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Proto Prospectus

Proposal Abstract.

In recent years, the United States and its military re-focused on near-peer nation states as significant threats. This change led many senior military leaders to push for a transformation in the way military operations are planned and executed from a traditional domain-centric model to Multi-Domain Operations (MDO). MDO, in the words of James D. Campbell is "visualizing and executing operations with simultaneity and depth to dislocate the adversary and outpace his ability to respond." Implementing MDO into the military requires definition of the problem, shared visualization of the solutions, and relevant innovation. The study of Serious Games, a continually growing and maturing field, provides a framework for developing education tools that engage learners in various ways. Building on the proven results of serious games to excel at experiential and hands-on learning, we will offer a framework for using a serious game as an innovation tool. The research will present the theory, a research framework, and a serious of human subject research studies identifying the efficacy of using a serious game as an innovation tool. This research will contribute a method for creating and evaluating a serious game as a tool for innovation and framing a broad, undefined subject area.

Annotated bibliography.

[1] Campbell, James D., "Teaching Multi-Domain Operations: The Case of British Field Marshal William Slim." Real Clear Defense. 25 January 2018. RealClearDefense.com. Retrieved on 21 February 2019.

Campbell provides a recognized definition of multi-domain command and control and explains how the Air Force's Air Command and Staff College have altered their approach to embrace Multi-Domain Operations (MDO). The main point of the paper is to explain a historical example of the use of multi-domain thinking and innovation to accomplish military objectives. One key aspect of this article for my research is realizing other organizations who are active in MDO research and education and may provide both lessons learned and data gathering opportunities.

[2] Alberts, David S. "Multi-Domain Operations: What's New, What's Not, and the Implications for Command and Control." Institute for Defense Analysis (26 March 2018).

Alberts provides a historical look at Multi-Domain Operations to identify what must change and what is a continuation of past efforts or methods. He focuses on the integration of the virtual and social domains which have far reaching impacts. Specifically, some operations will now be unfamiliar to almost all operators leading to a greater synchronization of operations and effects.

[3] Yannakogeorgos, Panayotis A. and John P. Geis II. *The Human Side of Cyber Conflict Organizing, Training, and Equipping the Air Force Cyber Workforce*. Air University Press, Air Force Research Institute, Maxwell Air Force Base, Alabama (June 2016).

The authors analyze the current cyber workforce and suggest specific and wide-ranging recommendations for Air Force leaders to enact to improve training, retention, operations, etc. Some of their recommendations point to more engaging current and future service members with games to peak their interests and show their skills. Future games, such as the MDC2 Card Game could provide a recruiting aspect where top players are "interviewed" for their interest and eligibility to join the Air Force either through direct accession or a commissioning source.

[4] Blumberg, Fran C. *Learning by playing: Video gaming in education*. Oxford: Oxford University Press. 2014.

Blumberg analyzes how video games enhance learning in children. The book covers the work of 52 experts in 22 chapters examining the intersection of at least 8 disciplines. She identifies five key characteristics that make games appealing: interactivity, agency and control, identity, feedback, and immersion. Immersion leads to flow which is defined as "game play is perceived as all-absorbing and seemingly automatic despite the cognitive resources needed to master the game (pg. 5)." Specifically, in educational settings, games provide more opportunities for learning. Key takeaway for my research is the nature of games to teach children, especially as games allow them to explore their world. Also, she traces the popularity of the term Serious Game to 2002 with the launch of the US Army's America's Army video game and the Woodrow Wilson Center for International Scholar founding of the Serious Game Initiative.

[5] Giessen, Hans W. "Serious Games Effects: An Overview." *Procedia - Social and Behavioral Sciences* 174: 2240–44 (12 February 2015).

This paper provides a brief overview of the early serious game field and how it touched various fields including the military. It discusses how the field of serious games has moved beyond the teaching of facts and rote memorization to encompass other aspects of education such as teaching, training, and informing. The key takeaway is the summation of information and how serious games were used up until 2007 and the possible negative effects of serious games.

[6] Connolly Thomas M., Elizabeth A. Boyle, Ewan MacArthur, Thomas Hainey, James M. Boyle. "A Systematic Literature Review of Empirical Evidence on Computer Games and Serious Games." *Computers & Education*, 59(2): 661-686 (March 2012).

The authors conduct a thorough literature review and analyze 129 papers describing empirical evidence about the impacts and outcomes of computer and serious games. Through their research they developed a multidimensional approach for categorizing games. Most often, positive impacts of serious games was linked to knowledge acquisition and content understanding and affective and motivational outcomes.

[7] Boyle, Elizabeth A., Thomas Hainey, Thomas M. Connolly, Grant Gray, Jeffrey Earp, Michela Ott, Theodore Lim, Manuel Ninaus, Claudia Ribeiro, and Joao Pereira. “An Update to the Systematic Literature Review of Empirical Evidence of the Impacts and Outcomes of Computer Games and Serious Games.” Computers & Education, 94: 178-192 (2016).

As the title suggest, these authors followed Connolly’s work to update the literature and empirical evidence for the positive impacts and outcomes of digital and serious games. This study concludes, after examining 143 papers, that the games provided a range of affective, behavior change, perceptual and cognitive and physiological outcomes. The key takeaway is the summation of current research and their methods for a systematic approach to research on serious games.

[8] Rhodes, Rebecca. E., Jonathon Kopecky, Nathan Bos, Jennifer McKneely, Abigail Gertner, Franklin Zaromb, Alexander Perrone, and Jason Spitaletta. “Teaching Decision Making With Serious Games: An Independent Evaluation.” *Games and Culture*, *12*(3): 233-251 (May 2017).

This journal article shows the methodology and results of a rigorous empirical study to prove the efficacy of serious games compared to other forms of instruction. The study compares three serious games and a professional video designed to train participants about cognitive bias. A key takeaway are the robust methodology section, the description of control conditions, and an example for quality data analysis.

[9] Roozeboom, Maartje Bakhuys, Gillian Visschedijk, and Esther Oprins. “The Effectiveness of Three Serious Games Measuring Generic Learning Features.” *British Journal of Educational Technology,* 48(1): 83–100 (January 2017).

This article shows another empirical study examining generic serious games for learning in the classroom. The key takeaway is another example for setting up a quality experiment using serious games in a different environment.

[10] Squire, Kurt D. "Games, Learning, and Society: Building a Field." *Educational Technology*. 51-55 (Fall 2007).

Squire approaches the topic of serious games in 2007 from three perspectives: (1) popular gaming culture, (2) design of learning environments, and (3) examining educational practice in the technology boom. The article is mostly asking questions about to shape the serious game movement to make it more academically and educationally relevant. He writes, “Just what the mix of technologies associated with digital media will result in remains to be seen, but as the Games, Learning and Society Group (2006) argues, the shift seems to be toward understanding complex systems, and crucially, identifying leverage points within those systems where one can have potential impact.” This is definitely what I want to explore. He concludes by calling the serious game community to make sense of unknown questions by “employing commensurate research methodologies (pg. 54). ” This may be a foundational

paper for my research as Squire seems to suggest that games could be used to make sense of currently unknown questions (and answers).

Article Review:

Rhodes, Rebecca. E., Jonathon Kopecky, Nathan Bos, Jennifer McKneely, Abigail Gertner, Franklin Zaromb, Alexander Perrone, and Jason Spitaletta. "Teaching Decision Making With Serious Games: An Independent Evaluation." *Games and Culture*, *12*(3): 233-251 (May 2017).

This journal article shows the methodology and results of a rigorous empirical study to prove the efficacy of serious games compared to other form of instruction. The study compares three serious games and a professional video designed to train participants about cognitive bias. The study also used a control group that did not address the subject matter. The study was careful executed using a standardized test for all participants with rotating questions created by individuals not connected to the experiment. Additionally, independent validation and verification as well as multiple control conditions were implemented during the experiment design. The experiment examined the difference between procedural knowledge versus declarative knowledge. Procedural knowledge addresses *how* to do something (hands-on knowledge) while declarative knowledge focuses on *what* something is (tested knowledge). Both phases of the study demonstrate that serious games had advantages over video-based discussion when teaching procedural knowledge but performed equally well for declarative knowledge. Additionally, a subset of the games tested increased knowledge retention over time, 8 to 12 weeks in this case.

One clear strength of this study is rigor. The sample size (1,219 participants) is significant for human subject research studies addressing the efficacy of serious games. Also, the independent validation and multiple control conditions provide more confidence in the author's conclusions. Also, using multiple serious games in parallel ensured that poor game design did not significantly skew the results. Finally, the pre/post/delay test given to participants included attention check questions that allowed researchers to exclude participants who did not pass at least two of the items. There are a few weaknesses in the study. First, there is little discussion about the design elements of the serious games used for the study. An existing framework for serious game design could have been used to bolster discussion and identify the most effective elements. Second, no data is collected showing the participants proclivity to learn through games or the response to participants to either the instructional video or the game. Did participants who enjoyed their method of instruction score better on the standardized test? Finally, discussions of serious games do not necessitate the exclusion of other instructional materials and methods but are usually paired with traditional instruction to enhance the learning process. The study could have easily extended their study to include a group that both viewed the instructional video and played a serious game. Examining the use of serious games to engage military personnel is currently focused on pairing games with traditional instruction (where it exists) or attracting personnel who may have access to traditional instructional material, but do not take the time to engage with the material in order to learn.