filed directly with the agency will be addressed to the contracting officer or other official designated to receive protests
    c. Protests based on alleged apparent improprieties in a solicitation shall be filed after the closing date for receipt of proposals
    d. In accordance with agency procedures, interested parties may request an independent review of their protest at a level above the contracting officer; solicitations should advise potential bidders and offerors that this review is available
3. All of the following are circumstances permitting other than full and open competition except:
    a. Only one responsible source
    b. Contingency operation
    c. Unusual and compelling urgency
    d. International agreement

Figure 26. Sinking Ship sample multiple choice questions

f. Map Room Game Design

Analogous to the first room, the second room had many of its assets already developed by the previous game team which meant that much of the game design was spent polishing the existing systems. In the map room shown in Figure 27, players find themselves in what appears to be an office, with a chart-laden desk in the center, a bookcase lining the back wall, and a giant map spanning the opposite side of the bookcase. In this room, players were meant to explore the environment until they found a hint which would lead them to locate the answer on the giant map. Players would go throughout the room and attempt to interact with the many assets present until they finally reach the room's secondary interaction object. This hint object would be a book in the bookcase which in the game's original design, showed geographic coordinates and led players back to the large map. There, players would need to interact with the location the coordinates

represented which would then show the door code for players to escape the room. Since the game mechanics for this room were so straightforward, the programming team was also able to focus on honing future assets such as creating an opening animation for the doors as well as incorporating a background texture which allowed the player to see where the door led.

Figure 27. Sinking Ship map room design

g. Map Room Lesson Content

Given the explorative nature of the second room, fabricating FAR part 33 lesson content which would not immediately drag the player out of the experience was the most difficult task the contracting team experienced to this point. Since the questions for this room would need to take advantage of the large-scale map, the team needed to get very creative when deciding on what would serve to increase a student's knowledge about federal contract protests whilst remaining relevant within the room's overall aesthetic. Initially, we considered asking players to locate certain regional contracting offices on the

map or perhaps having players explore geographical coordinates by using FAR parts and references as code but neither one of those ideas had anything to do with actual protests. After considerable thought, the team realized that there might be some real benefit in having players experience what a Government Accountability Office (GAO) protest report actually looked like. After all, many students who are at the beginning of their careers would likely have very little semblance of how GAO protests are documented yet alone how they occur. Since GAO protests have taken place across the globe, it fits very well with the game's existing map puzzle and provides players with experience in reading protest documentation. Figure 28 shows an example of one of the protest reports and outlines how players would use that example to unlock the room's escape code. By not overtly telling the player where to find the location within a GAO report, it requires that they read the entire document to ascertain where the findings originated which serves to get players familiar with not only the protest document but the global presence of DOD protests. Overall, we compiled nine geographically diverse protest locations scattered throughout the map in order to ensure that it would be highly unlikely that players would see the same protest more than once. Having players solve an escape room in this way allows them to review a real-world example of a protest while at the same time reinforcing the room's creative mechanics.

Figure 28. Sinking Ship map room lesson material

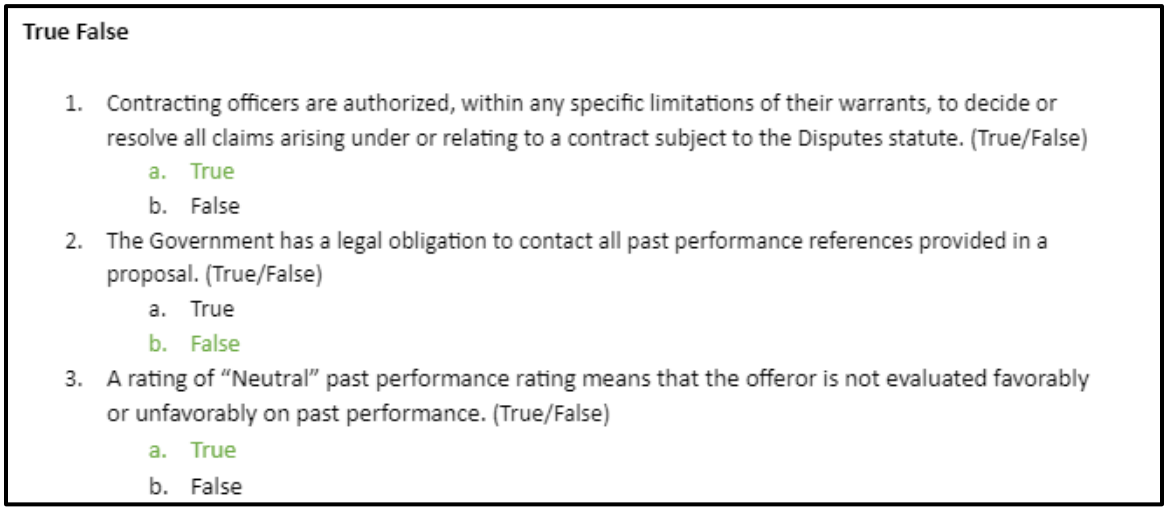
h. Candlelight Room Game Design

The candlelight room was the first level designed by our team from the ground up. Aside from the basic textures and asset packs which came with the project, the team had full creative liberty to do what they wanted with this room and by this time they had started to become more familiar with the project and its resources. The candlelight room, shown in Figure 29, casts players into a very dark room with five unlit candles sitting in front of five randomly generated numbers. Next to each candle, would be a sheet of paper whose texture would represent a binary question. Depending on the answer, players would need to light the candle, or leave it unlit and once the candles were lit, they would shine directly on the number behind them. By the time players completed the sequence of questions, they would then be required to use the lit-up numbers in order to unlock the escape door. This level challenged the player's thinking in a new and creative way by allowing them to interact with objects which had secondary effects on other textures within the game.

Figure 29. Sinking Ship candlelight room puzzle diagram

i. Candlelight Room Lesson Content

Due to the binary nature of this room's primary interaction objects (the candles), the contracting team was somewhat limited on their creation of lesson content. Much like the prior puzzles, the lesson material would need to integrate cohesively with the overall mechanics of the game which meant that our new question sets would need to have a similar binary nature about them. Therefore, questions would need to have only two possible outcomes each, they could have answers associated with a or b, yes or no, on or off, etc., so long as one outcome was associated with lighting the candle and another for leaving it unlit. The most obvious candidate for the team was to develop a series of true/false questions as it would allow us to generate a large number of questions in a very short amount of time whilst still providing the same benefit to the player. True/false questions were also perfect for this particular room because they take much less space when compared to other binary question formats because you're just identifying whether or not the statement is accurate. Players would be presented with relatively simple true/false contracting statements (see Figure 30) which matched the overall complexity of the room's lighting mechanics. Creating lesson content in this way allowed the team to replicate the entire question on the room's somewhat small paper textures as opposed to forcing players to click directly on the object to show the full image.


True False

1. Contracting officers are authorized, within any specific limitations of their warrants, to decide or resolve all claims arising under or relating to a contract subject to the Disputes statute. (True/False)
   a. True
   b. False
2. The Government has a legal obligation to contact all past performance references provided in a proposal. (True/False)
   a. True
   b. False
3. A rating of "Neutral" past performance rating means that the offeror is not evaluated favorably or unfavorably on past performance. (True/False)
   a. True
   b. False

Figure 30. Sinking Ship true/false sample questions

j. Cargo Room Game Design

By the time we began development on the fourth room, the team had completely found its stride. This competence reflected itself in the room's layout and layers of complexity. For the cargo room, players would find themselves in the ship's cargo hold where stacks of crates lined the room and passively guided the player to a visual hint on the ground showing them how they need to interact with the large cork board on the wall (see Figure 31). The cork board would contain a matching puzzle where players would need to make connections between lesson content in the form of matching questions. Once players would successfully solve the matching questions, they would then need to recognize the connection between the color of the matching strings in relation to the randomized color strip which would guide them to place the numbers in the correct order. It's this multi-layered approach to room design which not only exhibited the team's development but would also likely prove to be a favorite level amongst future players.

Figure 31. Sinking Ship cargo room puzzle diagram

k. Cargo Room Lesson Content

Creating lesson content for the cargo room was where the contracting team had perhaps the most fun because they had become familiar enough with the material that they could formulate questions which were not explicitly stated verbatim in the FAR. For example, one of the questions generated asked players to align GAO protest procedures in their order of occurrence (see Figure 32). The FAR doesn't explicitly state the exact order of the procedures so looking up the answer would take a great deal of time, thus players would need to rely on their overall understanding of the FAR part and imagine how a potential GAO protest would play out in real life. This level of difficulty paired very well with the overall complexity of the room because it incorporated an in-depth approach to knowledge and difficulty which would be expected of a late game level.

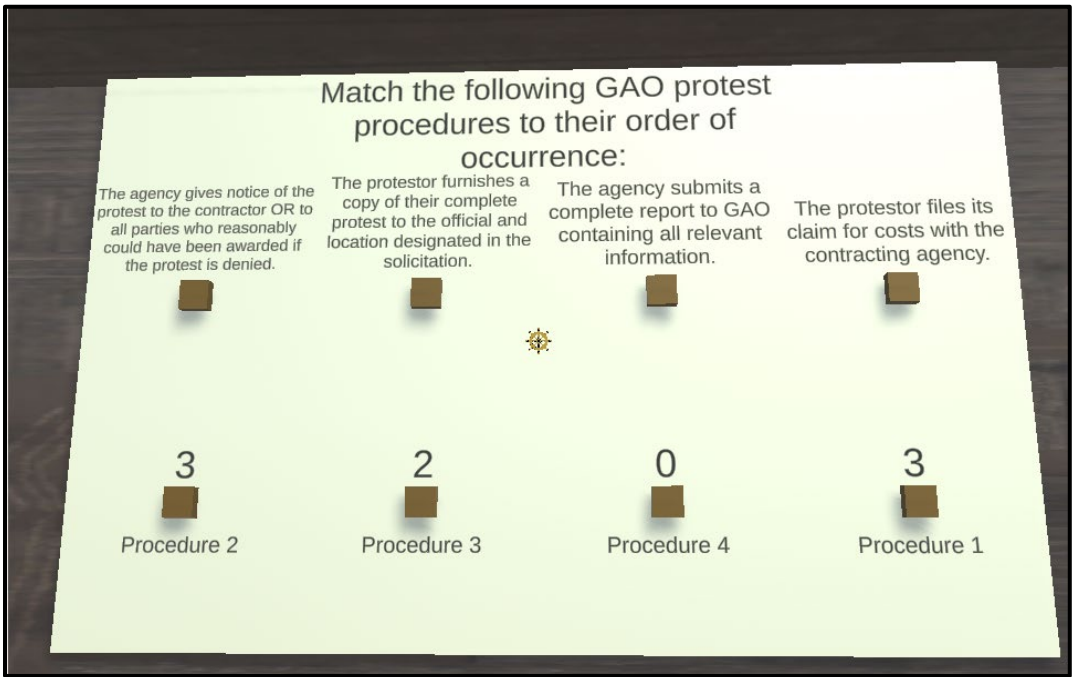


Figure 32. Sinking Ship matching sample question

l. Treasure Room Game Design

The team's fifth and final room proved to be challenging in different ways. Unlike all of the previous rooms, this room effectively had two working versions that students

could play to solve the puzzles. The first version, shown in Figure 33, had players enter the ship's treasure room where three locked chests piled atop gold coins sat across from a locked casket sitting on a table. To unlock the casket on the table, the players would need to acquire three gold doubloons from the opposite chests which required a passphrase to unlock. The tricky task with this version was getting players to remember or understand the passphrase based on the fill-in-the-blank questions on the three opposing doubloon chests. For example, a player could be asked a question which has either a non-intuitive answer or potentially many similar answers. If the player cannot determine the correct fill-in-the-blank phrase from a nearly unlimited pool of potential answers, then it is very likely that they will not make it past the fifth room. The team quickly realized that the doubloon chests were not as straightforward as they initially seemed and decided to develop a second version of the room in tandem with the first should it prove too difficult for new players to figure out.

Figure 33. Sinking Ship treasure room puzzle diagram

The second version of the room no longer had players interacting directly with the chests but rather had them answer the same fill-in-the blank questions by choosing theme-based coins which represented the answers. For example, players would now be presented

with the same matching questions on the wall, but instead of entering a passphrase, they would grab one of the themed coins from the opposite wall which was associated with the traditional answer and place it in a slot directly below the question. Rather than spelling out "claim" to unlock the chest, players could instead grab a coin from the wall with an image that they would associate with a claim such as a climber staking a claim on a hill (see Figure 34). Additionally, if players explored the room, they would be rewarded and find a board which contained all of the possible answers. Once players matched every question to the appropriate themed coin, the treasure chests would open to reveal the final exit code which unlocks the door. Designing the room in this way demonstrated the team's creative ingenuity because it not only mitigated the concern about getting stuck in the room but also added a layer of complexity as players were given a pool of potential answers, but without how said answers could be characterized through images

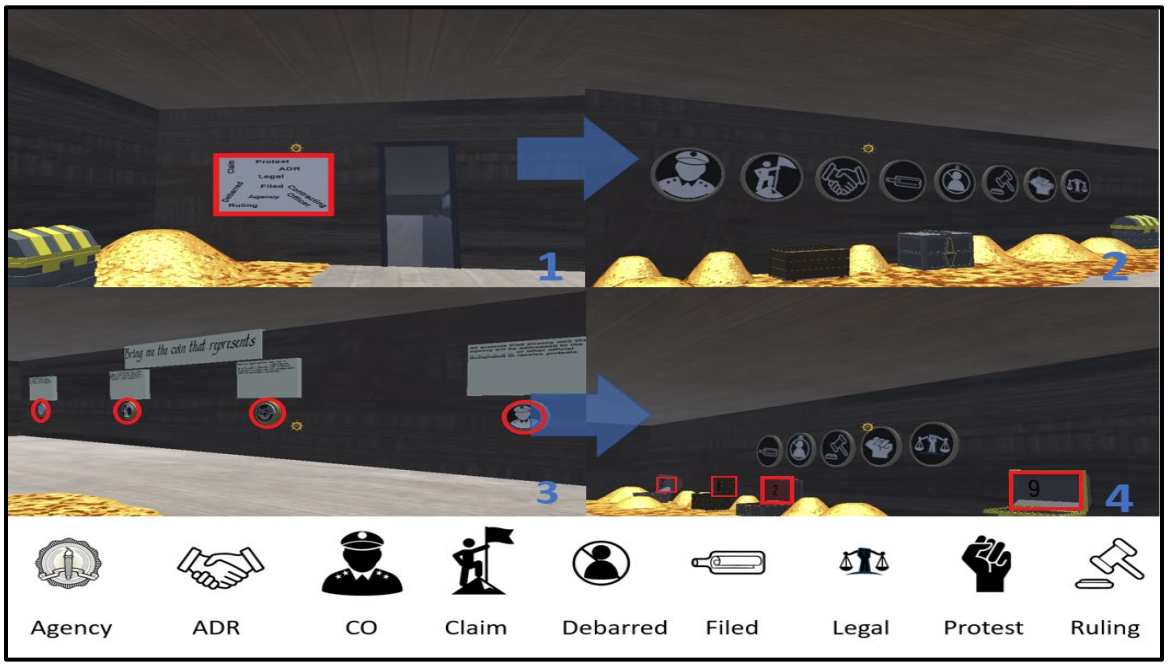


Figure 34. Sinking Ship treasure room version 2 puzzle diagram

m. Treasure Room Lesson Content

Much like the previous rooms, the lesson content that the contracting team developed for the treasure room was made to match the team's puzzle design. Since the puzzles were intended to be solved with fill-in-the-blank questions, and the room's puzzle in and of itself was determined to be rather simple in complexity, the contracting team attempted to find phrases which players should be relatively familiar with after either spending a few months in the career field or receiving initial training on FAR part 33. Additionally, considering that fill in the blank questions are inherently challenging for newer players, the contracting team also developed a set of hints that could be adapted into the game should players get the term wrong (see Figure 35). For example, a question where the player is expected to realize the basic definition of a protest (as outlined in question 6 of Figure 35), could be followed up by additional "hint" which outlines which actions are indeed protestable such as contract award, solicitation, cancellation, or termination. If this first hint did not jog the players memory of the content in question, then the follow up hint would simply direct players to the most applicable FAR reference since they would likely need further review of the lesson content. The treasure room was quite unique in the fact that both the room's puzzle design as well as the lesson content could be tailored to fit the needs of a very wide range of player career field experience.

5. Where appropriate, the use of _____ techniques, third party neutrals, and another agency's personnel are acceptable protest resolution methods.
    a. Alternative Dispute Resolution (ADR)
        i. Hint 1: _____ may include conciliation, facilitation, mediation, fact-finding, minitrials, arbitration, and use of ombudsmen.
        ii. Hint 2: See FAR 33.201
6. A _____ is a written objection by an interested party.
    a. Protest
        i. Hint 1: _____ may be in relation to a contract award, solicitation, cancellation or termination.
        ii. Hint 2: See FAR 33.101(2)(ii)
7. Contracting officers should contact their designated _____ advisor for additional information whenever they become aware of any litigation related to their contracts.
    a. Legal
        i. Hint 1: Adherence to this advisor's opinion is rarely required but often heeded.
        ii. Hint 2: See FAR 33.001

Figure 35. Sinking Ship fill-in-the-blank sample questions

n. Tutorial Room Game Design

The tutorial level of Sinking Ship was developed after all of the five of the main game rooms were completed at the request of the researchers. We believed that having a room which allowed players to interact with the game prior to the in-class demonstration would enable them to get the most out of the planned student-led lesson. As such, the room needed to be provided to players outside of the main game so that students would not be tempted to explore the other rooms before the scheduled event. Since this room was established with the sole purpose of teaching players the basic mechanics of the game, it didn't include any real puzzles to solve or contracting lesson material. Instead, the tutorial room intuitively explains to the player the game's control scheme and that the game should be treated like any other escape room experience. This was particularly important because, as we explained in our literature review, the use of virtual escape rooms is still relatively uncommon, and many people may not be readily familiar with the idea. The player begins the room with a very basic narrative explaining that they woke up in a cell, see text on the floor and walls, and that they should follow the directions. These groups of text or hints, which are scattered throughout the room, guide the player and explain the controls in an intuitive way by having the player use those controls in order to escape the tutorial room

(see Figure 36). Although the tutorial level hasn't been fully incorporated into Sinking Ship, we felt it was perhaps one of the more important upcoming revisions to discuss because it allows players to ease into the game without being overwhelmed. It also allowed players to learn the game's mechanics at their own pace without feeling the pressure to perform well during the in-class demonstration which we will discuss in future sections.

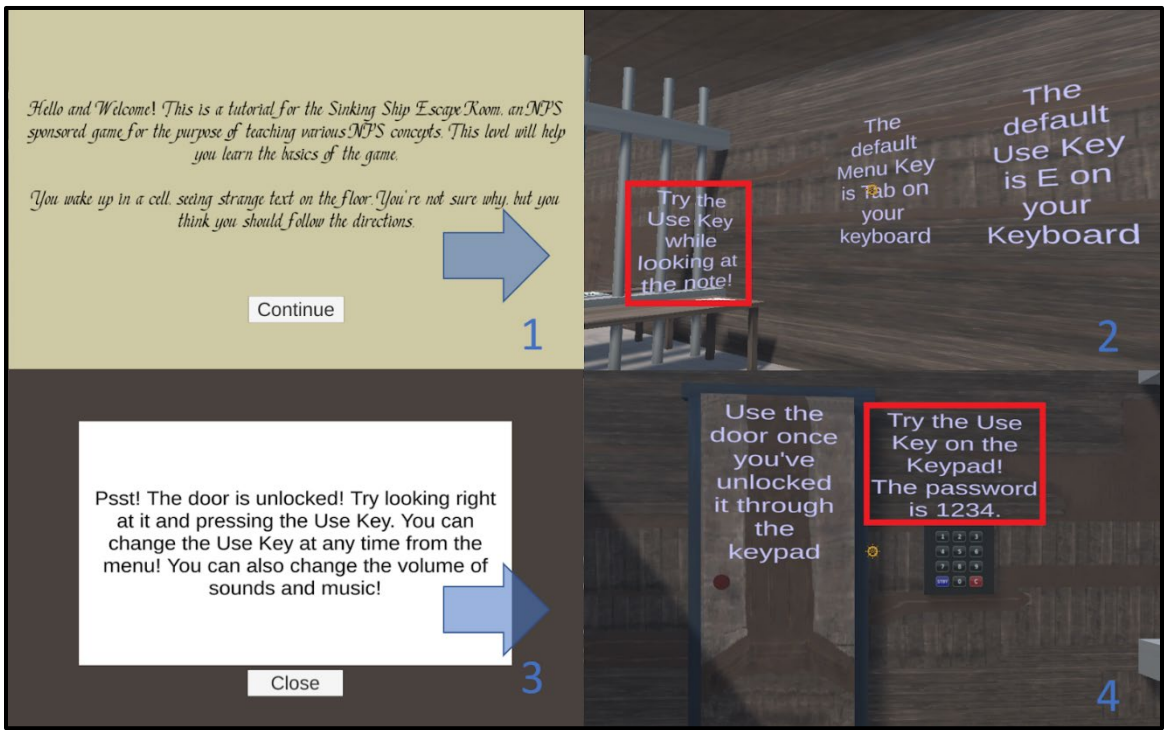


Figure 36. Sinking Ship tutorial room diagram

4. Player Motivation

Beyond just the initial cutscene and interesting room designs in Sinking Ship, the team was fundamentally concerned with maximizing player motivation throughout their experience. Since players would be expected to use this game alongside in-class teaching sessions, there would need to be something to attract the player outside of their desire to learn. Seeing that the game team was innately aware of the previous NPS cohort's Sandbox Contracting military feedback, we knew that one of the greatest drivers behind motivating our audience to keep playing the game outside of required hours would be their desire to

compete against their fellow coworkers. It was for this reason that we were so adamant in including some type of player differentiating feature within the game. This feature started out as the inclusion of a simple scoreboard which tracked the total time players spent tackling each room. Even though this data was not tracked anywhere aside from the final screen in the game, players could still save their results and compare them against the results of their peers. If the game caught on in a workplace or amongst the classroom, players would be much more likely to want to repeat the game and get closer and closer to edging out their friends and rivals. Future iterations of the game might even go well beyond a simple timekeeping system as the development team showed great enthusiasm in including the ability to earn in-game achievements and awards which could further differentiate players from their peers. For example, players who gave the correct answer for every question in the game might earn the title of "FAR Guru" or have a special badge associated with their rank in the scoreboard. This type of motivation would be critical in driving both veteran gamers and beginners alike to replay the game in order to hone their skills.

5. Narratives

On top of player motivation, the team also recognized the need for in-game character motivation which we incorporated in the form of game narratives. The game narratives would bring context and meaning to the character's actions, making it easier for players who might not be as familiar with playing imaginary characters in virtual worlds. Once we had begun to create additional rooms, we wanted to give players a sense that the game they were interacting with was leading them closer and closer to their end goal of escaping the ship. Further, the narratives would provide guiding hints for players to understand where they should start looking in order to understand the room's puzzle. For people who aren't familiar with the concept of escape rooms, the narrative would set the stage for the player and hopefully snap them into a more creative and exploratory mindset.

At the start of each room, the player would be greeted with a message giving them background information and any pertinent details they needed to get into the mindset of escaping the ship. These narratives would also introduce the player to Captain Sparrow

who added comedic value to the experience and could actively "hint" at what he believed might help the player escape. After players dismissed the narrative, they would then be free to explore the associated room. If after exploring the room for a while players needed an extra hint or simply wanted to re-read the beginning narrative, they could simply hit the "tab" key and navigate to "Opening Narrative" to read the information at their leisure (see Figure 37). This system allowed players to get as much or as little information as they wanted when they wanted without having to pause the game and wait for opening narratives to conclude. (the full narrative set can be found in appendix E).

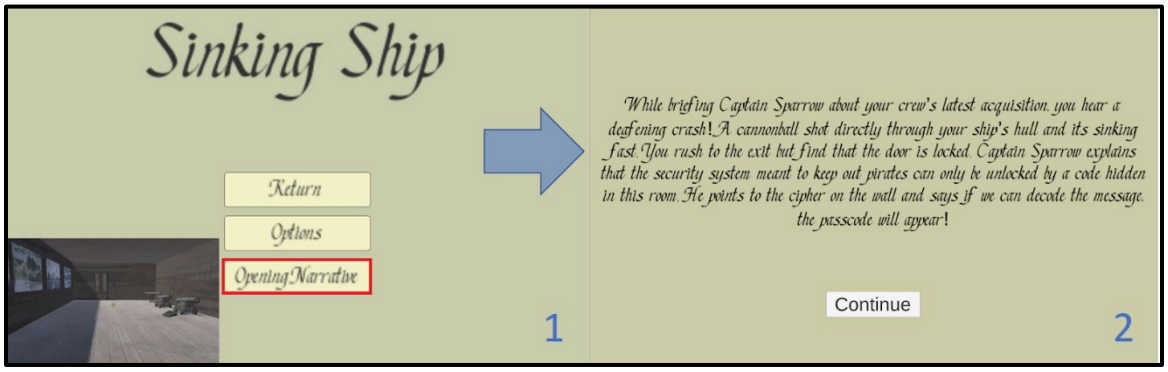


Figure 37. Sinking Ship narrative example

The development process for Sinking Ship provided us with a new perspective and understanding about how to approach challenges when developing serious educational games. The process for developing Sinking Ship was unique because we were able to apply many of the lessons from the creation of Project Admiral. As a result, the team was able to provide a detailed analysis of the development process for future contracting game development teams. The analysis of the development process included not only the day to day aspects of how we interacted as a team but also the design decisions we made along the way. Ultimately, the analysis provided by the team identified many of the challenges that future developers will face and this information should help them plan their development efforts more effectively.

6. Initial Game Curriculum Evaluation

Our experience with Project Admiral allowed us to progress Sinking Ship much further even though it only had a short development window of approximately seven months. Since the game progressed to an almost finished state, we were able to incorporate it into a student-led class and perform early stage curriculum evaluations which provided the team with a snapshot of the game's perception by contracting students at NPS. The first round of curriculum evaluations involved six participants (see Figure 38) and was aimed at fixing any issues they may encounter as well as gathering preliminary data on the easiest, most fun, and most desired rooms to play again while controlling for room order. The research team observed each participant one at a time, and the room order was randomized so as to minimize the effect that room order may have had on players' perception of each room. For example, if a player were to be faced with a level that they found particularly challenging, they may become frustrated and choose to rate the next room worse than they otherwise would. During the evaluations, the participants were told to focus on and provide feedback for the puzzles more than the FAR questions, as the content of this game is easy to adjust in the future. All participants were instructed to talk us through their thinking so we could take detailed notes on how to improve the game. After each room, the participants went to the questionnaire to fill out their rating for that room while it was fresh in their head. When providing responses to the questionnaire, we informed the students we did not benefit from high scores, but rather our aim was to find the most engaging rooms and to address any gameplay or design problems that may have been present. Being able to observe their reactions to each room allowed us to get a sense for how the game is perceived by players so that we could revise the game to best suit their needs.

Figure 38. Captain Gage Wright assisting NPS student Madison Tikalsky through Sinking Ship

After collecting the preliminary data, the research team created a consolidated document which outlined areas of improvement and issues that should be corrected with the game. This feedback was sorted by most repeated to least common in terms of how often participants would find the same issues with a room. Visualizing the data in this way was useful as in some rooms, the same issues were discovered by nearly every participant. The cipher room in particular had a problem where the players would not understand what to do with the final board which contained a scrambled message. Players would answer the question correctly and decipher the scrambled letters to find either 'turn around', "about face," or "flip painting." Upon discovering this, the players would perform the action shown on the board instead of entering the correct words which triggered the asset behind them to reveal the exit code. Without the research team actively participating in these early curriculum evaluations, every student was likely to be stuck at this obstacle in the game which could cause frustrations and impact the player's desire to play the game again.

In addition to general game design and bug feedback, we wanted to provide the developers with useful data about players' initial impressions of the game. To do this, we had several conversations with the developers about what metrics would be the most

valuable for them given the game's current development stage. They were interested in understanding how intuitive the puzzles were, whether or not the participants viewed the rooms as fun, and the game's replayability. Collecting these metrics for each room would allow us to determine the best order to present the rooms to maximize player motivation and engagement. In our first curriculum evaluation, we asked participants to answer three questions for each room by selecting how much they agreed with the following statements: "This room was easy," "This room was fun," and "I would play this room again." To avoid confusion, screenshots of the puzzles for each level were added as a visual to the survey (see Figure 39).

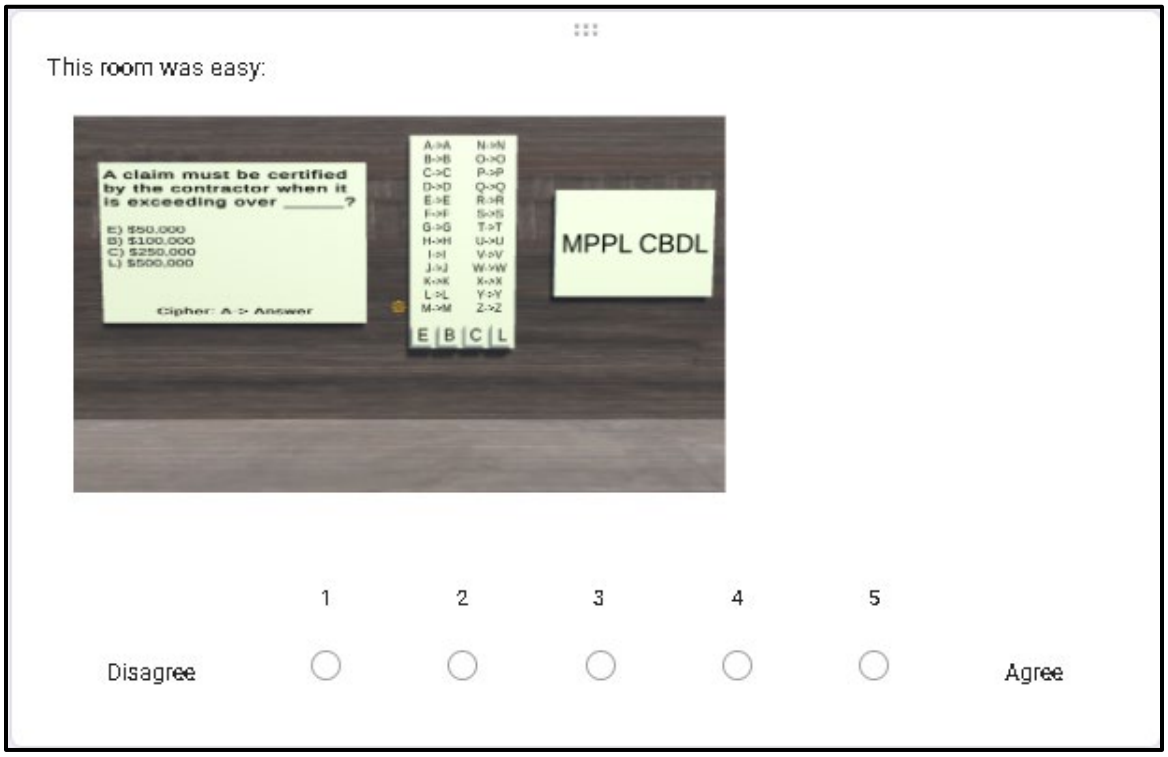


Figure 39. Example of question statement asked in Sinking Ship feedback

The results of the first round of curriculum evaluations are shown in Figure 40. As stated previously, the primary objective behind this initial round of curriculum evaluations was to identify any design flaws or bugs and to help the team determine the best order in

which to present the rooms. The game developers at NC State informed the researchers that the order of the levels should represent a general increase in difficulty as players progress. Further, the most difficult levels should be spaced out such that players feel as though they aren't becoming over-challenged. Additionally, an optimal sequence would ensure that the hardest levels are not positioned as either the first or last rooms of the game. The table below outlines the average room ratings submitted by the six participants on a 1 to 5 scale. When we sort them by their average difficulty rating we see that the cargo room was rated as the least difficult followed by the treasure room, map room, candlelight room, and finally the cipher room respectively. After reviewing the average scores for the participant impression metrics, the team decided that an optimal sequence for this game would be playing the candlelight room followed by the map room, cargo room, cipher room, and then the treasure room. Playing the game in this order would avoid facing the hardest puzzles back-to-back and would also allow the player to start with the room perceived to be easiest.

Participant Information **n = 6**

Avg Military Exp: 4.8 years
Avg Contracting Exp: 2.2 years
Avg Completion Time: 22:24

Room Ratings

1 (Strongly Disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly Agree)

Cipher Room Averages:
Easy 2.50
Fun 4.00
Replayability 3.84

Cargo Room Averages
Easy 4.50
Fun 4.34
Replayability 4.67

Map Room Averages
Easy 4.34
Fun 4.00
Replayability 3.67

Treasure Room Averages
Easy 4.34
Fun 5.00
Replayability 4.84

Candle Room Averages
Easy 4.17
Fun 4.67
Replayability 4.84

Overall Room Averages
Easy 3.97
Fun 4.40
Replayability 4.37

Figure 40. Ratings feedback from first evaluating participants of Sinking Ship

We also wanted to visualize the results we received from the curriculum evaluations to understand the data better. We used the visualization tools available in Stata/IC 16.0 to produce box and whisker plots for each of the three primary metrics. In addition, we compared participants' military and contracting experience in years. In Figure 41, the boxes represent the data from the first and third quartiles, while the lines in between represent the median or second quartile. The whiskers show the highest and lowest values of the data. Box plots can be an effective tool for visualizing data with small samples because they make it easy to see the range and dispersion of the data. Visualizations like this are especially useful in research where the data is not all normally distributed. All six participants said they had the most fun in the Treasure room, as shown in Figure 41. Similarly, for replayability, the treasure room and candle room were both perceived as the most repayable rooms, with only two users ranking the rooms lower than a 5. In terms of ease, we can see that the cipher room scored much lower when compared to the other four

rooms. Looking at the participants' past work experience, we observe that they generally have more military experience than contracting expertise. Although this is a small study with only six participants, these results help paint a picture of the trends we observed in our data.

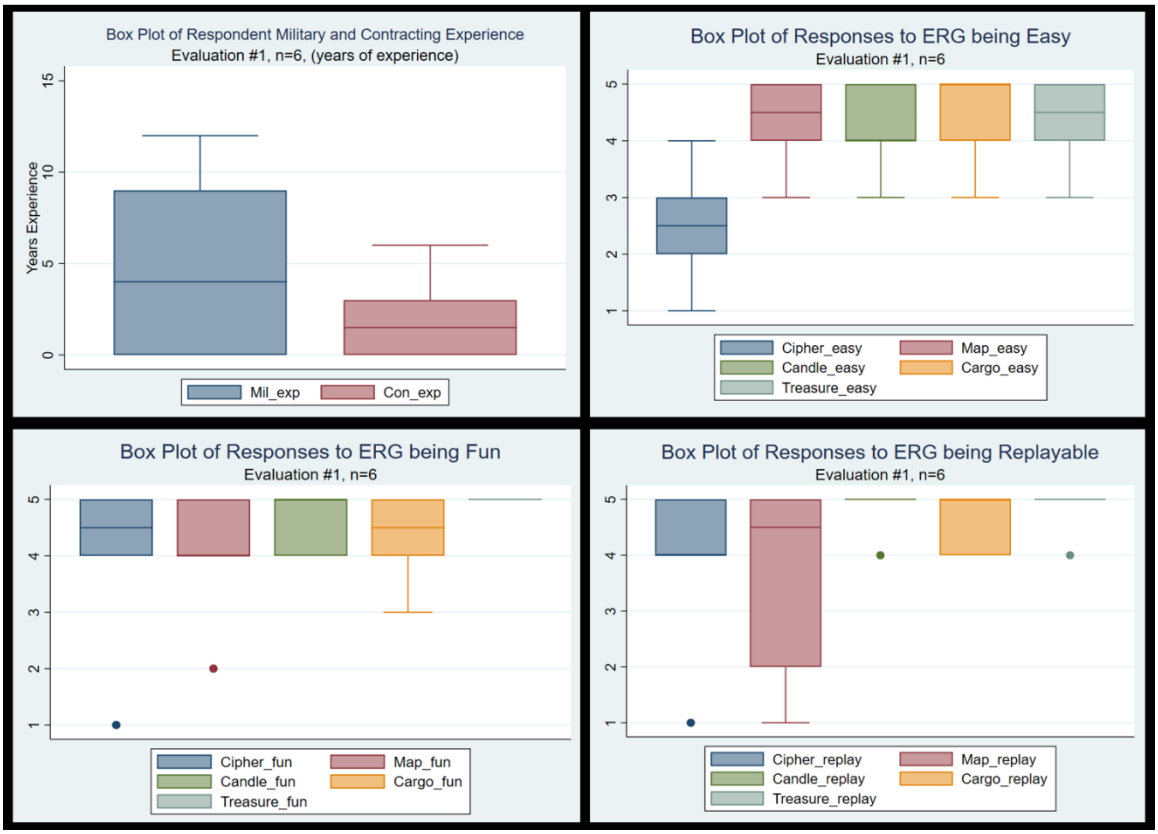


Figure 41. Initial curriculum evaluation visualization (Stata/IC 16.0)

Along with difficulty, the fun and replayability factors of the game are important for its future success. Our first curriculum evaluation was performed on a very small sample size and future curriculum evaluations were needed in order to draw representative conclusions, but the initial feedback we received was overwhelmingly positive. As seen in Figure 40, the average rating for fun in a room was 4.40 and the average rating for replayability of a room was almost 4.37. On the 1 to 5 scale that we utilized, this would place these averages between the 4 (agree) and 5 (strongly agree) statements for each category. Along with the agree/disagree statements, the bottom of the survey included fill

in the blank questions that asked participants how else we could improve the game, how this game compared to other military training they had received, and any other general feedback they would like to provide. The statements received were strongly positive and most notably, the participants felt this game was better than other military training they have received. "Way better." "easier," and "very fun" were phrases used multiple times throughout these answers as the participants responded to how it compared to other military training. Lastly, one participant was particularly positive and noted the possibilities for this game including studying for the Contracting Officer Test (COT) or for the unlimited warrant board. These results suggest that the game may be perceived as an effective means of contracting training and that additional curriculum evaluations should be considered.

7. Second Game Curriculum Evaluation

The second curriculum evaluation group consisted of a group playthrough in a classroom setting with 10 participants simultaneously (see Figure 42). The plan for this session was to have participants play the game with our optimal sequence from the first curriculum evaluation group. Unfortunately, on the day of the in-person evaluation of the game, the team experienced technical difficulties with the addition of the new iteration of the treasure room. This room was uploaded to the game just before the playthrough along with a tutorial level. The inclusion of the new treasure room inadvertently affected some of the underlying game code and subsequently the back wall of every other room completely disappeared. Additionally, we found that even simple features like the ability to change the game's level order were impacted as a result of the new treasure room. This made every room aside from the new treasure room unplayable which would have made the second curriculum evaluation invalid.

Thankfully, the research team's close coordination with the developers throughout the development process allowed them to identify the problem and request that the most recent update be rolled back. The evaluation team's relationship with the developers was such that they immediately responded to the request and the researchers were able to carry out the test. Since the in-class evaluation time was cut considerably due to the fix, the researchers decided to disregard the optimal sequence in order to allow enough time to

collect additional data. This choice allowed all 10 participants to complete the game. It should be noted that the technical difficulties experienced the morning of the evaluation could have had a negative impact on the results we received from this course evaluation and the overall participants' impression of the game. Additionally, the time constraints of our evaluation session being cut shorter due to technical difficulties could have had a negative impact as players weren't able to explore each room as long as they otherwise would have. However, we did have 30 minutes to play through the game which was more than the average completion time from the first curriculum evaluation group of 22:24. Additionally, we tried to combat time constraints by assisting students through the end of rooms when they were falling behind the pace required to complete all 5 rooms in the allotted time. Identical to the first curriculum evaluations, we assisted the participants with the contracting questions when they needed it and had them focus on the puzzles and the gameplay experience instead. Although there were a great deal of challenges performing the second curriculum evaluation, the researchers were still able to collect additional feedback about the game which proved to be valuable for the development team and the game as a whole.

Figure 42. Group of participants for evaluation group two

The second curriculum evaluation asked participants the same questions as the first group along with the addition of a few questions that focused on the learning aspect of the game. Just as we did in the first curriculum evaluation, we asked the participants to state how much they agreed with the following statements for each room: "This room was easy," "This room was fun," and "I would play this room again." This was again rated on a 1 (disagree) to 5 (agree) scale and the averages of each room as well as the overall averages can be seen within Figure 43. Additionally, this group of participants were all Air Force officers working within the contracting career field and studying at NPS. We also added questions on how confident the participant was in protest risk knowledge before and after playing the game along with how much the game improved their overall understanding of the subject. Lastly, we wanted to know if the participants felt that this was an appropriate game model for teaching protest risk, so we included the question "How appropriate is this game for learning protest risk lesson material?." The average answers rated on a 1 to 5 scale are shown in Figure 43.

Participant Information n = 10

Avg Military Exp:	6.7 years
Avg Contracting Exp:	3.5 years
Avg completion time:	21:16

Game Learning Improvement

Avg rated confidence in subject BEFORE:	2.3
Avg rated confidence in subject AFTER:	3.5
Game improved overall understanding:	3.6
Appropriate for learning protest risk:	3.7

Using this game for job specific training would increase my job satisfaction:	3.7
I'd be more likely to study outside of work/class using this game:	4.1

Room Ratings

1 (Strongly Disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly Agree)

Cipher Room Averages:

Easy	3.40
Fun	3.30
Replayability	3.30

Cargo Room Averages:

Easy	3.90
Fun	3.80
Replayability	3.90

Map Room Averages:

Easy	2.90
Fun	3.40
Replayability	4.00

Treasure Room Averages:

Easy	3.90
Fun	4.30
Replayability	4.30

Candle Room Averages:

Easy	3.20
Fun	3.10
Replayability	3.80

Overall Room Averages:

Easy	3.46
Fun	3.60
Replayability	3.86

Figure 43. Second curriculum evaluation results

Just like our first round of curriculum evaluations, we visualized the results of our second round using Stata/IC 16.0. Figure 44 shows the box and whisker plots for the same three metrics we used in our first evaluation and participants' military and contracting experience. We can see that all three primary metrics had a much wider range in the second round of evaluations. In other words, where the first round of evaluations was positively skewed, the second round was more balanced. This could have been due to various reasons, which we cover in other sections, such as the technical difficulties we experienced in the classroom or the fact that we could not perform the evaluations in the same manner as we had in the first round. Additionally, it should be noted that this group's military experience was far more centralized around the median score than the

participants in our first round. In that round, we had participants with a wide range of military experience ranging from zero to over ten years. In the second round, most participants had five to ten years of experience. Finally, we can see that some of the trends we saw in the first round were still present in the second round. For example, the treasure room remained one of the most fun and replayable rooms for participants. Even though the sample size for our second round was still small, these results are promising considering the general trends we saw. This group tended to be less favorable towards games, yet they showed encouraging signs in this experiment.Overall, users of the ERG had a positive perception of the game and the rooms themselves.

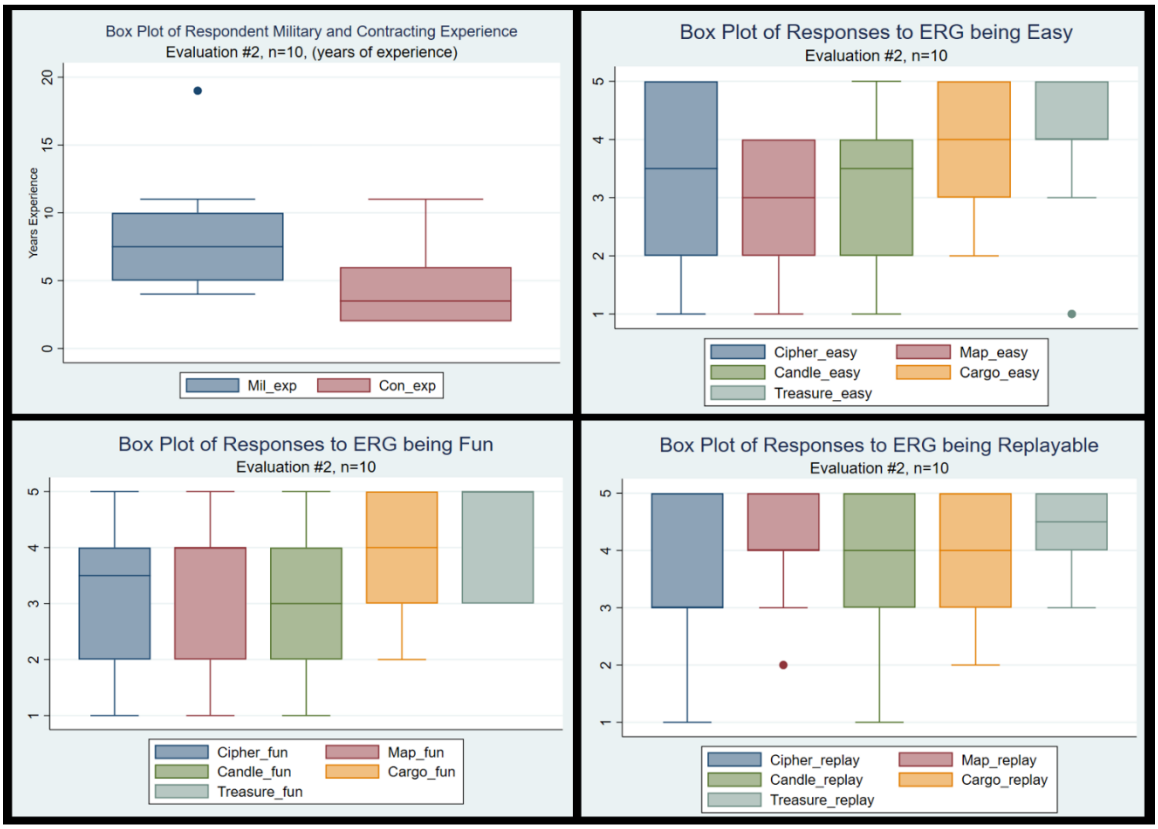


Figure 44. Second curriculum evaluation visualization (Stata/IC 16.0)

The feedback we received from the second curriculum evaluation showed a continued trend in the positive outlook by participants for gamification efforts in Air Force contracting. The responses also identified some key challenges that can be addressed in

future efforts. Two of the players did not enjoy the game experience and scored all of the rooms as difficult, not fun, and not better for learning than traditional methods. Even with the in-game narratives and hints scattered in each room, both students stated the game was confusing and they preferred a traditional classroom setting for learning. This information is important because it is possible that educational games are not for everyone — hence, not everyone within Air Force contracting is going to enjoy learning through this game. Despite these participants having lower average room ratings when compared to the previous group, the feedback from the second curriculum evaluation was still overall positive. With the exception of the ease of the map room, every room was rated above a 3 out of 5 for ease of use, fun, and replayability. Although the sample size was still very small, the data from the second curriculum evaluation showed that, while there are still some challenges to address, gamification efforts in Air Force contracting continued to be viewed positively by players.

The first set of curriculum evaluations rated higher in 13 out of the possible 15 categories when compared to the second group. It is possible that this overwhelming positivity is due to the fact that the first group consisted of volunteers who offered to play and test the game. It is also possible that participants in the first evaluation viewed the experience as more positive because they played the game one on one with the researchers who were able to provide them with immediate assistance. This experience differed from the second group of contracting professionals who were required to play this game as part of the curriculum within our capstone class at NPS. This situation can be classified as "mandatory play" which as Larsson et al. (2021) found in their research, could feasibly cause users to have negative opinions on the game even if they may have otherwise enjoyed playing the experience on their own. With all of these considerations in mind, the feedback received from the second curriculum evaluation being slightly less optimistic than the first group of participants is understandable.

In the second round of curriculum evaluations, we also questioned the contracting elements and learning objectives of the game since every participant of this group had between two and eleven years of contracting experience within the Air Force. The additional questions we asked about participant learning outcomes and the potential this

game had were also positive. The average rating of player confidence in protest risk knowledge before playing the game was 2.3 out of 5 and improved to an average of 3.5 out of 5 after playing the game. Additionally, we reviewed each submission individually and 7 out of the 10 participants rated their knowledge after the game at least one integer higher than before playing the game, indicating that they felt they had learned something. Three of the participants kept their knowledge as the same answer before and after the game — one of these players rated their knowledge as a 5 for both and the other two players were the same individuals who reported that they disliked the experience as a whole. We also asked these participants to identify if the game was an appropriate modality for learning protest risk lesson material. This answer rated relatively high at 3.7 as the average even with the two students who did not like the experience, who rated it as a 1 out of 5 overall.

Lastly, the team wanted to evaluate what participants thought of this game in terms of how it would impact their work or classroom settings. We molded these questions from the pre-established question sets developed by Larson et al. (2021) in their Sandbox Contracting research. The first question asked players to rate how much they agreed that using this game for job specific training instead of traditional methods would increase their job satisfaction. This received a 3.7 out of 5 on average including the two participants who were opposed to the game. Next, we asked if participants agreed that they would be more likely to study outside of class or work using this game compared to traditional training methods. This rated the highest of almost all the feedback we received from the second curriculum evaluation group scoring a 4.1 on average. Interestingly, one of the two individuals who identified their lack of interest in playing Sinking Ship rated this statement a 4 while the other participant remained consistent, rating it at a 1. Overall, the game received generally positive feedback from the participants. Although some disliked the game, many found it enjoyable and helpful. The majority of participants in our second curriculum evaluation found that using this game for job-specific training would increase their job satisfaction and that they would be more likely to study outside of class or work using this game compared to traditional methods. It should also be noted that this positive outlook about the ERG remained despite the technical difficulties we outlined earlier.

Participants were willing to overlook the early frustrations and still found the game to be useful compared to traditional training methods.

Even though the curriculum evaluations were performed on a limited number of participants, the majority of both groups indicated that Sinking Ship has promise as an effective educational ERG. Not only did it rate highly when participants were volunteering to play, but it also rated reasonably highly when a group of contracting professionals were required to play the game as part of a student-led capstone demonstration. With that being said, we would recommend that if this game is implemented in the future it should not be a mandatory part of a curriculum. Rather Sinking Ship might be best utilized as an optional practice tool to use for learning in place of traditional study materials or as a supplement to traditional in-class instruction. Since participants indicated that they would be much more likely to study outside of class or work using this game compared to traditional methods, using this tool in a supplemental capacity may prove to be useful. If this finding can be replicated in larger populations, then it may revolutionize how we educate our contracting professionals. By giving them more engaging options to study outside of class, future contracting officers may study longer and become more proficient in the art of DOD acquisition as a result.

V. LIMITATIONS, AREAS FOR FURTHER RESEARCH, AND RECOMMENDATIONS

A. LIMITATIONS

While we were able to advise both game development teams to a minimum viable product (MVP) for each of their projects, there were still factors that limited us in how far we could progress both games. In approximately 10 months we succeeded in getting both games to a playable state with the possibility for future improvements. Some of the key factors that limited us were time, student graduations, the number of participants tested, the potential bias of the participants, a limited number of case studies, and greater funding for the projects.

Time was a major constraint for this research in several ways. First, we were restricted by the timeline our thesis group had at NPS. The 18-month program gave us just enough time to achieve the MVPs that we set out to create, but the full completion and testing required to finalize these games and test their efficacy was not possible within that small of a window. Knowing this, we focused on taking detailed notes and assisting the team through the development stages with the belief that our findings could be used to help future development teams. For Project Admiral, the NC State students we worked with faced a similar constraint as they only had one semester to develop this project with us. Along with this, they were college students and had other assignments to work on as Project Admiral was only a small part of their workload prior to their graduation in May 2022. For Sinking Ship, we started advising the team roughly seven months prior to our graduation from NPS. Due to our limited amount of time left at NPS, we were not able to gather as much feedback as we had originally set out to do. Being able to provide class demonstrations to larger groups of participants and collecting more curriculum evaluation data detailing the effectiveness of both Sinking Ship and Project Admiral would have been possible if the team had additional time. The challenges we faced in terms of time constraints shaped the final research findings and overall influence that our projects could have. Future teams could mitigate this constraint by incorporating adequate succession planning into their research. For example, one team could focus solely on developing the

game and another could be dedicated to gathering external data and feedback. This would provide more comprehensive results and potentially lead to a larger impact on educational game research.

The limited number of participants who were able to play our games during our curriculum evaluations also reduced the impact that our research could have. Due to the development schedules of the games, neither were ready for standardized testing by the time we finished our research. This is an area that we recommend for future research as in-depth and formalized testing for both of these projects could be useful in determining the effectiveness of educational contracting games. Although we were able to get initial feedback in the form of curriculum evaluations for Sinking Ship from 16 peers and colleagues, we were not able to formally test the impact the game could have when compared to traditional learning methods. We were able to perform initial curriculum evaluations for the game to determine level orders and gain a general understanding of participant impressions but would have benefited from a larger sample size and multiple test groups to compare a professor driven teaching session to that of simply playing the game. For Project Admiral, the NC State development team did not have the capacity to enter secondary development stages until November 2022, which left us with too little time left at NPS to continue advising the team or coordinate future testing for it. Although we were not able to formally test the impact of our games, the feedback we received from participants was positive and indicated that both games have potential as educational tools which may or may not translate to larger studies. Along with the succession planning outlined above, one way future teams could mitigate this limitation is to plan for formal testing throughout the process. Testing the games early on (perhaps even one level at a time) would allow teams to determine which research objectives to focus on and ensure that the research conducted is as impactful as possible.

Along with the low total of 16 contracting professionals who evaluated our game, another limitation was the potential bias this group may have had toward our project. Although we assured each participant that we did not benefit from high marks or positive feedback, we believe our relationship as peers could be a potential limitation that may take away from the true uncensored feedback desired when evaluating a game. This group of

participants consisted primarily of students at NPS in our program and our direct relationship with them could have led to slightly higher results in the feedback than we would have received on totally unbiased third parties. While we cannot discount the possibility of bias in our participants, we believe that the feedback received from them was still valuable and can help improve future iterations of the game. Future researchers supporting these efforts should continue to seek out unbiased participants to get a more accurate representation of how people react to the games.

Additionally, testing 16 contracting professionals who were all competitively selected to attend NPS could be considered a limitation in our research. It could be the case that the group of contracting NPS students that took part in our course demonstration and subsequent curriculum evaluations do not reflect the greater Air Force contracting population. Since the contract management program at NPS is only offered to USAF candidates who have already demonstrated an aptitude for contracting in their previous assignments, they may know more about the lesson material and ultimately view our games as less challenging. Further, the underlying leadership traits which have a higher propensity to make it into the program may have led to an overly confident participant pool. Additionally, the innate desire to learn characterized by a population of MBA students may have otherwise precluded individuals from providing harsh or overtly negative critical feedback when experiencing a new learning modality. While our study had many strengths, it is important to note that there were several limitations in the populations we were able to expose to the game. The participants in our study may not have been representative of the general Air Force contracting population and therefore their feedback may not be indicative of how others in the target audience would have reacted. To mitigate this constraint, future researchers should consider a more diverse group of participants to evaluate the games. By seeking a wider variety of opinions, the games could be further refined to better meet the needs of their intended audience.

Another limitation we encountered was that we were only able to assist in the development of two educational contracting games. We believe that we found valuable information for future use, but our study is limited by the fact that we only had time to assist in the development of two games and each of those games had significant overlap in

terms of the personnel who worked on them. For example, one of the primary game developers for Project Admiral continued as a developer on Sinking Ship which meant that their knowledge about both the subject matter and game objectives were greater than it would be if we started with a fresh team. The personnel being roughly the same for both projects may have only given us information that is specific to working with NC State as the game developer. As such, the exact experiences we had may not be entirely replicable for future researchers. Further, the level of continuity between development teams will likely not be as high for future contracting gamification efforts. Although our research could serve as a guide for future researchers as they develop serious educational contracting games, they should be aware that many of their challenges may not be the same.

Compared to other game development efforts, the funding available for this project could also be considered a limitation. Even though we had what could be considered as enough funding for these gamification efforts, the process and quality of the games could have been increased with more funding. This additional funding could have been utilized to procure additional personnel. For example, a graphic designer could have been integrated into the team and this addition would have raised the overall aesthetic of each game. The development team for Sinking Ship was one paid, recently graduated student and one paid intern. If we had the funding for additional developers and more experienced developers, this could have led to improvements in terms of quality and timeliness. Although we reached the goals that we set out to achieve with this research effort, the lack of additional funding for this game development project caused several limitations that could have been avoided with more money. Future researchers should take into consideration the importance of sufficient funding for game development projects. Sufficient funds can help create higher quality games, as well as provide additional resources for better time management and development. Furthermore, additional personnel can help create a more complete team for game development by including people with different skill sets.

B. AREAS FOR FURTHER RESEARCH

The research we conducted has revealed various areas where further study is necessary to understand the full potential of gamification in government contracting training. Some areas we identified for future research would include developing new games while applying what can be learned from our case studies, formally testing these games with larger participant pools, assessing player types in Air Force contracting personnel, and examining the effectiveness of other game types. In the same way we built upon the research done by the Sandbox Contracting thesis team, further research can continue to add to the conversation and development of gamification in contracting. More areas for additional research and game creation will surely be revealed as the data and benefits to Air Force contracting are evaluated.

The first area for future research that we want to highlight is the development of new games which could apply our findings and expand on them. Future contracting integration or advisory teams could follow our strategies and avoid pitfalls to continue developing new and unique games that can be used for training. The notional application matrix for defense acquisition subjects and game types developed by Finkenstadt et al. (2022) can be followed to develop games that have not yet been explored. FPS, TD, and escape room games have been developed which leaves room for the exploration of other game types such as role-playing, tycoon, adventure, and simulation games. These each have their own specified government acquisition subject that is recommended and can be seen in Figure 45. Future researchers can expand the arsenal of games that have been developed until we reach all of the possible avenues available to the realm of gamified educational training. Additionally, games like Sandbox Contracting, Project Admiral, and Sinking Ship can be further improved through use of the experienced game development teams. Creating new games and improving upon the existing MVPs in the future could allow for better results in the research and testing of the impact of gamification for contracting learning objectives.

As we discussed in our literature review, the research carried out by Finkenstadt et al. (2022) allowed them to create a notional matrix that effectively outlines the different game types which might translate well to certain contracting topics. If future researchers

are able to develop similar rapid game prototypes which can match some of the pairings represented in Figure 45, then the DOD will be better equipped to determine an optimal product mix for future contracting students. Once a suitable prototype for each of the games above has been created, researchers could easily evaluate the effectiveness of different contracting game types. This testing could be done on a larger scale than has been possible by recent studies at NPS with the potential to reveal the true impact of gamification on contracting studies. Testing each of the game type combinations outlined would represent a large undertaking which could be the focus of future NPS thesis projects. Comparing the games with different lesson content or using the same content and seeing what game type is truly the most beneficial for learning each subject would add a great deal of value to the wider gamification research community. Such comparison would require multiple rounds of evaluation as every government contracting topic from the notional matrix would need to be integrated into each game type and then every game prototype would have to be tested and compared to traditional learning methods.

	Game Types					
Subject	First Person Shooter	Escape Rooms	Arcade-style	Role-playing	Puzzles	Tycoon
Requirements Development						
Systems Engineering						
Mandatory Sources	x					
Market Research/ Intelligence		x				
Category Management	x					
Acquisition Plans						
Solicitation Development						
Contractor Evaluations						
Negotiations						
Intellectual Property						
Contract Protests			x			
Contract Quality Management						
Contract Changes and Mods						
Closing Contracts						
Contingency Contracting/ OCS						
DevSecOps / Software Acq						x
Subject	Game Types					
	Action-adventure	Sandbox	Real-time Strategy	Tower Defense	Base build	Simulation
Requirements Development						
Systems Engineering						
Mandatory Sources						
Market Research/ Intelligence						
Category Management						
Acquisition Plans						
Solicitation Development						
Contractor Evaluations						x
Negotiations						
Intellectual Property						
Contract Protests						
Contract Quality Management						
Contract Changes and Mods						
Closing Contracts						
Contingency Contracting/ OCS				x	x	
DevSecOps / Software Acq		x				

Figure 45. Notional application matrix for defense acquisition subjects and game types. Source: Finkenstadt et al.(2022).

As originally identified in the research by Larsson et al. (2021), Richard Bartle's Taxonomy of Player Types (Bartle, 1996), divides players into four main types — killers, achievers, socializers, and explorers which may reflect larger trends within the wider Air Force acquisition community. Larsson et al. (2021) performed an initial survey of NPS contracting students to identify their underlying player type, but the same could be done on a larger scale to identify how best to serve the acquisition community through gamification. For example, certain player types like killers may be more susceptible to learning from a fast-paced, competitive FPS game whereas explorers may benefit most from expansive RPGs. Similar large-scale surveys could identify the main type, or types of players which make up the greater government contracting workforce and such information would allow game developers to create serious educational games which conform to the player. Being able to design games which align with the target audience

might allow future SG developers to captivate the greater contracting community in a way that traditional methods simply cannot.

The last area we identified for future research is formally testing these games in larger Air Force contracting participant pools to gather better data. Such data would likely be a better representation of the greater community and could potentially offer more compelling reasons to continue funding these efforts. The limited feedback we were able to gather from our curriculum evaluations on Sinking Ship cannot provide conclusive evidence as to whether these games are truly effective. In future studies, researchers could experiment with using these games to supplement or replace traditional teaching methods and compare the differences in learning outcomes between students who receive traditional education versus those who utilize the games. While the current research is inconclusive, it does suggest that further study in this area could be beneficial in determining whether or not these games are effective teaching tools.

C. RECOMMENDATIONS

We learned a lot about the development of SGs for education from documenting and analyzing these two unique case studies. We believe our research will contribute to the gamification of government acquisition literature by providing a firsthand account of what future developers can expect. Additionally, there are several areas in which we have recommendations for future gamification research efforts. The first recommendation would be to ensure that the participants who will be evaluating the games receive a fully working and relatively bug-free revision. While performing course evaluations for Sinking Ship, the students were presented with a version of the game which included a new iteration of one of the rooms but made every other room unusable and denied users the ability to change the game's level order. Although the game developers and researchers were able to test the functionality of the new treasure room, they did not have enough time to observe the new level's impact on the other areas within the game. This lack of playtesting likely led to a negative skew in player impressions and could have been avoided if the researchers had more time with the latest revision or didn't push out a large feature update immediately before performing curriculum evaluations. As such, researchers should make sure they

have enough time to test large updates or new features before conducting player evaluations in the future.

On top of software limitations, the researchers also experienced a low degree of hardware limitations when players attempted to play Sinking Ship on certain devices. Although Sinking Ship would not be considered graphically intense by today's standards, the game would occasionally not load on some devices. We did not have the opportunity to perform capability testing on the wide range of devices which were used to play the game, but we believe that most of the issues could have been due to either home internet stability or the power of the device used. If future teams were to evaluate the effectiveness of serious educational games on a larger scale, they would want to make sure the participants have access to equipment that enables them to fully engage with the game. Further, future researchers engaged in larger testing could benefit from playtesting their games on a very wide range of available platforms to ensure that the maximum number of users can enjoy the experience.

Another recommendation we identified would apply to the communication tools and strategies that future SG research teams employ throughout their projects. Over the course of our research, we found that open and frequent communication is vital to the success of these efforts as it greatly enhances team cohesion and performance. Using an instant messaging platform like Discord for quick communication in between meetings was a great way to make sure everyone on the team had what they needed when it mattered most. Additionally, incorporating a gamer-centric communication platform that the developers were accustomed to encouraged open communication throughout the project, which in turn made our face-to-face meetings even more efficient. Along with the use of apps like Discord, we also think that regularly scheduled face to face game update meetings are crucial for communication. Even if face to face meetings can only be achieved through software like Zoom or Microsoft Teams, we would highly recommend that future researchers take advantage of every opportunity to get fully acquainted with their development partners. These meetings became especially useful because we often found it difficult to understand the specific challenges the game developers were going through in a week. Conversely, the developers also found it difficult to understand the government

contracting concepts we wanted to integrate into the games. Being able to see the developers as well as the updates on the game was crucial for effective progress meetings, as well as understanding what challenges the other party was currently facing. The seamless integration of multiple communication strategies sped up our case development progress significantly and will likely have similar impacts for future teams.

The final recommendation we identified for future researchers would be to incorporate a process which allows for frequent and structured playtesting throughout all stages of development. Although we as researchers had the opportunity to playtest Sinking Ship ourselves, Project Admiral did not reach a fully playable state during our time at NPS. Despite the fact that we are not game testers by trade, getting hands-on experience with Sinking Ship allowed us to pinpoint what would be obvious bugs or necessary corrections from a contracting perspective before they could present themselves during our classroom demonstration. The research team also recognized the potential value that third party game testers could have for future game development efforts. During our first round of curriculum evaluations many users brought up issues that did not recognize because we were so ingrained in the development process and are video game enthusiasts. For example, some players would struggle with the movement control keys being W, A, S, and D instead of the more intuitive arrow keys on a keyboard even though most commercial games use the prior control scheme. Designing a structured playtesting regime which incorporates third party game testers could provide great value for future game development efforts by identifying issues that the research team may have overlooked due to being entrenched in the development process.

D. CONCLUSION

Throughout our time at NPS, our research taught us a great deal about how to effectively translate contracting education and training into compelling rapid prototype video games. Our findings aim to help future game developers and contracting advisory teams alike understand how to create more immersive and engaging learning experiences for students while simultaneously providing educators with a valuable new tool for teaching the complexities of government contracting. Additionally, we wanted to

understand what underlying factors make for an effective educational game. To set our efforts on a trajectory to meet those goals, we identified four research questions to consider along the way. Even though we were not able to directly answer our two secondary questions, our comprehensive understanding of the two primary questions in conjunction with our detailed reporting of the development process will provide a well-rounded picture for future researchers.

The first primary question concerned the largest hurdles that could be expected when developing a video game centered around contracting. Throughout our experience we found that there were two key hurdles: explaining how contracting functions to those outside of the contracting profession and incorporating useful contracting elements into the game. Explaining how contracting functions to outsiders can be difficult because of the complex and ever-changing nature of the field as well as its specialized jargon. We found that this can be mitigated through having a knowledgeable and enthusiastic contracting advisory team as well as through the use of visual aids or artifacts. Incorporating meaningful contracting elements into a video game can also be challenging because it requires the team to think outside the box and create gameplay mechanics that mesh well with contract-based interactions. We discovered that the engaged scholarship techniques detailed in our methods section in tandem with careful planning and execution allowed us to be able to develop creative solutions that resulted in more effective game prototypes.

Our next primary question related to how the development process could be improved for future games. Beyond the solutions outlined in the first question, our findings suggest that the development process can be improved by streamlining communication and collaboration between designers, developers, and those with contracting expertise. This can be achieved by establishing regular meetings or touch points between the game development team and contracting advisory team in addition to leveraging some of the tools we outlined in our methods section. We also found that establishing a formal playtesting regime early in the development stages would have likely enabled a smoother gameplay experience and a more polished final product.

The secondary questions were broad in nature and they reflected ideas that we were not sure we could address over the course of our studies. The first asked what game type

is the most applicable to Air Force contracting, which slowly diverged from our project's scope as our research evolved. Even though our research did not identify any particular game type that was the most suitable for contracting, we were able to closely examine two very different game types which were adapted into contracting training with relative ease. Further, the detailed findings present in our methods section will serve to equip future researchers to develop even more effective iterations of these game types. The second question related to what content areas in Air Force contracting translate best to games. Although we did not identify the specific contracting areas which translated best to gamified training, we found that Finkenstadt and Helzer (2022) created a notional matrix which matched specific acquisition subject areas to what they believed would be the most appropriate game type. We could not comment on all of the contracting specific areas outlined in their research, but we were able to replicate their findings by matching TD games with OCS concepts and ERGs with contract protests. We also suggested that future projects examine additional subject areas outlined in their matrix to see if there is a relationship to game types.

In developing two new rapid prototype games, we expanded the lexicon of knowledge that will inform future game development teams. We believe our research provides the best data to date on the development of games for Air Force contracting. Our research adds to the literature on serious contracting game design and development, and we hope it will be useful for future researchers in the field. Presently, the future looks bright as our research has inspired the creation of a new educational contracting TD game at NC State. This game is currently in the early development stages by the game development team and it has the potential to improve on Project Admiral, perhaps even replacing it in terms of training new specialists in OCS concepts (see Figure 46). The new game is being designed with an improved user interface and game mechanics based on our findings. The continued desire to explore future gamified education in acquisition has the potential to revolutionize the way we train contracting professionals and we are excited to see what the future holds.

Figure 46. Mini TD initial prototype diagram

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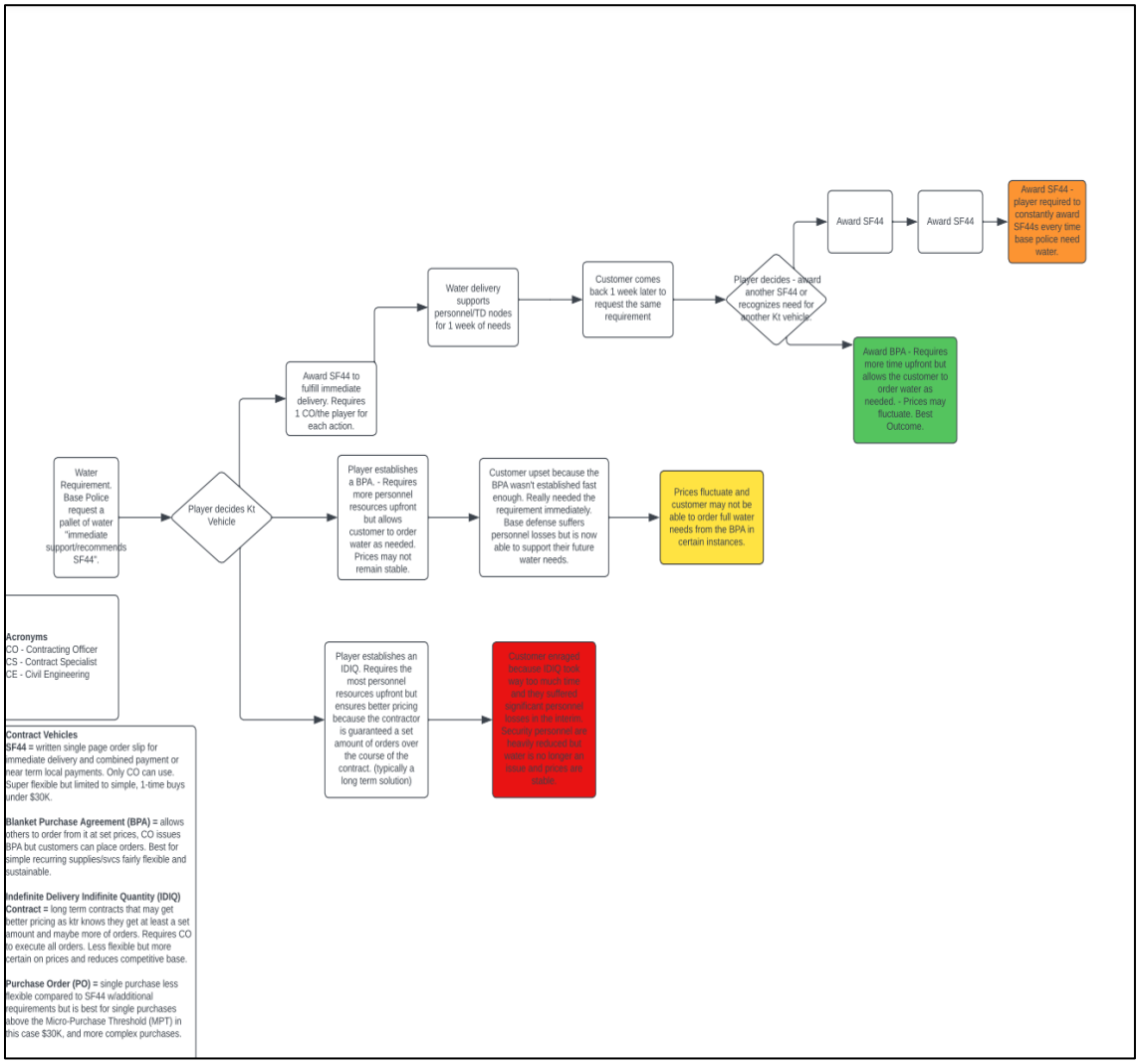
APPENDIX A. PROJECT ADMIRAL WATER SCENARIO INJECT FLOWCHART



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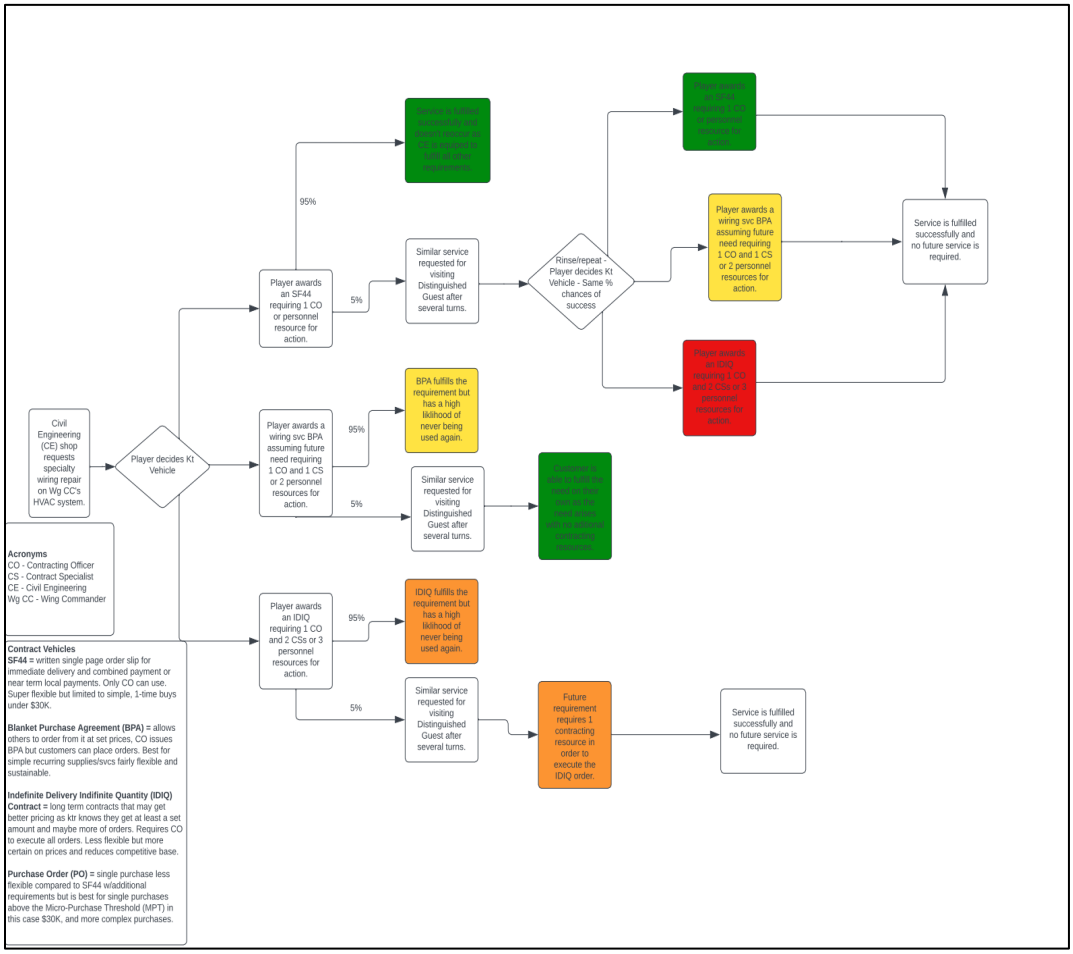
APPENDIX B. PROJECT ADMIRAL CE WIRING SCENARIO INJECT FLOWCHART



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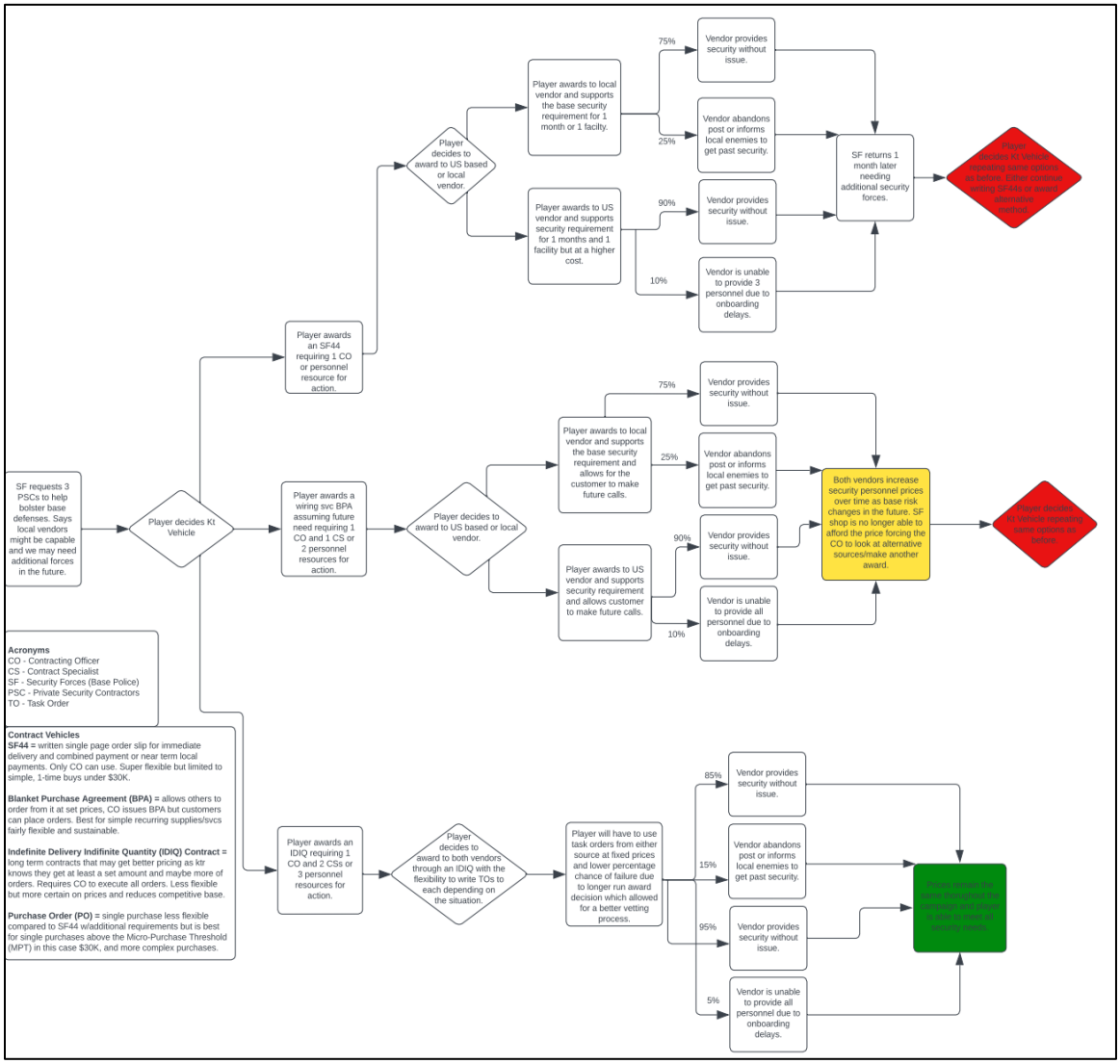
APPENDIX C. PROJECT ADMIRAL BASE SECURITY SCENARIO INJECT FLOWCHART



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APPENDIX D. SINKING SHIP QUESTION SETS

Source: Federal Acquisition Regulation 2.101 and Part 33

Multiple Choice (Cipher)

1. What action(s) can be protested?
    1. A solicitation or other request by an agency for a contract for the procurement of property or services.
    2. The cancellation of the solicitation or other request.
    3. An award or proposed award of the contract.
    4. All of the above.
2. All of the following are procedures established to resolve agency protests effectively, to build confidence in the Government's acquisition systems and to reduce protests outside the agency except:
    1. Protests shall be concise and logically presented to facilitate review by the agency
    2. All protests filed directly with the agency will be addressed to the contracting officer or other official designated to receive protests
    3. Protests based on alleged apparent improprieties in a solicitation shall be filed after the closing date for receipt of proposals
    4. In accordance with agency procedures, interested parties may request an independent review of their protest at a level above the contracting officer; solicitations should advise potential bidders and offerors that this review is available
3. All of the following are circumstances permitting other than full and open competition except:
    1. Only one responsible source
    2. Contingency operation
    3. Unusual and compelling urgency
    4. International agreement
4. Protests can be filed through all the following entities <u>except</u>:
    1. The U.S. Supreme Court
    2. The Government Accountability Office
    3. The Agency
    4. The U.S. Court of Federal Claims
5. Where are the vast majority of protests filed by contractors?
    1. Directly with the agency
    2. U.S. Court of Federal Claims
    3. The Government Accountability Office
    4. Small claims court
6. How long does the government have to submit a report to GAO?
    1. 15 days
    2. 30 days
    3. 45 days
    4. 60 days

7. How long does the GAO have to formulate a decision in response to a protest?
    1. 30 days
    2. 50 days
    3. 60 days
    4. 100 days
8. A claim must be certified by the contractor when it is exceeding over _____?
    1. $50,000
    2. $100,000
    3. $250,000
    4. $500,000
9. When performance has been suspended or terminated, the CO should attempt to negotiate___?
    1. Mutual agreement on a no-cost basis
    2. In the best interest of the government
    3. For reductions in decision time
    4. Award of costs to the protestor

True False (Candlelight)

1. Contracting officers are authorized, within any specific limitations of their warrants, to decide or resolve all claims arising under or relating to a contract subject to the Disputes statute. (True/False)
    1. True
    2. False
2. The Government has a legal obligation to contact all past performance references provided in a proposal. (True/False)
    1. True
    2. False
3. A rating of "Neutral" past performance rating means that the offeror is not evaluated favorably or unfavorably on past performance. (True/False)
    1. True
    2. False
4. When performing the past performance evaluation, the Government may consider items such as the company's predecessor companies, key personnel who have relevant experience, or subcontractors that will perform major or critical aspects of the requirement. (True/False)
    1. True
    2. False
5. An Organizational Conflict of Interest can be waived by the agency. (True/False)
    1. True
    2. False
6. During the source selection process, the Government agency should retain all evaluation documents. (True/False)
    1. True
    2. False

7. When evaluating proposals and assigning strengths and weaknesses, the Government must be able to tie those strengths, weaknesses and ratings to a requirement that is "explicitly stated" verbatim in the solicitation. (True/False)
    1. True
    2. False
8. Alternative dispute resolution (ADR) must be applied to either all or none of the claims. (True/False)
    1. True
    2. False
9. A certificate which alters or otherwise deviates from the language in 33.207(c) or which is not executed by a person authorized to bind the contractor with respect to the claim is known as defective certification. (True/False)
    1. True
    2. False
10. A Contracting Officer must consider all protests regardless of protest venue, but need not seek legal advice. (True/False)
    1. True
    2. False
11. The fastest, least formal, and least costly forum to pursue a protest is with the agency itself. (True/False)
    1. True
    2. False
12. All parties should first make their best attempt to resolve protests at the Contracting Officer level through "open and frank discussions." (True/False)
    1. True
    2. False
13. The potential protester must be an interested party and the protest must include a detailed statement of the legal and factual basis for the protest. (True/False)
    1. True
    2. False
14. A protester is not allowed to request an independent review of the merits of its agency protest at a level above the Contracting Officer. (True/False)
    1. True
    2. False
15. An interested party with regards to a protest means an actual or prospective offeror whose direct economic interest would be affected by the award of a contract or by the failure to award a contract. (True/False)
    1. True
    2. False

Matching (Cargo)

1. Match the following clauses to their FAR prescriptions
    1. Protests after award -> a. 52.233-3
    2. Service of Protest -> b. 52.233-2
    3. Disputes -> c. 52.233-1
    4. Applicable Law for Breach of Contract Claim -> d. 52.233-4
2. Match the following terms to the most appropriate definition:
    1. Protest Venue

1. _____means protests filed with the agency, GAO, or the U.S. Court of Federal Claims. U.S. District Courts do not have any bid protest jurisdiction.

2. Alternative Dispute Resolution
    1. _____ means any type of procedure or combination of procedures voluntarily used to resolve issues in controversy.
3. Misrepresentation of Fact
    1. _____ means a false statement of substantive fact made with intent to deceive or mislead.
4. Interested Party
    1. _____means an offeror whose direct economic interest would be affected by the award of a contract or by the failure to award a contract.

3. Match the following GAO protest procedures to their order of occurrence:
    1. The protestor furnishes a copy of their complete protest to the official and location designated in the solicitation.
        1. 1.
    2. The agency gives notice of the protest to the contractor OR to all parties who reasonably could have been awarded if the protest is denied.
        1. 2.
    3. The agency submits a complete report to GAO containing all relevant information.
        1. 3.
    4. The protestor files its claim for costs with the contracting agency.
        1. 4

Fill in the blank (Treasure)

1. A _____ is a written demand or written assertion by one of the contracting parties seeking, as a matter of right, the payment of money in a sum certain, the adjustment or interpretation of contract terms, or other relief arising under or relating to the contract.
    1. Claim
        1. Hint 1: The contractor must deliver this to the CO in writing and a decision must be made within 6 years of receipt.
        2. Hint 2: See FAR 2.101 & FAR 33.206
2. A document is considered _____ when completely received by an agency before its close of business.
    1. Filed
        1. Hint 1: When something is documented in a contract file it is considered…
        2. Hint 2: See FAR 33.101(2)(ii)
3. A contractor is considered _____ when they are excluded from Government contracting and Government-approved subcontracting for a reasonable, specified period of time.
    1. Debarred
        1. Hint 1: A contractor can be considered _____ for a time period of no more than 5 years.
        2. Hint 2: See FAR 2.101
4. All protests filed directly with the agency will be addressed to the _____ or other official designated to receive protests.
    1. Contracting Officer
        1. Hint 1: See FAR 33.103(d)(3)
5. Where appropriate, the use of _____ techniques, third party neutrals, and another agency's personnel are acceptable protest resolution methods.

    1. Alternative Dispute Resolution (ADR)
        1. Hint 1: _____ may include conciliation, facilitation, mediation, fact-finding, minitrials, arbitration, and use of ombudsmen.
        2. Hint 2: See FAR 33.201
6. A _____ is a written objection by an interested party.
    1. Protest
        1. Hint 1: _____ may be in relation to a contract award, solicitation, cancellation or termination.
        2. Hint 2: See FAR 33.101(2)(ii)
7. Contracting officers should contact their designated _____ advisor for additional information whenever they become aware of any litigation related to their contracts.
    1. Legal
        1. Hint 1: Adherence to this advisor's opinion is rarely required but often heeded.
        2. Hint 2: See FAR 33.001
8. A _____ is considered final on the date on which the time allowed for filing an appeal or request for reconsideration has expired, or the date on which a decision is rendered on such appeal or request, whichever is later.
    1. Ruling
        1. Hint 1: A _____ is considered a final legal opinion.
        2. Hint 2: See FAR 33.102(c)
9. Prior to submission of a(n) _____ protest, all parties shall use their best efforts to resolve concerns raised by an interested party at the contracting officer level through open and frank discussions.
    1. Agency
        1. Hint 1: What are the three types of protests covered in FAR part 33?
        2. Hint 2: See FAR 33.103(b)

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APPENDIX E. SINKING SHIP NARRATIVES

Cipher Room	While briefing Captain Sparrow about your crew's latest acquisition, you hear a deafening crash! A cannonball shot directly through your ship's hull and its sinking fast. You rush to the exit but find that the door is locked. Captain Sparrow explains that the security system meant to keep out pirates can only be unlocked by a code hidden in this room. He points to the cipher on the wall and says if we can decode the message, the passcode will appear!
Map Room	You open the door and find yourself in a room with a large map in front of you. Your only escape is once again locked via keypad. Captain Sparrow remembers there being legal precedent for what caused our ship to sink but he simply can't pinpoint where that precedent took place! He recalls recently documenting this in one of his notebooks and says if we find the location that the passcode will be revealed! Take a look around and see if you can pinpoint the source of his legal woes and show Captain Sparrow where the problem started on the map.
Candle Room	You open the door and find yourself in yet another room! This time, there's several candles lining the wall in front of you. You look at the exit and curse the fact that every door on this dreaded ship seems to have a passcode… This time you're both stumped but you see a series of true and false statements on each table. Maybe if we light the candles in the correct sequence the passcode and your ticket off this ship will finally be revealed?
Cargo Room	You've reached the cargo room. Captain Sparrow hasn't done any work in years so he hasn't spent much time here. You look around and see a row of color-coded blocks across from a cork board with familiar color-coded string hanging down from the top. Oddly enough, each lower block seems to correspond to a number. You look at the exit, and sure enough there's another keypad…
Treasure Room	You open the door and can't believe your eyes, this room's full of treasure. Captain Sparrow reminds you that this treasure won't be very useful if you're stuck at the bottom of the ocean. He remembers that the final door code is kept hidden in the locked casket on the desk. If you can find the three gold doubloons to unlock that casket, we'll finally earn our ticket out of here!

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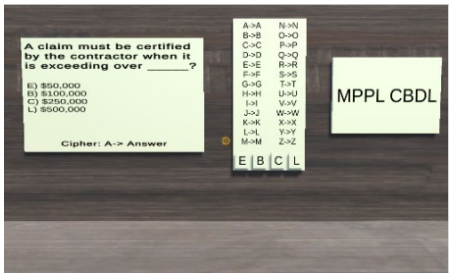
APPENDIX F. SINKING SHIP CURRICULUM EVALUATION QUESTIONS

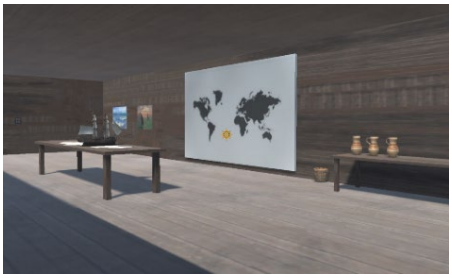
1. What was your tracked game completion time? _____(mins:secs)
2. How many years of military experience do you have? _____(years)
3. How many years of contracting experience do you have? _____ (years)

Rate the Following according to the scale below for each room::

1 (Strongly Disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly Agree)



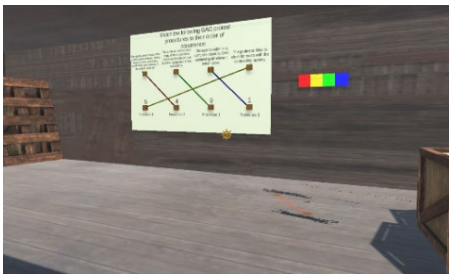
4. This room was easy _____
5. This room was fun _____
6. I would play this room again _____



7. This room was easy _____
8. This room was fun _____
9. I would play this room again: _____

10. This room was easy _____
11. This room was fun _____
12. I would play this room again _____

13. This room was easy: _____
14. This room was fun _____
15. I would play this room again _____



16. This room was easy _____
17. This room was fun _____
18. I would play this room again _____

Rate the Following according to the scale below:

1 **(Very Low)**	**2** **(Low)**	**3** **(Neutral)**	**4** **(High)**	**5** **(Very High)**

19. Rate your confidence in protest risk knowledge BEFORE playing this game ____
20. Rate your confidence in protest risk knowledge AFTER playing this game ____

Rate the Following according to the scale below:

1 **(Strongly Disagree)**	**2** **(Disagree)**	**3** **(Neutral)**	**4** **(Agree)**	**5** **(Strongly Agree)**

21. The game improved your overall understanding of protest risk _____
22. How appropriate is this game for learning protest risk lesson material? _____
23. Using this game for job specific training instead of traditional methods (e.g. PowerPoint) would increase my job satisfaction _____
24. I would be more likely to study outside of class/work using this game compared to traditional methods (e.g. PowerPoint) _____

Open Ended Feedback

25. How would you compare this to other military training you've received?

    _____

26. How could the game be improved? _____

27. Other general observations/thoughts (if applicable) _____

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