Evaluating Adaptive Training for Teams using the Experience API

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ABSTRACT

The Army's Training and Doctrine Command (TRADOC) has described plans for modernizing Army training in documents such as the Army Learning Model (ALM, TRADOC PAM 525-8-2). The ALM calls for increasing the personalization of the soldier learning process so that training is tailored to the individual soldier throughout his/her career. In our previous efforts to address this goal, we conducted research to determine the extent to which using an adaptive training approach would improve soldier performance in unstabilized gunnery simulators. Using the Experience API (xAPI) data specification, performance data from an individual gunner was used to adapt crew training. We compared performance between crews that received an adaptive curriculum based on the gunner's performance in the individual gunnery trainer and crews that received a standard curriculum without adaptive elements. Our research suggests that using an adaptive training curriculum led to a significant reduction in the amount of time to train with comparable final qualification scores. While the data is promising, the applicability of the results is limited in that the crew training was adapted based on the performance of the gunner, not the entire crew. This paper describes the implementation of a fully adaptive crew curriculum and the study for validation with active duty soldiers. In addition to assessing training efficiency, we will assess the extent to which adaptive training improves team knowledge. We predict adaptive training will not only result in more effective training for the individuals in the crew but also for the crew as a cohesive unit.

ABOUT THE AUTHORS

Rodney Long is a Science and Technology Manager at the Army Research Laboratory, Human Research and Engineering Directorate, Advanced Training and Simulation Division in Orlando, Florida. He is currently conducting research in adaptive training technologies, including intelligent tutoring systems, architectures, authoring tools, etc. Mr. Long has a wide range of simulation and training experience that spans 27 years in the Department of Defense (DoD) and has a Bachelor's Degree in Computer Engineering from the University of South Carolina and Master's degree in Industrial Engineering from the University of Central Florida.

Ashley Medford is the Director of Government Services at Problem Solutions. She is an experienced program manager, specializing in the development and use of immersive technologies for Federal and Government education, training, analysis, and collaboration. Throughout her career, Ms. Medford has led various immersive learning technology programs and projects for major Government and Defense clients, including the Air Force Research Laboratory, United States (U.S.) Naval Air Systems Command, Army Research Laboratory, National Aeronautics and Space Administration (NASA), Office of Naval Research, U.S. Special Operations Command, and U.S. Central Command. Ms. Medford has provided consultation and program management for modeling, simulation, and virtual training and collaboration environments. She is also a member of the e-Learning Guild, the American Society of

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Gabriel Diaz the Project Manager for Government Services for Problem Solutions. He has 20 years of military experience in the Marine Corps. As an active duty enlisted Marine he served as a surface to air missile operator and electrical repair specialist. Upon his commission as an officer he executed duties as a communications and data network planner and operator. He was then selected to hold the duties as a Modeling and Simulation Officer where he developed a passion for developing simulation technology in support of live experimentation for the Marine Corps Warfighting Lab. He holds a Bachelor's of Business Administration degree in Management Information Systems from the University of New Mexico, and a Master's of Science in Modeling & Simulation from the Naval Postgraduate School. Gabriel has been an active participant in support to subcommittees for I/ITSEC on the Human Systems Performance and Training committees.

Jennifer Murphy is the Chief Executive Officer of Quantum Improvements Consulting, LLC. She has over 10 years of military selection and training research experience, with an emphasis on leveraging innovative technologies for improving training in a measurably effective way. Upon completion of her Ph.D. from the University of Georgia in 2004, Dr. Murphy took a position as a Research Psychologist at the U.S. Army Research Institute (ARI) for the Behavioral and Social Sciences. Her research focused on the development of technology-based selection and training measures for cognitive and perceptual skills. Dr. Murphy served as Director of Defense Solutions at Design Interactive, Inc., where she managed a portfolio of training and performance support efforts incorporating cutting edge technology into training solutions for defense clients. Her research has been featured in *The New York Times*, the Pentagon Channel, *Soldier* Magazine, and *Signal* Magazine.

Chad Ruprecht is a Research Fellow at Quantum Improvements Consulting. Chad's current research involves assessing the effectiveness of adaptive training systems on the individual and team level for Army clients. His skills include literature review, research design and execution, and data analysis. He has over five years of experience in designing, analyzing, and evaluating the learning process.

Tara Kilcullen is the Technical Director of Training Content & Analytics – Business Development at Raydon Corporation. Ms. Kilcullen has over 13 years of experience leading and managing cross-functional teams in the design and development of training and simulation systems with a focus on training technologies and development as well as data collection and analyses for both military and commercial systems. She helped drive the development and implementation of the understanding and adoption of Agile principles and Scrum processes both within her previous leadership roles within Engineering and other organizations at Raydon to include Business Development. Through the Agile and Scrum implementation these organizations were able to expand into better processes, metrics, and analyses, these organizations have gained numerous efficiencies revolving around planning, organization, execution, and quality. She holds several B.S. and A.S. degrees from University of Pittsburgh and Full Sail University.

Robert Harvey is the Director of Applied Training at Raydon Corporation. Mr. Harvey has over 20 years of experience developing training simulation systems with a primary focus on training effectiveness and performance data collection and analysis. His expertise and knowledge of training design, development and analysis enables him to guide the design, development, and application of technologies as they are applied to training courseware and training system development, to include a wide array of military and commercial training applications. He is also is one Raydon's primary architects and researchers specializing in the collection and analysis of simulation and training performance data. He holds a Bachelor of Science Degree in Aeronautical Engineering from Embry-Riddle Aeronautical University.

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INTRODUCTION

Training and education is a critical part of the military institution. With increasingly complex and uncertain combat environments, a focus on full-spectrum operations and readiness aims to ensure the military is equipped to face today's emerging threats. This requirement to maintain a constant state of preparedness, in combination with training budget constraints, has military leaders looking for innovative methods to enhance the efficiency and effectiveness of training and education. As a potential means to meet the challenges and intricacies that operational environments bring, the United States (U.S.) Army has been investigating the use of adaptive training environments (The U.S. Army Training Concept 2012-2020, 2011). In addition, adaptive training technology research directly aligns with the Army's initiatives to implement a comprehensive, learner-centric, career-long, adaptive learning model in support of the 21s[t] century soldier, as directed by the U.S. Army Learning Concept for 2015 (TRADOC, 2011).

When compared to traditional training approaches, research indicates that there are several benefits associated with the use of adaptive training technology (Durlach & Ray, 2011). While additional research is necessary to validate effectiveness findings, adaptive training has the potential to provide effective and cost-efficient training to both individuals and teams. In one instance, individual performance of trainees was leveraged to make interventions to the curriculum in order to maximize the understanding of the trainees' tasks (Landsberg et al., 2010). This method can be expanded to address adaptive team training within simulators. In order to achieve this objective, however, multiple systems must share performance data about individuals and groups using a common language. One mechanism to address this interoperability requirement is the Experience Application Programming Interface (xAPI).

Stewarded by the Advanced Distributed Learning (ADL) Initiative, the xAPI is an open source, technical specification, which provides a flexible means to describe and track learning experiences across multiple training modalities (Advanced Distributed Learning, 2014). Individual and group learning experiences are stored within a database known as a Learning Record Store (LRS). By storing these data in a central location, the xAPI offers the ability to gain greater insight into learning ecosystems via cross-system data interoperability. With the capacity to measure and analyze performance across simulators, the xAPI also enables training effectiveness evaluations, and in turn, the ability to identify a return on investment (ROI) for costly, adaptive training systems.

Currently, few training systems have incorporated the xAPI specification. To address this limitation, the Army Research Laboratory (ARL) developed a simple tool called Pipeline. A Microsoft.NET Dynamic Link Library (DLL) written in C#, Pipeline provides the ability for simulator vendors to quickly produce and track performance data using the xAPI specification. By providing a streamlined format that abstracts many of the implementation details, such as security and formatting, Pipeline reduces the complexity and time for training simulators to generate and consume xAPI data (Long et al., 2015). As such, training developers are able to quickly implement Pipeline in their current system(s) without any prior knowledge of the xAPI specification. This innovation has facilitated further research into the use of adaptive training systems using the xAPI.

ARL has other ongoing investigations exploring adaptive training using the xAPI. In a recent study on adaptive team training, individual performance data was leveraged to adapt team training in a gunnery simulator. More specifically, gunnery crew training was adapted based on the gunner's performance during individual training. If the gunner performed poorly during individual training, for instance, the team training for that gunnery crew would lower the difficulty and increase the number of training scenarios to accommodate the gunner's proficiency level. Conversely, if the gunner performed superiorly during individual training, the gunnery crew's team training would increase the difficulty and lower the number of training scenarios. Notably, this effort found an average of 40% less time and 60% fewer scenarios required for adaptive versus non-adaptive training groups, all while maintaining training effectiveness (Long et al., 2015). This unique instance of a one vs. one comparison between adaptive vs. non-adaptive training systems provides compelling evidence to support the usage of this technology for both individuals and teams. While these initial findings are compelling, further research is necessary to substantiate the identified ROI and benefits for adaptive team training.

In this paper, we describe a follow-on research effort to develop and validate a fully adaptive crew gunnery curriculum for the Unstabilized Gunnery Trainer – Crew (UGT-C^{TM}), based on the performance of the crew members during individual training in the Unstabilized Gunnery Trainer – Individual (UGT-I^{TM}). In the UGT-C^{TM}, crews are made up of a driver, commander, and gunner. While the driver plays a role in the training by responding to the commander's commands, the crew's qualification is not determined by his or her behavior. On the other hand, the commander has specific tasks and behaviors that directly contribute to the overall performance of the crew. As a result, the adaptive crew curriculum is based on a combination of both the commander and gunner's performance in individual training. The resulting training model is a first of its kind, combining both positions' performance data into an adaptive crew training curriculum.

ADAPTIVE SIMULATOR SYSTEMS

Raydon Corporation's Unstabilized Gunnery Trainers^{TM} (UGT) are simulation devices that enable units to train individual gunners, crews, and platoons in mounted machine gun platforms in accordance with (IAW) the current U.S. Army gunnery standards, i.e. TC 3-20.31 (Training and Qualification Crew) and FM 3-20.21 (Heavy Brigade Combat Team (HBCT) Gunnery). The UGT-I^{TM} (Figure 1) is a training system that uses virtual simulation to train and evaluate gunners on a wide range of mounted machine gun platforms, or unstabilized vehicle platforms, to include High Mobility Multipurpose Wheeled Vehicles (HMMWVs) and Mine-Resistant Ambush Protected (MRAP) vehicles. This training system provides the gunner with a fully functional, simulated M2 HB .50 caliber machine gun, turret traversing controls (manual traverse platform, joystick, and manual hand crank), a simulated heavy weapon thermal sight (HWTS), and a universal pintle mount with an attached traverse and elevation (T&E) mechanism. The UGT-I^{TM} places the gunner into a virtual environment with a synthetic crew, i.e. driver and commander, as well as a synthetic instructor. The gunner is expected to employ proper gunnery Requirement Performance Measures (RPMs) by interacting with the synthetic crew to acquire and destroy threats. The gunner's performance is assessed by measuring engagement times and proper responses to fire commands IAW FM 3-20.21 Gunnery.

Figure 1. Unstabilized Gunnery Trainer - Individual (UGT-I^{TM})

The UGT-C^{TM} (Figure 2) is a virtual training system that enables units to train and evaluate crews on a simulator capable of supporting a wide range of mounted machinegun platforms IAW the new TC 3-20.31. The UGT-C^{TM} provides simulated operating positions for the vehicle driver, commander and gunner, as well as an instructor/operator station (IOS). The crew's performance is assessed by measuring engagement times and proper responses to fire commands IAW FM 3-20.21 HBCT Gunnery. The vehicle gunner station from the UGT-I^{TM} is integrated and used with the driver and commander positions and has the same capabilities as the UGT-I^{TM}. All of the crew members and the instructor communicate using tactical vehicle headsets over a vehicle intercom system.

The instructor uses the IOS to register the crew, initiate the training session, select and monitor the training exercise, and perform an After Action Review (AAR). The AAR is completed with the crew using a scoring results page and an exercise playback capability. If an infraction is witnessed, the instructor also uses the IOS to record penalties to the crew score.

Figure 2. Unstabilized Gunnery Trainer - Crew (UGT-C^{TM})

Adaptive Training Curriculum

The UGT-I^{TM} has a library of exercises with a multitude of conditions and arrays that drive scoring IAW the published gunnery manuals. The following is a subset of these conditions:

- Target arrays
- Target movements
- Range to target
- Posture of firing vehicle
- Visibility

According to crew gunnery standards within the corresponding gunnery manual, there are prerequisites to live fire that each crew must meet. The crews are required to train to specific actions, conditions, and standards. The virtual exercises the user runs contain the appropriate prerequisite requirements in order to properly evaluate and score the user for each table. These requirements present specific threat numbers and threat postures designated by each Gunnery Table and Gunnery Table task. These scores are populated into the Gunnery Table Task Table (Figure 3). When the user's performance has met crew gunnery standards, a Gate to Live-Fire (GTLF) exercise is available for the user. This exercise simulates Gunnery Table VI qualifications and assesses the user's readiness level for live fire qualifications in accordance with the actions, conditions, and standards for that qualification table.

Task Table

		Table III Proficiency	Table IV Basic	Table V Practice	Table VI Qual
Task 0 VC Single/Sta		74 7 / 10	74 7 / 10	74 7 / 10	74 7 / 10
Task 1 VC Single/Sta		74 7 / 10	74 7 / 10	74 7 / 10	74 7 / 10
Task 2 Single/Sta		65 3 / 10	65 3 / 10	65 3 / 10	65 3 / 10
Task 3 Single/Mov		65 3 / 10	65 3 / 10	65 3 / 10	65 3 / 10
Task 4 Single/Sta (Degraded)		73 7 / 10	73 7 / 10	73 7 / 10	73 7 / 10
Task 5 Mult/Mix (Degraded)		75 4 / 10	75 4 / 10	75 4 / 10	75 4 / 10
Task 6 Mult/Sta					
Task 7 Mult/Sta					
Task 8 Mult/Mix					
Task 9 Mult/Mov					

Task Table

		Table III Proficiency	Table IV Basic	Table V Practice	Table VI Qual
Task 0 VC Single/Sta		85 8 / 10	85 8 / 10	85 8 / 10	85 8 / 10
Task 1 VC Single/Sta		78 8 / 10	78 8 / 10	80 8 / 10	80 8 / 10
Task 2 Single/Sta		85 8 / 10	85 8 / 10	85 8 / 10	85 8 / 10
Task 3 Single/Mov		85 8 / 10	85 8 / 10	85 8 / 10	85 8 / 10
Task 4 Single/Sta (Degraded)		81 8 / 10	81 8 / 10	81 8 / 10	81 8 / 10
Task 5 Mult/Mix (Degraded)		83 7 / 10	83 7 / 10	83 7 / 10	83 7 / 10
Task 6 Mult/Sta		83 7 / 10	83 7 / 10	83 7 / 10	83 7 / 10
Task 7 Mult/Sta		78 8 / 10	78 8 / 10	78 8 / 10	78 8 / 10
Task 8 Mult/Mix		78 8 / 10	78 8 / 10	78 8 / 10	78 8 / 10
Task 9 Mult/Mov		80 8 / 10	80 8 / 10	80 8 / 10	80 8 / 10

Figure 3. UGT-I Skill Progression Using Gunnery Table Task Tables

The UGT-C™ curriculum (Figure 4) consists of a library of exercises that contain Pre-Live Fire (PLF), Gunnery Tables, and GTLF exercises. The PLF exercises train and assess the proficiency and readiness level of the crew, primarily the gunner and commander. Upon completion of the PLF training curriculum, the crew progresses to the Gunnery Tables beginning with Gunnery Table II through Gunnery Table V. Once the crew has run through the Gunnery Tables, they are then progressed into the GTLF exercise to determine the crew's readiness to go into live fire qualifications.

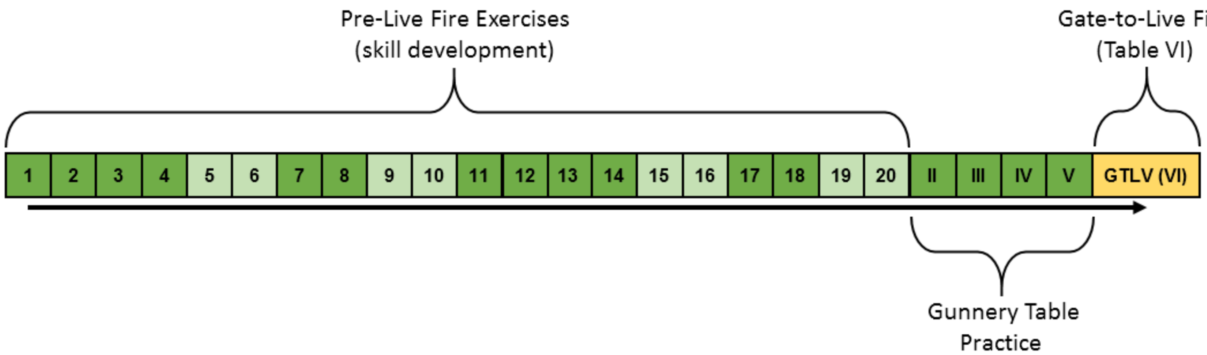

Figure 4. UGT-C™ Crew Training Program

An adaptive training curriculum, based on the crew gunnery standards IAW TC 3-20.31, was developed for the crew training program. The adaptive curriculum uses the gunner's training records from the individual training program and applies an algorithm giving credit for tasks and conditions where the gunner showed proficiency. After the credit is applied, the crew will progress through a modified training progression based on the skills in which the gunner needs improvement. Regardless of crew scores and qualifications, the crew is required to perform and pass Gunnery Table V prior to firing GTLF. This allows for a final assessment on the crew's readiness to begin the GTLF exercise. If there are any issues that arise during this exercise where the crew receives substandard scores, the program and/or instructor may not allow them to progress to GTLF instead having the crew re-run one or more of the practice exercises. Figure 5 demonstrates an example of how the adaptive crew training curriculum responds to a gunner's individual performance record.

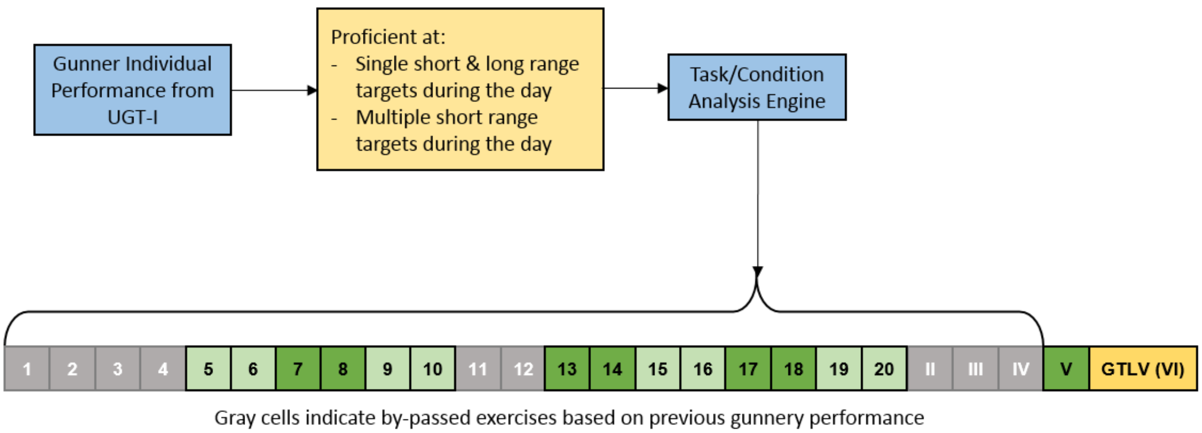

Figure 5. Example Application of Adaptive Crew Training Program

Performance Assessment

The gunnery engagement evaluation criteria specified in the HBCT gunnery manual (FM 3-20.21) is leveraged to evaluate gunnery performance. Each engagement fired receives a score between 0 and 100 points. The scores are calculated from a group of tables that use a combination of factors: firing vehicle's postures, the target type, target movement, target range, and the time that the target is destroyed. These factors' points are summed to determine if the engagement is qualified/passed, which is achieved by scoring 70 or more total points. Conversely, the engagement is assessed as unqualified if one or more targets in the engagement receive a score of less than 70 points. Additional penalty points may be deducted if the gunner fails to respond to fire commands correctly during the firing engagement.

A pass/fail status is assigned at the end of a UGT-I™ or UGT-C™ exercise. A pass is provided if 70% or more of the available points are earned and 70% or more of the presented engagements are qualified. If either of these conditions are not met, the exercise receives a fail status. For any GTLF exercise completed on the UGT-I™ or the UGT-C™, a qualification status is calculated using the total engagement points and the number of qualified engagements. Table 1 summarizes the qualification ratings for GTLF exercises based on these specific score and engagement conditions.

Table 1. Gate-to-Live Fire Qualification Ratings

Qualification Rating	Score and Engagement Conditions
Distinguished	The crew obtains a score of 900 to 1,000 points with 70 or more points on 9 of the 10 tasks.
Superior	The crew obtains a minimum score of 800 points with 70 or more points on 8 of the 10 tasks.
Qualified	The crew obtains a minimum score of 700 points with 70 or more points on 7 out of 10 tasks.
Unqualified	The crew obtains a combined score of 699 or fewer points, or 69 or fewer points on 4 or more of the 10 tasks.

METHODOLOGY

Participants

A total of up to 100 active duty soldiers will participate in the UGT-I™, UGT-C™, and Live Fire training. These soldiers will be assigned positions within a gunnery crew by their leadership as part of their ongoing training, or will be established crews who have served together previously. Each crew will consist of a gunner, a commander, and a driver. Twenty soldiers will be assigned to each of the four crew training conditions. Some soldiers may have no previous experience with Army gunnery or gunnery simulations, whereas some soldiers will. We plan to assess previous experience in a demographics survey. Potential participants will be notified of the possibility of participation through their chain of command, and will be asked to participate in this research. Participation in this research will be part of each soldier's regular qualification sequence on the unstabilized gunnery platform. The sample size for this experiment is constrained by access, although a power analysis indicated a sample of N =100 to be sufficient to demonstrate significant effects of our manipulation that involve 4 conditions.

Apparatus

We will first collect demographic data about our participants in order to control for differences between participants that may affect performance in the simulator using a questionnaire developed for this research. Then, individual and crew training will be conducted using Raydon's UGT simulators. These simulators are housed in Raydon's Virtual Combat Operations Trainer (VCOT), a 53 foot-long commercial semi-trailer with 8'6" width and 13'6" height. After simulator training, the soldiers will conduct their routine gunnery qualification exercises on a live-fire range. The live-fire exercise will serve as the soldier's actual training qualification event, as described in the Army field manual for live fire exercise and testing of unstabilized gunnery apparatus.

Method

Gunners and Commanders will first complete the individual gunnery curriculum in the UGT-I™ simulator. In the UGT-I™ simulator, each participant trains as the gunner in a HMMWV, regardless of their future assignment (Gunner, Commander) within crew training. The simulator presents 23 desktop-based scenarios involving engagements with stationary and moving targets to students in a prescribed curriculum based on Army gunnery tables. The scenarios present the trainees situations varying by target range, movement, and offensive versus defensive position. In these scenarios, the participants' tasks include initiating and responding to verbal commands, target acquisition, and loading, firing and clearing a simulated weapon. Over the course of the training, the participant receives auditory feedback coaching from the simulator. The simulator provides an adaptive curriculum that enables trainees to skip ahead to more difficult scenarios based on their performance.

In the UGT-C™, participants will be further developing the skills they have learned in the UGT-I™ in the context of a crew consisting of a driver, commander, and gunner. The participants will receive scenarios in the same format using the same equipment as the UGT-I™, and the participants' tasks will be the same. Gunner and/or commander performance data from the UGT-I™ will be used as the basis for adaptive placement within the training curriculum in the UGT-C™ for the participants in the adaptive conditions, however, in some conditions, gunner, commander, or both will receive standard training not adapted to previous UGT-I™ performances. The crew will participate in a subset of the training scenarios followed by a GTLF exercise, which will serve as a final transfer exercise.

Each participant at the completion of crew training will be administered a brief 15-item scale called the Transactive Memory Scale (TMS; Lewis, 2003; Marques-Quinteiro, Curral, Passos, & Lewis, 2013). The TMS measure gauges each participant's current assessment of their own team's performance along three key dimensions: 1) Specialization (e.g., "do my crew members hold specialized knowledge of their individual role"?); 2) Credibility (e.g., I was confident relying on the information provided by my fellow team members); and 3) Coordination (e.g., "our crew had very few misunderstandings about what to do").

Procedure

In this research, we plan on comparing performance between four groupings of inexperienced gunners and/or commanders receiving either adaptive or non-adaptive versions of training on the UGT-C™. Table 2 illustrates the experimental method. We first plan to administer adaptive UGT-I™ gunnery training to a group of participants (gunners and commanders). In Phase 2, for one fourth of the crews, UGT-C™ training will be based on the both gunner's and commander's previous performance in the UGT-I™. In another fourth of the crews, the crew will receive adaptive UGT-C™ training based on the gunner's UGT-I™ performance. Another fourth of the crews will train based on the only commander's UGT-I™ performance. The final fourth of the crews will receive non-adaptive crew training. After completing Crew training, all soldiers regardless of condition or role (Commander, Gunner, or Driver), will complete the TMS survey. In phase 3, all three-person crews will participate in a live fire exercise.

Table 2. Experimental Conditions

Condition	Crew Training
Standard	No adaptive training
Gunner-Only	Adapted based on Gunner's performance in individual training
Commander-Only	Adapted based on Commander's performance in individual training
Fully Adaptive	Adapted based on both Gunner and Commander's performance in individual training

At the start of each curriculum set, participants will be given an overview of how to use the equipment by an instructor and a safety brief. The instructor will be an employee at Raydon and will remain constant throughout the experiment. The instructor will answer any general questions prior to the start of the experiment; participants will be asked to keep questions and discussion during the experiment to a minimum. After the participant is familiarized with the apparatus, the instructor will load the UGT-I™ curriculum into the trainer. The participant will complete the training curriculum. Each training session is expected to take 2-3 hours, and time in the trainer will be capped at 3 hours to reflect the real constraints of simulation-based training on soldiers. The individual training should be completed for all participants in one day, using multiple UGT-I™ simulators. Data are collected and scenarios are adjusted automatically by the UGT-I™ simulator. During individual training, we expect no differences between crews in the UGT-I™ training in terms of time to completion, scenarios to qualification and qualification scores.

On a subsequent training day, the participants will complete the UGT-C™ training using the same apparatus. The participants will perform the role of the driver, commander, or gunner in the UGT-C™. The crew training will take one half-day session to complete. Training in each session will be limited to 3 hours. At the conclusion of their prescribed training curriculum or training time, all crews will fire a GTLF exercise until they achieve a qualifying score that satisfies the required prerequisites for live-fire gunnery. Specifically, soldiers from all four groups must run as many exercises as needed to achieve a score of at least 700 points and 7 qualified engagements. While we expect the adaptive training condition to move more quickly than the non-adaptive condition, due to individual differences in skill, it is still likely that not all participants will complete the training in its entirety. During the crew training, performance is scored by an instructor, who will be pre-identified and will remain constant throughout the experiment.

During crew training, we hypothesize that adapting training for both the gunner and commander will provide advantages in terms of time to completion, number of scenarios required to reach criterion, and overall performance compared to groups receiving no adaptive crew training, or crews in which only one member receives adaptive training. In addition, we predict that crews with two members receiving an adapted UGT-C™ curriculum will show higher TMS scores than crews in the other three conditions. Finally, in live fire training, we hypothesize that crews with members who have received adaptive crew training will receive higher final qualification scores than those who did not, with the crews including two members who received the adaptive curriculum showing higher live-fire qualification scores than crews in the other three conditions. We anticipate that crews with the highest scores on the TMS will display the strongest performance during live-fire training.

CONCLUSION

Training is necessary to maintain a world class fighting force. With constant pressure to reduce defense budgets, the military must find ways to do more with less. Often, adaptive training can result in improved learning of the material presented, or comparable learning in a shorter amount of time. Our research on data interoperability has shown that training can be adapted from one system to another, based on the leaner's performance, providing more efficient training. Specifically, prior research for adapting training based on a soldier's prior performance, suggests that the Army stands to gain considerable cost savings with no loss in training effectiveness.

Overall, our research serves to demonstrate the power of the xAPI specification as a means of standardizing military training performance data. Through widespread adoption of the xAPI, performance data can be shared across training platforms, generating an increase in the return on investment. Furthermore, this emerging capability will enable tailoring of training throughout the career of a soldier at the units to which he or she is assigned. Ultimately, our follow-on research will serve to validate initial findings and provide supplemental evidence for adapting training for teams using the xAPI.

REFERENCES

Advanced Distributed Learning (2014). Training and Learning Architecture (TLA): Experience API (xAPI). Retrieved from http://www.adlnet.gov/tla/experience-api.

Cannon-Bowers, J. A., & Salas, E. (2001). Reflections on shared cognition. *Journal of Organizational Behavior Special Issue: Shared Cognition*, *22*, 195–202.

Department of the Army Training and Doctrine Command (TRADOC) (2011). TRADOC PAM 525-8-3, The U.S. Army Training Concept 2012-2020. Washington, D.C.: Department of the Army.

Department of the Army Training and Doctrine Command (TRADOC) (2011). TRADOC PAM 525-8-2, The Army Learning Concept for 2015. Washington, D.C.: Department of the Army.

Durlach, P. J., & Ray, J. M. (2011). Designing adaptive instructional environments: Insights from empirical evidence (ARI Technical Report 1297). Arlington, VA: U.S. Army Research Institute.

Hruska, M., Amburn, C., Long, R., & Poeppelman, T. R. (2014). Experience API and Team Evaluation: Evolving Interoperable Performance Assessment. Proceedings of the Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC). Orlando, FL

Landsberg, C.R, Van Buskirk, W.L., Astwood, R.S., Mercado, A.D, Aakre, A.J. (2010) Adaptive Training Considerations for Use In Simulation Based Systems. *Naval Air Warfare Center Training Systems Division: Special Report*. p.9

Landsberg, C.R., Astwood, R.S., Van Buskirk, W.L., Townsend, L.N.; Steinhauser, N.B., & Mercado, A.D. (2012). Review of adaptive training system techniques. *Military Psychology*, 24:2, 96-113.

Lewis, K. (2003). Measuring transactive memory systems in the field: Scale development and validation. *Journal of Applied Psychology*, *88*(4), 587–604.

Long, R., Hruska, M., Medford, A.L., Murphy, J.S., Newton, C., Kilcullen, T., & Harvey, R.L. (2015). Adapting Gunnery Training Using the Experience API. Proceedings of the Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC). Orlando, FL

Kraiger, K., & Wenzel, L.H. (1997). Conceptual development and empirical evaluation of measures of shared mental models as indicators of team effectiveness. In M.T., Brannick, E. Salas, & C. Prince (Eds.) *Performance assessment and measurement: Theory, methods, & applications* (pp.63-84). Mahwah, NJ: Erlbaum

Marques-Quinteiro, P., Curral, L., Passos, A. M., & Lewis, K. (2013). And Now What Do We Do? The Role of Transactive Memory Systems and Task Coordination in Action Teams, *17*(3), 194–206.

U.S. Army Training and Doctrine Command. The United States Army Learning Concept for 2015. Fort Monroe, VA, 2011.