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GAMIFICATION IN DEFENSE ACQUISITION TRAINING AND EDUCATION

NAVAL POSTGRADUATE SCHOOL

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EXECUTIVE SUMMARY

Leveraging research conducted as part of an Acquisition Research Program sponsored thesis, this paper expands upon an essay written by our research team (submitted to *USNI*), in which we argue that gamified learning (building games to promote learning of traditional material) presents a unique opportunity for enhancing education and training within the defense workforce.[1] We provide an in-depth explanation of what gamification is and why it might be particularly useful for enhancing learning in non-traditional defense contexts, using defense acquisition as a test case. We present initial evidence from our empirical research to highlight the opportunities and challenges for advancing military education into the present age through gamified learning methods. Finally, we outline future directions for research in gamification for defense applications, bringing attention to the need for collaboration across the defense-focused entities exploring the potential for gaming in future defense education and training.

INTRODUCTION

> "One of the lessons we've learned is that we're going to have to be flexible enough that different subjects and different kinds of training are going to require different kinds of technology."
>
> - Major General Andrea D. Tullos, Commander, 2nd Air Force (Hudson, 2021)

The Department of Defense (DoD) is looking for new and better ways to educate and train its increasingly tech-savvy workforce. Research indicates that traditional military schoolhouse models, which rely on rote memorization of task-relevant knowledge, are ill-suited for learning, particularly among a target population of 18–24-year-olds who have been raised entirely in the digital age. In this paper, we argue that gamified learning may be a huge part of the answer to this force readiness issue. We present initial evidence from our empirical research to highlight the opportunities and challenges for advancing military education into the present age through gamified learning methods.

DEFINING GAMIFICATION

In the context of learning, gamification occurs when the means of acquiring new skills or knowledge are infused and enhanced with game-like elements, including fantasy or simulated game environments; competition; points, leaderboards and badges; and other features (see Table 1). In academia and industry, gamified methods have been applied to a range of subjects and industries with the intent to enhance learning through increased engagement and motivation with content. Relative to conventional modalities for learning new information, gamified learning can engross the learner in the material, offering the potential and motivation for deeper processing and retention.

To date, the military and the DoD have leveraged games and simulations in traditional areas including wargaming, flight training, and weapons skills training (Smith, 2009). Recently, the Navy announced a plan to bolster recruiting efforts through the development of an Esports team, Goats and Glory. The application of gamification to less traditional skills acquisition and refinement, however, is only a recent innovation.[2]

Through the course of our research, we have discovered disparate cells across the DoD ecosystem that are bringing innovative minds together to explore the potential for using gamification to enhance learning in foreign language, program management, and –our focus– defense acquisition (DA).

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[1] Portions of this article were derived from Finkenstadt and Helzer (2022).

[2] For a critical review, see Dichev, C., & Dicheva, D. (2017). Gamifying education: What is known, what is believed and what remains uncertain: A critical review. *International Journal of Educational Technology in Higher Education, 14*. https://doi.org/10.1186/s41239-017-0042-5

SHOULD GAMIFIED LEARNING WORK FOR DEFENSE ACQUISITION?

DA specialists operate in a high-risk, tightly regulated, zero-defect environment with acute public scrutiny. Decades of research in organizational science caution that such environments, which offer little room for experimentation and put a high price on failure, instill a *performance orientation* and stifle learning. This presents a paradox: How do organizations promote effective and deep learning in professional fields where the conditions most supportive of learning are perceived as a risk to ultimate mission?

The paradox is resolved if we decouple the operational environment from the learning environment. Yes, DA specialists must operate in a performance-oriented, zero-defect environment, but that does not mean they need to learn in that same environment. Indeed, in fields for which requisite knowledge is detail-focused, highly manualized, and, frankly, dry, gamified learning might spark engagement with material that does not inherently engross the learner.

Games have a typical set of core features that can be highly useful for overcoming challenges in translating operational, performance-oriented environments to learning-oriented education and training environments. Larsson et al. (2021) use the term "feature" to describe the underlying design components of games, including inter-game mechanics. Games created for the primary purpose of learning may employ different features than games focused on entertainment; however, there are many features that span all types of games. Primarily, games seek to be *fun*. This ability to evoke a sense of fun separates games from many other activities. Malone (1980) has described three features through which good games evoke fun: challenge, fantasy, and curiosity. Wilson et al. (2008) contend that fantasy, representation, sensory stimuli, challenge, mystery, assessment, and control are among the most important distinguishing features of games. McGonigal (2012) puts forth four defining features of games: a goal, rules, a feedback system, and voluntary participation. We draw a common set of game features from these three sources.

Fantasy involves creating make-believe environments, scenarios, or characters (Wilson et al., 2008). It allows players and learners to escape the real world and take on a variety of traits or identities previously inaccessible. Examples of fantasy include mythical creatures like the minotaur, far-off lands such as the Moon or Mars, or imaginary moments in the future. *Challenge* requires a balancing game difficulty to promote player motivation and desire to achieve a goal. Players that are motivated want to reach the goal and win the game. McGonigal (2012) states, "the goal provides players with a sense of purpose" (p. 31). However, if the level of challenge does not match the player's skills, by being too easy or too hard, it can result in players becoming disengaged or frustrated (Wilson et al., 2008). *Representation* is the complement of fantasy. It is the physical and psychological similarity between a game and the environment it represents (Wilson et al., 2008). It is important when applying games to training or education that they mimic the real world since trainees would not experience fully fantastical situations in any other facet of life, such as with war and combat tactics, techniques, and procedures related to defense applications.

Curiosity and *mystery* affect motivation, similar to challenge. Malone (1980) claims that "game environments should be neither too complicated nor too simple" (p. 165); they should be novel, but not incomprehensible. Mystery paints a broader stroke but arouses curiosity in "two forms— sensory curiosity and cognitive curiosity" (Wilson et al., 2008, p. 233). *Feedback* can work in sync with curiosity and mystery features. Sensory curiosity attracts the attention of players through sensory feedback, such as light or sound (Malone, 1980). This can be experienced in games through offering players audible cues such as dings or buzzes when reaching a new level or getting a response incorrect. Cognitive curiosity is provoked by paradoxical information (Wilson et al., 2008). In a game, learners want to complete their information by filling in any information gaps. The feedback system informs players of their performance or how close they are to reaching the goal (McGonigal, 2012). Feedback is important for learners, and it is a concept taught throughout military training and education systems.

McGonigal (2012) separates *rules* from *goals* and clearly defines rules. "Rules place limitations on how players can achieve the goal" (McGonigal, 2012, p. 32). Without rules, the path to a goal becomes unclear, as the player can navigate through objectives free of any restriction. Rules motivate players to explore uncharted possibilities in games (McGonigal, 2012). Rules foster increased creativity and strategic thinking (McGonigal, 2012), furthering levels of fun and participation. Wilson et al. (2008) agree that well-established rules are necessary components of effective education games. There are three types of rules: system rules, procedural rules, and imported rules (Wilson et al., 2008). System rules are those functional parameters inherent to the game itself (Wilson et al., 2008). Procedural rules are in-game actions that control behavior (Wilson et al., 2008). Lastly, imported rules are those that originate from the real world (Wilson et al., 2008), such as physical limits of human beings. Without rules, games do not exist, as the greater goals of the game become too easy to reach (Suits, 1978/2005).

Voluntary participation is a critical feature of games. Wilson et al. (2008) call this feature "safety." It is a safe way to experience reality through the disassociation of actions and consequences (Wilson et al., 2008). This feature means that players willingly accept the parameters of the game. The goal, the rules, and the feedback are known by all, and that establishes the common ground from which all players start (McGonigal, 2012). This makes games transferrable between all players, meaning no player has an unfair advantage as a participant. Also, the ability to come and go in a game "ensures that stressful and challenging work is experienced as a safe and pleasurable activity" (McGonigal, 2012, p. 32). Voluntary participation can be critical to the success of games that are focused on training and education. We know that DA is characterized by a high-risk, tightly regulated, zero-defect environment overseen with acute public scrutiny. Lowering or removing the consequences in a training environment allows learners to experiment in ways that may not be comfortable in traditional training delivery methods and may encourage greater student learning orientation over performance orientation. Finally, *mulligans* refer to the ability for games to allow trainees and players a "do-over." This interacts with the features of curiosity and feedback, allowing the student to take risks based on intellectual curiosity, receive feedback, and learn the greater lesson without fear of irreparable harm to themselves or their missions.

Table 1 provides a side-by-side depiction of the alignment between the typical features of games with those of the DA operational environment. The interaction column indicates how features of the game environment interact with features of the DA operational environment to promote greater learning by either reducing features of the DA operating environment that are detrimental to learning or reinforcing those features that promote critical learning objectives. For example, the threat of real-world legal consequences in the DA operational environment limits students' exploratory behaviors; however, the fantasy aspects of the gamified learning environment can encourage students to explore, try, and fail. *Voluntary participation and mulligans* allow players to experience various roles within the DA process and redo experiences within the DA process to improve outcomes or simply explore alternative results without fear of consequence. Of course, unbounded fantasy is unlikely to promote transferrable knowledge to the DA operational environment, so counterbalancing this with *representation*, which increases exposure to actual complexities in these markets, and *game rules*, which reinforce the limits of highly regulated environments, can potentially optimize the balance between operational realism and game-enhanced learning. Other game features, such as *challenges/goals, curiosity/mystery*, and *feedback*, not only mimic features of the DA environment but may enhance motivation and engagement with the material to be learned. In short, games allow learners to enter a world of low consequence and strong feedback with variable degrees of operational realism—one in which the decisions and challenges are entered into voluntarily and allow for freedom of exploration.

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 that, in many cases, is based on procedural rules.

Features of Gamified Learning Environment	Interaction	Features of DA Operating Environment
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.)

Table 1. Alignment of Gamified Learning Environment With Features of DA Operating Evnironment (Finkenstadt & Helzer, 2022)

GAMIFIED EDUCATION AND TRAINING RESEARCH LINES OF EFFORT

Our research has shown us that the design and development effort for gamification studies is highly involved, including three concurrent lines of effort. First, teams must design game content. They must focus on the curriculum and subjects of interest and specify learning objectives. This can include designing material to be learned in a variety of manners, from simple rote memorization to complex derivative means such as procedural rhetoric. Second, teams must design the game itself. It involves skilled development teams with proficiencies in a variety of skills from coding, commercial game development software functionality, graphic design, visual narratives, etc. Finally, research teams must design the study to explore efficacy and other research questions. This may include survey design, pre- and post-tests, timing, internal review board approvals, etc. Synthesizing these three lines of effort is a complicated undertaking that requires sound program management skills to pull off successfully.

GAME TYPES

Our research and experiences in exploring gamification for defense training and education have revealed three primary game modalities that can be used for learning: (1) serious/simulation gaming, (2) exposure gaming, and (3) engagement gaming.

Serious games are realistic games that put the player through the motions of performing real world tasks in a simulated operating environment with the intent to sharpen skills. These games closely recreate physical and relational environments, as in the case of the widely popular "Apex Officer" VR game or Walmart's Spark City game, in which players are required to manage the day-to-day operations (keeping shelves adequately stocked, keeping customers satisfied) of a fictional Spark City store.

In exposure games, players also practice the skills and abilities of their real-world roles but do so through proxy or by way of carry-over effects. For example, financial managers or logisticians in the military playing games such as "7 Days to Die" or "Green Hell" must rely on resource management skills and planning over long horizons of time in order to successfully survive the game, even though the game environment bears little resemblance to players' real world operating environments.

Finally, in engagement games, very few elements of the game environment or activities within the game match the players' real world operating environments; it is more about introducing curriculum subject matter to the player in an alternate universe/setting to evoke a sense of increased interest and engagement. In our research to date, we have worked from the modality of engagement gaming to allow players to learn and rehearse otherwise "dry" material in a learning environment that leverages game-enhanced motivation and cognitive engrossment.

GAMIFICATION OF TRAINING AND EDUCATION IN INDUSTRY

Gamification is being used by many commercial firms. With over 500,000 downloads on the Google app store as of March 2022, Walmart's Spark City game stands out as a clear example of simulated work that has gained popularity (Grill-Goodman, 2019). In the game, players are required to manage the day-to-day operations of a fictional Spark City store. This includes keeping shelves adequately stocked and keeping customers satisfied. The intent is to help managers improve skills and to encourage non-managerial associates to learn more about each department.

Deloitte is a well-known consulting firm that has been named one of the best 100 firms to work for by *Fortune* magazine. Deloitte also does a substantial amount of work with the federal government, with over 4,000 contracts and subcontracts in the last seven years. Deloitte chose to gamify its executive leadership training when they observed that the standard delivery model was being underattended or not completed. They developed a serious game related to leadership interactions. They introduced gamification elements such as badges, leader boards and status indicators. Deloitte has reported that players interacting with the game achieve greater intrinsic reward, enter a sense of flow, want more experience with the game as difficultly progresses, and enjoy instant feedback on their performance. Employees reported the game becoming almost addictive, and participation in the training nearly doubled. Performance on cognitive ability tests were 10–20% higher among game players than those that did not play the game or those who played a game that did not increase game difficulty progressively (Bradt, 2013).

GAMIFICATION OF TRAINING AND EDUCATION IN THE MILITARY

Gamification in the military has been previously utilized and is becoming more common as the digital world becomes more ubiquitous to professional military communities. As the next generation of warfighters (i.e., those born in or before 2004) enters the military, they bring their tendencies and preferences for learning. For many, this includes video games and simulations. Since 2002, the Army has used "America's Army" as a recruiting tool and means of improving strategic communications with citizens. The military has used simulators for years for training pilots, missileers, or simulating troop carrier rollovers in Iraq and Afghanistan. More recently, this has expanded into other areas, including VR simulation games that train security personnel in the U.S. Air Force with the game "Street Smarts." However, not all training has to be directly attributed to technical or tactical skills. Other, less kinetic areas of military training are moving into VR space. In 2021, the Air Force began training for sexual assault and prevention using VR from the firm Moth+Flame. Games that cross into simulation and engagement are being built. For instance, the Defense Acquisition University is building a game called "MindShift" that teaches players how to run a software development acquisition team and an organic software factory within the military. "MindShift" allows players to trade real world decision criteria in a resource-constrained environment while playing in a space that feels more like Minecraft or Roblox than a military office.

We see engagement gaming increasing in the military as well. Our "Sandbox Contracting" game, discussed in detail below, was launched at the 344th Training Squadron in San Antonio, Texas, in 2021 and tested on four waves of contracting students and a wave of Naval Postgraduate School (NPS) graduate students during the summer and fall of 2021. The Defense Language School is building a linguistics game entitled "Mage Duel" that allows players to earn magical powers and energy to fight off enemies by successfully translating phrases in various languages associated with their area of study. Our teams at NPS are working with NC State University to build short pinball and pachinko games for teaching contract protest areas of risk for junior acquisition personnel and more robust games such as market intelligence-based virtual escape rooms and tower defense games for learning operational contracting support skills. And there are any number of opportunities to build and test technical and communication skills development using exposure gaming with products like "Keep Talking and Nobody Explodes" or "Satisfactory." The military services have all invested in building up their own Esports teams, and military education organizations like the Air University (AU) are posting open calls for schools and firms to propose ideas about how to build leadership skills through gamified learning. AU has recently launched "Project DAWG (Developing Airmen with Games)" in collaboration with Innovatrium at the University of Michigan as an open innovation tournament for training and education game development.

ENGAGEMENT GAMING FOR DEFENSE ACQUISTION: AN INITIAL INVESTIGATION THROUGH CURRICULUM MODALITY EVALUATIONS

In initial work, our MBA students at NPS programmed a first-person shooter game involving gun battles and bomb diffusion, in which success depended on players' ability to correctly answer questions about federal acquisition rules and regulations (Larsson et al., 2021). We were fortunate enough to be able to team with the 344th Training Squadron at Lackland AFB, Texas, for the testing phase. Our partners at the 344th provided our MBA students with approved curriculum and assisted in developing pre- and post-tests for assessing short-term, immediate knowledge retention. A wave of data was also collected from NPS students in the DA field.

As the game begins, an on-screen manager provides players with an overview of relevant curriculum content and information needed to answer future game questions correctly. At the end of the instruction period, the player learns that the office is under siege. Upon entering the main game area, players must fight off waves of attackers in each level. At each critical juncture, players are presented with a bomb to diffuse by cutting one of four wires, corresponding with four possible answers (one correct and three foils) to a federal acquisition related question. As shown in Figure 1, if the correct wire is cut, the bomb is diffused, and the player earns points to put towards upgraded equipment. If the player fails to answer the question correctly, the bomb explodes, and the player takes damage. At the end of the game, each player receives an after-action report detailing their performance on attacker engagement and bomb diffusion (i.e., correct answers).

Learning outcomes for our "gamer" participants were compared to outcomes for control groups who received the very same material delivered in standard instructional format (PowerPoint-guided lecture). Along with post-training knowledge tests, we compared learners' satisfaction and engagement to understand the opportunities and challenges of gamified learning in military education.

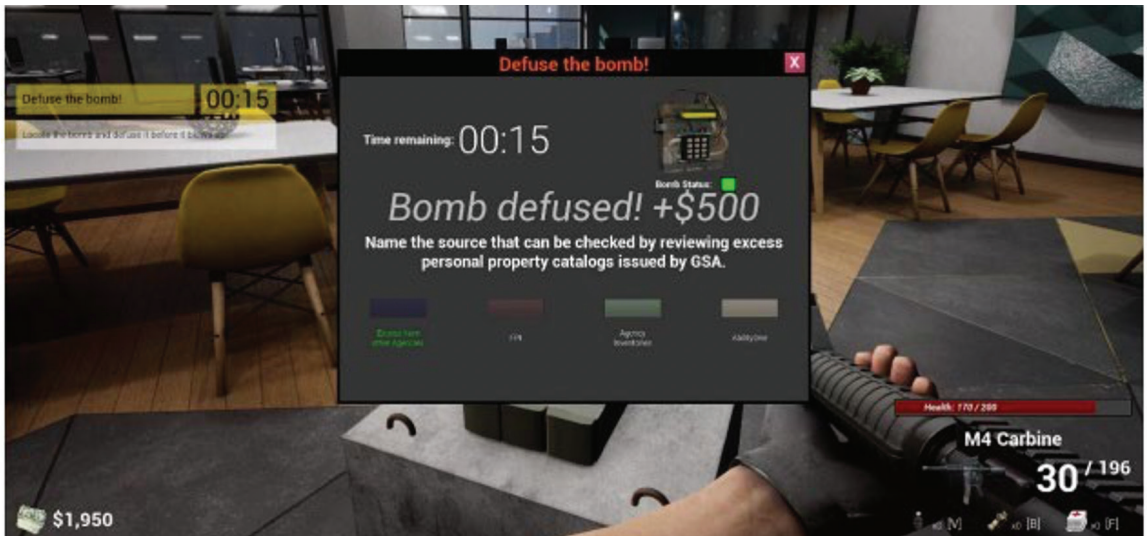

Figure 1. Screenshot of Sandbox Contracting Player Feedback (Larsson et al., 2021)

FINDINGS

We find that gamified DA training shows mixed results in short-term material retention (Larsson et al., 2021). All results indicate a positive increase in material retention; however, variation exists across study waves when comparing the retention of students exposed to gaming versus those exposed to conventional methods. Figure 2 presents the pre- and post- scores on lesson quizzes related to FAR Part 8 for waves 1–4 and category management for wave 5. Figure 3 represents the same results for the students exposed to gamified versus conventional lessons. Table 2 provides a summary of overall findings from the Larsson et al. 2021 study. In three of the five waves, the traditional (control) method outperformed gamified (treatment) method by a median improvement of 5–10%. In one wave, the gamified and traditional methods performed equally well. In a final wave, with

environmental and curriculum variation, the gamified method outperformed the traditional method by more than 15 percentage points. We attribute much of the variation in results to three primary factors: 1) students' prior preferences for gaming, 2) the gaming environment versus control environment, and 3) curriculum learning objective design.

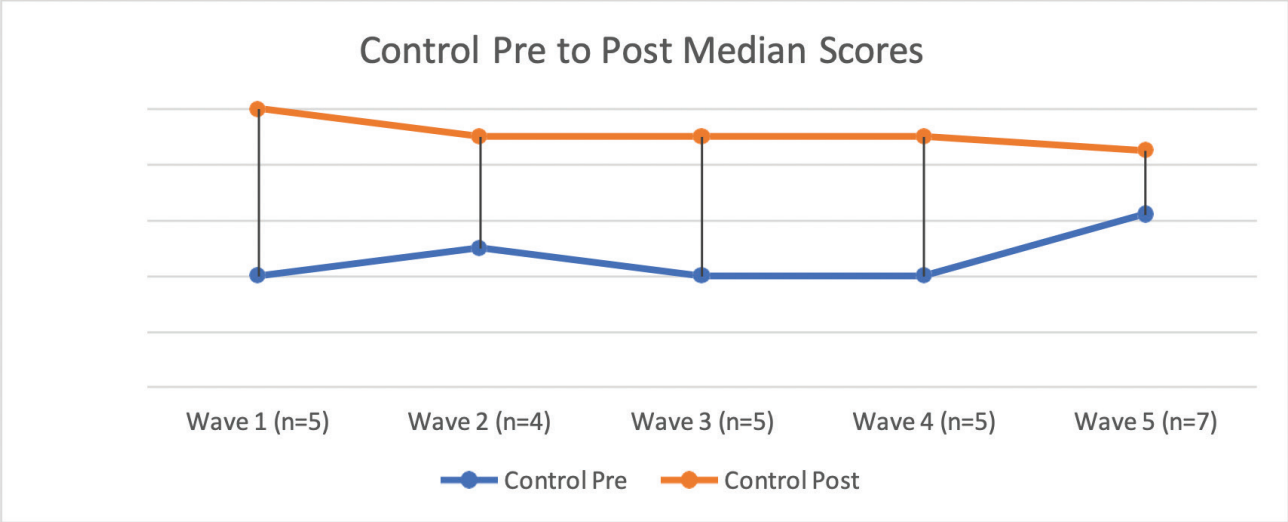

Figure 2. Control Pre to Post Quiz Score Comparison Across Waves

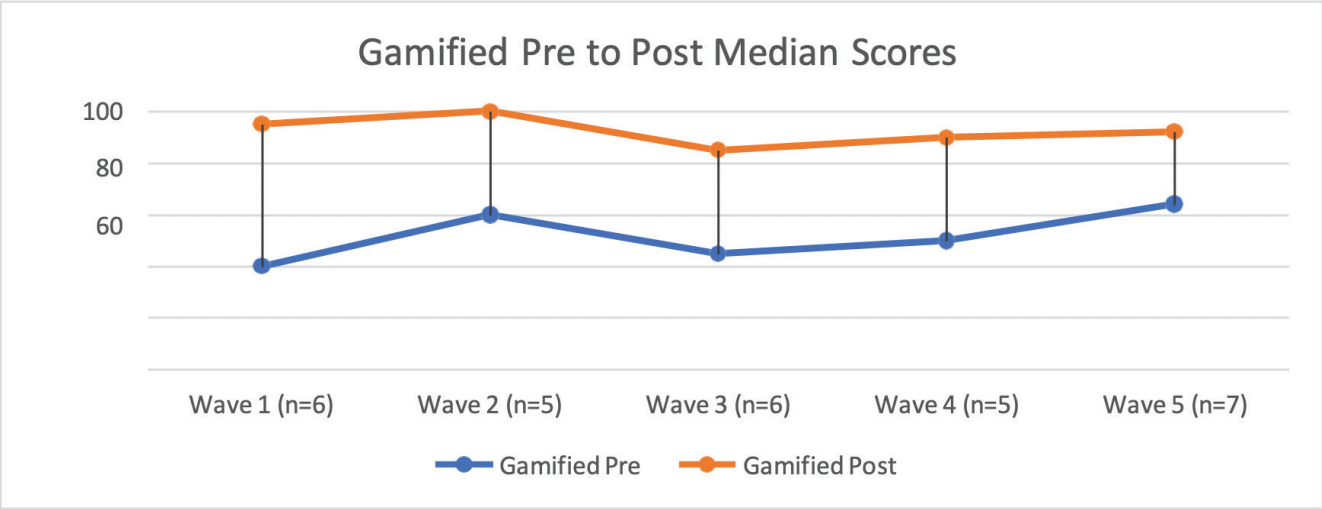

Figure 3. Gamified Pre to Post Quiz Score Comparison Across Waves

Wave	Curriculum	Treatment Median Pre-Post Change	Control Median Pre- Post Change	Question Type
344-A	FAR Part 8, Mandatory Sources of Supply	55%	60%	1-for-1
344-B	FAR Part 8, Mandatory Sources of Supply	40%	40%	1-for-1
344-C	FAR Part 8, Mandatory Sources of Supply	40%	50%	1-for-1
344-D	FAR Part 8, Mandatory Sources of Supply	40%	50%	1-for-1
NPS	OMB Category Management	30%	23%	Derivative
Wave	**Game Version**	**Game Hardware**	**Treatment Environment**	**Control Modality**
344-A	1.0	Chromebook	Individual play in instructor observed lab	In-person PowerPoint (PPT) and discussion
344-B	2.0	Chromebook	Individual play in instructor observed lab	In-person PPT and discussion
344-C	2.0	Chromebook	Individual play in instructor observed lab	In-person PPT and discussion
344-D	2.0	Chromebook	Individual play in instructor observed lab	In-person PPT and discussion
NPS	2.0	Gaming CPUs	Competitive play in SILAS gaming lab	Zoom PPT and discussion

Table 2. Summary Results From Larsson et al. (2021)

Our research found that students come to the education and training experience with a range of preferences for learning modalities. Some students prefer any form of game over traditional instruction, others prefer only specific types of games over traditional instruction, and still others find gamified learning undesirable before ever experiencing it. This latter group should receive special attention as agencies determine whether to gamify education and training, especially if gamified methods are being considered as a full replacement for traditional methods. Voluntary participation is a key tenet in the concept of play. Researchers have found that mandatory play may remove the benefits from gamified learning (Furdu et al., 2017). Our findings suggest that gamified learning as augmentation may be the best approach for most situations and curricula. Our research utilized randomized assignment of students to gamified versus traditional methods. This may have negatively impacted the performance of those learners who are not predisposed to playing video games. Future studies should consider allowing for self-selection. Though this is contrary to most clinical between-groups study design recommendations, it may be the best way to capture the benefits of gamified learning for those who would self-select into the method. Agencies should be open to the idea of offering a variety of learning modalities to meet heterogenous student preferences.

We attribute the next important source of variation in outcomes to varied gamified and conventional learning environments. The four waves of research conducted at the 344th were limited in computational capabilities. We ran our games on Chromebooks versus gaming computers, which provide better graphics capabilities and smoother running performance. Based on comments from learners in the gamified environment at the 344th, this seemed to impact their experience with the game. Notably, students in our fifth wave of research at NPS utilized gaming computers. They reported enjoying the experience and had fewer complaints about game performance impacting their learning. Using appropriate technology to support gamified learning is a critical element to successfully deploying these instruction modalities. Additionally, players at the 344th were instructed to play individually with instructor observation, whereas NPS players were allowed to openly interact and engage in competitive practices with the MBA study team standing by for technical assistance. Taken together, these environmental variations could have meaningfully impacted students' performance.

Finally, we would point out that our waves show variation in short-term lesson retention across varied curricula. The curriculum for NPS covered federal category management principles using derivative learning (questions in the game were not exactly what was on the pre- and post-test but could help the player answer the post-test questions by deriving the information from questions within the game). The waves at the 344th used 1-for-1 questions: questions in the game exactly matched what players saw prior to and following the game. All versions of the game randomized the sequence of questions within the game such that the player could not simply memorize a pattern of answers to beat the game; however, the one wave in which gamification outperformed conventional methods relied on higher level of critical thought. This should be further studied, as it suggests that gamification can lead to greater improvements in higher-order learning when compared to conventional methods, perhaps by leveraging cognitive curiosity. Simple recall objectives may be more sensitive to other areas of variation, such as player predispositions toward games and environmental heterogeneity.

PLAYER EXPERIENCES

In our study, we explored a variety of measures of efficacy, player engagement, and player sentiment. The evaluation instrument contained multiple choice questions related to pre- and post-evaluation of student knowledge, five-point Likert scale–type agreement questions, and open-ended questions related to experience and satisfaction. Likert-based questions were used to assess favorability and quality of the training, confidence in participants' answers, and experience with video games. The open-ended questions asked about military experience, the player's most often played games, and open feedback on each type of training. A recommendation-based question was inserted to assess the Net Promoter Score (NetPS) for each participant. This score was based on how likely the respondent was to recommend these learning methods to a friend or colleague. We decided to use NetPS to directly compare favorability between the groups as it is a commonly used technique for product evaluation in industry. NetPS is a metric used in customer experience programs and measures the loyalty of customers to a company (Qualtrics, 2021). NetPS can give an instant indication of customer satisfaction, informing overall favorability (Jain, 2020). This data was collected in five waves (four at the 344th and one at NPS) during the second half of 2021 to align to active course schedules at both locations.

Table 3 shows the categories that were created to identify trends in the responses by learning groups. Treatment groups tended to attribute their NetPS to game design factors, while control groups overwhelmingly attributed their NetPS to method/modality preference. Interestingly, when it comes to Net Promoter Scores, for all 344th waves in which the control group outperformed the treatment group on test improvement medians, control groups also assigned a higher NetPS score than did treatment groups. This suggests that learners' satisfaction with the learning modality was partly a function of how well they learned the material.

A representative quote from 344-C (wave 3) demonstrates the importance of game design in conducting these studies and employing gamified education and training methods:

> If the idea of gamifying the learning environment is to take off, a larger investment needs to be put in the development and hardware aspects of the games. The game ran choppily, glitches occurred to many of my fellow students, and overall, the quality of the game itself played fairly poorly compared to what one would expect from a new experiment designed for learning.

Similarly, 344-B (wave 2) and the NPS wave 5, which had equal or greater improvement scores by treatment versus control groups, showed higher promotion for the game method versus the traditional method.

A representative quote from 344-B (wave 2) demonstrates a preference for gamified learning in the treatment group:

> I believe that gamification takes the mundane feeling out of learning. Death by PowerPoint is never a fun time for anyone, and it can make learning (and teaching) an arduous experience and task. Being able to break up that monotony with interactive games which utilize repetition and recall, I believe, would drastically improve test performance and overall opinion on the classroom environment. If you make individuals have a desire to come to class and be engaged (i.e., playing games, having fun, etc.) then they will be more eager to learn and have an overall more positive attitude towards the subject. I believe gamifying military education is a wonderful step in the right direction.

This may indicate that these samples were predisposed to the benefits of the gaming modality, which could have contributed to their post-testing improvement. Additionally, we found that many participants stated that they would use gaming to learn outside of class and that they felt that using game training methods would increase their job satisfaction. Finally, we would point out that the gaming literature discourages the idea of mandatory play (i.e., forcing subjects to play a game they do not opt into). Our prototype testing utilized random assignment of learners to treatment versus control groups. Although this is a "gold standard" practice in randomized control trials, in this case it may have negatively impacted the performance of those subjects who were not predisposed to playing video games. Future studies should consider allowing for self-selection, and agencies should be open to the idea of offering various learning modalities to meet heterogenous student preferences.

Theme	Definition
Active Learning	Mentions of different concepts of active learning (see Chapter III literature review) – Treatment group
Ease	Participant rated the experience based on ease of learning/information delivery – Treatment group
Game Design	Includes game genre, various gameplay mechanics, difficulty of gameplay, gameplay issues (bugs/glitches) – Treatment group
Instructor Delivery	Mentions of instructor delivering material effectively – Control group
Neutral	Comments did not provide significant insight to the reason for rating – Both groups
Opportunity for Feedback	Learning environment presents opportunity for immediate feedback. Respondent appreciates the opportunity for feedback and interaction with instructor – Control group
Perceived High Level of Learning	Respondent perceived their level of learning to be high – Control Group
Preference	Mentions of a preferred method/modality of learning i.e., visual learning, auditory learning, active learning, gamified learning etc. – Both groups

Table 3. Stated Reasons for Player Net Promoter Score Rating (Larsson et al., 2021)

GAMER TYPES

One of the most important lessons we have learned throughout our research is the role that gamer types may play in player perceptions of games and gamified learning experiences. Anytime a game is developed, it is important to consider a variety of player types. Most games do not entice every type of player. In 1996, Bartle created a taxonomy of player types based on a debate about what people wanted out of a multi-user dungeon (MUD) game (Bartle, 1996). Bartle summarized months of discussion on the topic into four sub-groupings of player types and their desires. Bartle (1996) found that people typically enjoyed four things about MUDs: achievement within game context, exploration of the game, socializing with other players, and imposition of one's will upon others. These four aspects were graphed using the source of players' interest as axes (see Figure 4).

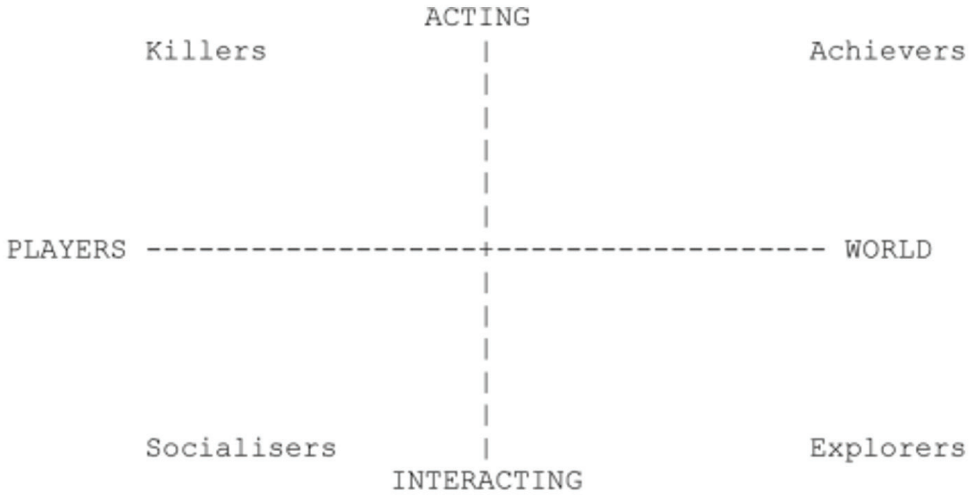

Figure 4. Bartle's Taxonomy of Player Types (Bartle, 1996)

This 2×2 taxonomy results in four types of players: killers (those with an interest in acting on other players), achievers (those with an interest in acting on the game world), socializers (those with an interest in interacting with other players), and explorers (those with an interest in interacting with the game world). The x-axis stems from an interest in *players* to an interest in the *gaming world*; the y-axis ranges from an interest in *interacting with other players* to an interest in *acting on other players* (Bartle, 1996). This typology can serve as a foundation for developing gamified contracting training, informing future game design and studies following our work. There are additional typologies that have emerged since Bartle's work in the 1990s. Our research points to a need to conduct a wide-ranging assessment of overarching player archetypes within DA to maximize the effectiveness of gamified education and training design.

In a short in-class test of DA gamer types, we found evidence that DA players were most likely to fall into the category of *achievers*, followed by a mix of *explorers/killers*, and were least likely to be *socializers* (see Figure 5). This is only based on a small sample of active-duty U.S. Air Force Contracting personnel at NPS, and given the low number of respondents, the types are essentially evenly split across an average DA player. But this is an early indication that each of Bartle's (1996) gamer types should be considered in DA game design efforts in the future. The students are officers competitively selected for higher education. They are more than likely pre-disposed to achievement orientation as well as a tendency to want to act on others versus with others. They may not represent the wider swath of DA personnel but may represent a prototypical officer within DA. Further research is needed to explore the various levels of heterogeneity in player types (officer/enlisted/civilian, active/reserve/guard, gender, experience levels, etc.) before a generalized finding can be reported.

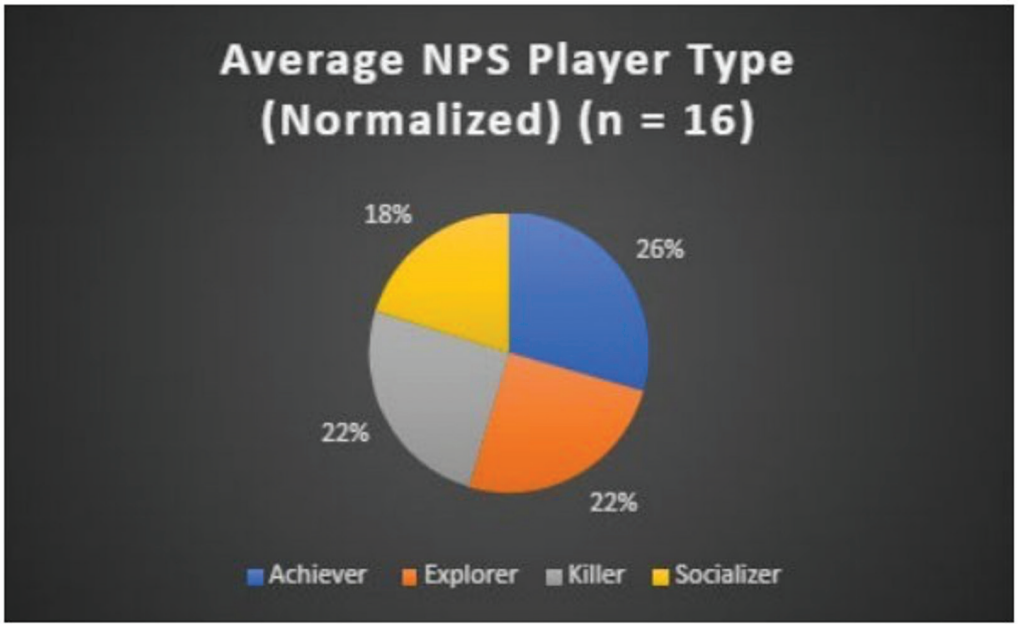

Figure 5. Normalized Prototypical Player Type, NPS DA Stuent (Larsson et al., 2021)

FUTURE STUDIES

We have found that gamified learning is a ripe area for future development, research, and investment in military education. Currently our team at NPS is working in the SILAS lab to build games related to acquisition sciences. We believe that these and other military specialty focused gamified learning opportunities should be explored. One avenue for future research is to explore how different types of games (e.g., first-person shooter, role playing games) can promote enhanced learning by appealing more closely to the preferences of the individual player. We anticipate a future in which a range of curricula are offered to students via a suite of gaming options, like the app store within Oculus. Table 4 provides a representative matrix concept. Matrix cells marked with an "x" currently have a game design effort complete or underway within our network of DA game developers.

	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						
Contract or 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						
Contract or 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				

Table 4. Notional Application Matrix for Defense Acquisition Subjects and Game Types

As our research and thinking has developed, we have discovered various cells within and outside of the DoD all working on developing games for promoting learning in military education. Currently this space is primarily filled by NPS, North Carolina State University, Defense Acquisition University, Defense Language Institute, and a small band of organic developers within the Air Force Installation Contract Center, each working independently with very little crosstalk. We are currently working with support from the Acquisition Research Program and Acquisition Innovation Research Center to explore further areas of research in DA gamified learning. Most notably, we plan to explore gamer types in DA communities, the potential dark side of gamified training and education, the use of virtual escape rooms for DA training and education, and the development of a tower defense game to meet DoD operational contracting support (OCS) learning objectives. The opportunity for collaboration on these and other gamification-related research is at our fingertips, enhancing the potential of game-based learning to become a reality for 21st century military education.

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