Enhancing Soldier-Centered Learning with Emerging Training Technologies and Integrated Assessments

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ABSTRACT

The Army Learning Model (ALM) discusses the importance of using valid and reliable assessments in training technologies. It specifically mentions the use of pre-tests to tailor training and post-tests to ensure that learning has occurred to a standard. However, other than these recommendations, the ALM does not address how assessments should be designed, delivered, and otherwise used to maximize Soldier training. Questions regarding which type of assessment should be used, the optimal frequency of assessment, and how to automate assessment in collaborative problem-solving scenarios remain to be answered. To address these issues, the U.S. Army Research Institute (ARI) and ICF International developed prototype training that provides a test-bed for conducting research on assessment strategies with maturing training technologies. The training content, which teaches Soldiers how to operate a common piece of signal equipment, is delivered via a mobile device, virtual classroom and game-based training platform. The mobile training focuses on declarative knowledge and covers basic terminology and principles for operating the radio; the virtual classroom covers more advanced procedures topics; and the collaborative scenario serves as a capstone exercise where Soldiers apply the knowledge they gained from the mobile and virtual classroom in a team-based problem-solving task. Assessments are integrated within each training platform to track learning. This paper discusses the development of the prototype training and assessments, including a discussion of the prototype concept, the instructional design approach we used to develop the training and corresponding assessments, and the technology considerations and constraints. Then, we describe the results of a beta test that examined the validity and usability of the training platforms and assessments. We conclude with a discussion of future research, which examines critical questions regarding the design and delivery of assessments within the prototype training.

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INTRODUCTION

The Army Learning Model (ALM) sets forward an agenda for innovation in Army training where instructor-centered training is replaced by learner-centered training (TRADOC, 2011). Rather than limiting training to specific timeframes and locations, the ALM calls for a training system that can be accessed at the 'point of need' and one, "...that extends knowledge to Soldiers at the operational edge, is capable of updating learning content rapidly, and is responsive to Operational Army needs" (TRADOC, 2011, p. 16). Furthermore, it calls for training to be tailored to the needs of the learner in order to maximize training efficiency and effectiveness. A key element of this vision is the use of distributed learning technologies including mobile, virtual, and game-based training platforms to support learning at the point of need. Another critical piece is the integration of assessments within these technologies to ensure learning has occurred to a standard and training is tailored to the learner's level of experience and competence.

Technologies that facilitate the type of learner-centered training advocated by the ALM are advancing quickly. For example, researchers cite a number of potential advantages of using mobile learning technologies for training and education, such as giving learners more flexible access to learning materials, which can increase learning gains (c.f., Holden & Sykes, 2011; Norris & Soloway, 2004; Rochelle & Pea, 2002), and providing a means for assessing performance. However, researchers are only beginning to investigate optimal use and effectiveness of these types of technologies for these purposes.

The educational and training literature also discusses the benefits of leveraging simulated and virtual learning environments (SLE/VLE) and videogames for training. Specifically, research shows that VLEs and games can lead to increases in trainee motivation and engagement, thus increasing the desire to learn, the desire to practice, and other training related outcomes (Mautone, Spiker, Karp, & Conkey, 2010; Topolski, Leibrecht, Cooley, Rossi, Lampton, & Knerr, 2010). Further research shows that embedding and delivering assessments within these environments is critical for learning (Bedwell & Salas, 2010; Johnson & Mayer, 2009). Still, questions regarding what type of assessment should be used, the frequency of assessment delivery, and how to best automate assessment in VLEs for collaborative problem-solving scenarios remain to be answered. Research into these areas is required if the Army's vision for a Soldier-centered learning environment is to succeed.

In response to these needs, the U.S. Army Research Institute for the Behavioral and Social Science (ARI), in collaboration with the U.S. Army Research Laboratory's Simulation and Training Technology Center (ARL-STTC) and ICF International, have developed prototype training that provides a test-bed for conducting research on assessment strategies in maturing learning technologies, including mobile devices, virtual classrooms, and SLE/VLEs. This paper provides a case study documenting the development of the training and assessment prototypes. We include a discussion of the prototype concept, the instructional design approach used to develop the training and corresponding assessments, the technology considerations and constraints, and the assessment strategy used within each training platform. We also discuss the results of a beta test that captured Soldiers' reactions to using the prototypes in an institutional training setting. The paper concludes with a discussion of our current line of research.

PROTOTYPE CONCEPT

The content selected for this project involved the assembly, configuration, programming, and operation of a widely used combat radio, the AN/PRC-148 Joint Enhanced Multiband Inter/Intra Team (JEM) radio. Currently, training on the JEM is conducted over the course of one day at the Signal Regimental Non-Commissioned Officer (NCO) Academy at Ft. Gordon, Georgia. During the one-day course, a class of approximately 30 NCOs participates in PowerPoint-based didactic instruction, followed by hands-on practice with the radio. At the conclusion, students take an open-book test to determine whether they pass or fail the course. The goal of this project was to transition this training content to a VLE, leveraging mobile, virtual classroom, and collaborative technology, and to integrate learning assessments throughout the training.

In transforming the JEM training from classroom-based instruction to mobile, virtual, and collaborative training (and the corresponding suite of assessments), the team used an integrated approach. Our concept for the training and assessments was for the training presented in each platform to build upon one another and for the assessments to track learning within and between modules. Specifically, a computer adaptive test (CAT) is used to track learning progress between the mobile and the virtual classroom training. Interim assessments, referred to as check on learning activities are used to measure learning within each platform. A collaborative, capstone-like exercise is used to measure learning and performance at the end of training at both the individual and team levels. All components are coordinated and aligned using an overarching instructional systems design (ISD) map and a comprehensive technology architecture plan. All portions of the training are integrated into the Soldier-Centered Army Learning Environment (SCALE), a prototype data-driven training architecture and learning management system (Mangold, Beauchat, Long, & Amburn, 2012). Figure 1 provides an overview of our concept.

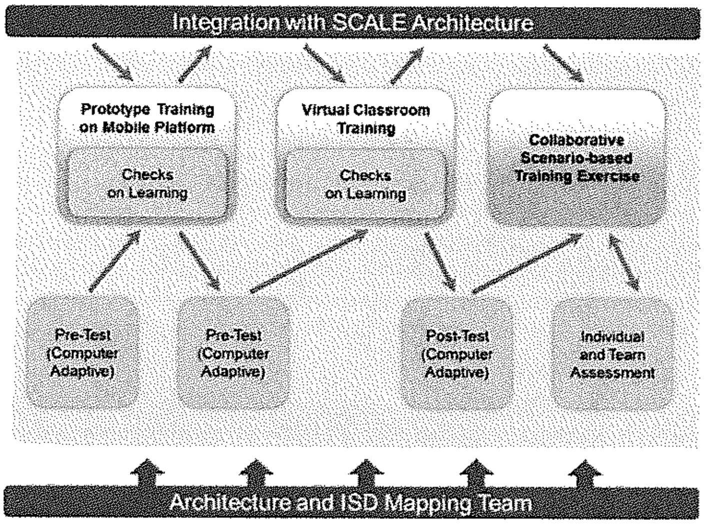


Figure 1. Prototype concept.

Critical to the success of this effort were an adherence to sound instructional design, integration of employed technologies, and use of an assessment strategy that mapped closely to the learning objectives and to the goals of the ALM. Our approach to these three dimensions is described in the sections that follow.

INSTRUCTIONAL DESIGN APPROACH

SLE/VLEs can only reflect ISD principles if they are designed using those principles. A critical component of this effort was that all assessment components and all training components were carefully planned and aligned. One of the first tasks was to identify (and in some cases modify) the learning objectives related to the assembly, configuration, programming, and operation of the JEM. The learning objectives were decomposed into terminal, subordinate, and enabling objectives that were visually depicted on an ISD map.

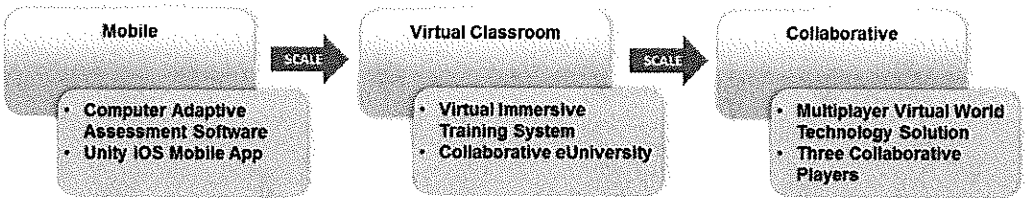
The ISD map was used as a blueprint for many segments of the training development process, as it visually depicted the concepts that were to be trained, the sequencing of content, and the training delivery platform for each objective. The map was also used to identify missing learning objectives and to determine which objectives were out of scope for our specified audience. In addition, it illustrated which aspects of the training program covered declarative, cognitive, psychomotor, or procedural objectives.

In the case of the JEM training, the ISD map revealed three terminal learning objectives that progressed from learning basic features and components of the radio, to demonstrating how to operate the radio, and finally to troubleshooting the radio. Each terminal objective was decomposed further into subordinate objectives. In addition, the map was used to align assessments with training content. Specifically, we identified four primary content domains that spanned across the learning objectives (e.g., Terminology and Specifications, Functionality/Basic Procedures, Complex Procedures, and Troubleshooting). These will be described in the assessment approach.

The ISD map also enabled the team to determine which learning objectives were best taught in an informal manner, using a self-directed mobile platform, in a more guided manner, using a virtual classroom platform, and in a collaborative manner, using a multi-player virtual environment. The learning objectives that were declarative in nature or moderately demonstrative (i.e., Identify the battery latch and explain when it is used and how to use it) were determined to be more conducive to the mobile platform as this medium can be used to present didactic content and interactive assessments (i.e., multiple choice quizzes, interactive radio tasks). The objectives that involved programming the radio were determined to be conducive to the virtual classroom, as an instructor would be able to demonstrate how to manipulate the radio for more complex concepts. Finally, those objectives which were more evaluative in nature and required critical thinking were aligned best with the collaborative scenario.

TRAINING TECHNOLOGY DEVELOPMENT APPROACH

While the ISD map was being created to serve as a blueprint for the content, we also developed a parallel technology architecture plan to support the integration of the mobile, virtual classroom, and collaborative training and assessment technologies. A goal of our development approach was to create consistency between all of the prototype components while capitalizing on the unique features each training and assessment mode provided. This was important for creating a cohesive user-experience, and for developing valid assessments and effective training. Figure 2 provides a high-level outline of our technology architecture.



Mobile

- Computer Adaptive Assessment Software
- Unity IOS Mobile App

Virtual Classroom

- Virtual Immersive Training System
- Collaborative eUniversity

Collaborative

- Multiplayer Virtual World Technology Solution
- Three Collaborative Players

Figure 2. High Level Architecture

The first step in our technology development approach was to determine which technologies would best support the training and assessment methodology. In order to generate a cohesive and uniform approach to development, we evaluated technologies that adhered to the following criteria:

- *Use a 'Build Once" approach to development*: The technology framework supported multiple platforms including mobile, web, and personal computer
- *Choose thin client systems with efficient load and run times*
- *Minimize language integration*: The number of computer programming languages used in this development was be held to a minimum to simplify the development process
- *Use DoD accredited technologies and standards to the extent possible*: In order to build towards a system that can rapidly transition to operational use, the technology must generate approved Certificate of Networthiness (CoN) content.

Based on the above criteria, a training framework was designed and implemented as three separate, yet integrated, applications – a mobile iOS application, a virtual classroom, and a collaborative multiplayer virtual world. The framework was designed to share content, assessments, and scores across the three platforms. For example, a learner may embark on mobile training as a prerequisite and scores on the mobile training post-test would inform the item selection for the virtual classroom post-test. Assessment scores from each platform were stored in the SCALE prototype learning management system, which provided a method for tracking and evaluating student learning skills.

Mobile Application

The mobile application (see Figure 3) was designed to teach introductory facts and concepts regarding the radio through a combination of didactic learning content and simple hands-on use of a virtual radio. Although the training was designed to run on iOS devices, specifically the iPad, the core content and technologies are portable to other tablet devices, web-based and stand-alone PC and Mac environments. A key feature in the application is a functional 3D model of the JEM. This model allows the user to practice functions with a simulated radio. For example, a learner using the iPad application is able to program the radio by actually pressing the buttons on the virtual radio. The model was leveraged throughout all modes of training and the assessments.

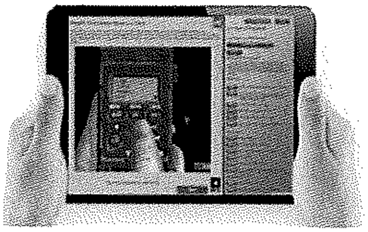


Figure 3. Mobile Application

Virtual Classroom Application

The virtual classroom technology extends aspects of the core mobile application to include the ability to share and deliver content in a 'virtual schoolhouse' style interface (see Figure 4). An instructor can lead the virtual classroom course using text chat, voice over IP, and has the ability to both manipulate a virtual radio and share content with students in the classroom. Students can communicate with the instructor, interact with course material, and complete assessments throughout the course. Once again, all performance data is stored in the SCALE architecture and the 3D model of the radio was leveraged throughout.

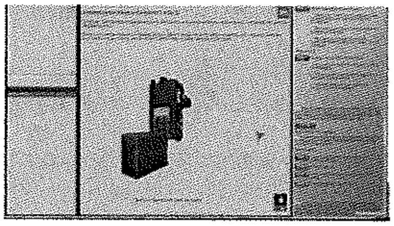


Figure 4. Virtual Classroom

Collaborative Application

The collaborative scenario was developed so that students can apply the information learned from the mobile application and virtual classroom. The collaborative application extends features of the mobile application and virtual classroom to include realistic scenario-driven vignettes where students work in teams to collaboratively resolve issues related to manipulating and troubleshooting the JEM radio (see Figure 5). The training and assessment technologies utilized in the virtual classroom and mobile app were also leveraged in the collaborative technology framework. This facilitated consistent user-interface experience, reduced cognitive load, and minimized development cost.

Figure 5. Collaborative Scenario

ASSESSMENT APPROACH

A primary purpose of this effort was to develop a suite of assessments that could measure learning progress, provide feedback in order to support and reinforce learning, be integrated into the training technologies, and be utilized for future research. The suite of assessments developed included a CAT administered at three points throughout the training and interim assessments (called "checks on learning," adopting a term frequently used in Army training) that were administered periodically within each training platform. It also included a collaborative-scenario that served as a capstone assessment exercise. In response to the vision set out by ALM, the CAT was designed such that the test could eventually be used to allow learners to test-out of portions of the training, while the interim assessments and the scenario-based collaborative exercise were designed such that instructors would be able to ensure learning occurred to a standard. The three types of assessments, and our approach to developing each, are described in detail below.

Computer Adaptive Testing

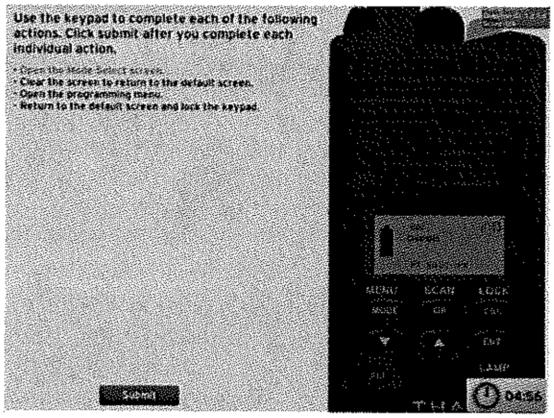
To complement the mobile device training and the virtual classroom modules, we developed a CAT to be implemented at different time points for evaluating learning progress. Specifically, the CAT was designed to serve as the pre- and post-tests at the beginning of the mobile training, upon completion of the mobile training, as well as after the virtual classroom training.

We employed item response theory (IRT) and adaptive testing principles as the base psychometric technology for the CAT (Harvey & Hammer, 1999). One advantage of IRT is that scoring does not require trainees to receive the same sequence of items; instead a subset of items is chosen from an item pool to gauge levels of competency. Consequently, trainees can take an assessment more than once without seeing the same exact items. In addition, a CAT maximizes testing efficiency by identifying the most diagnostic items for each trainee using adaptive item selection. This technique can reduce test length by approximately 50% without losses in measurement precision (Weiss & Kingsbury, 1984).

Development of the computer adaptive test. The CAT item pool was designed to vary sufficiently in difficulty to accurately assess individuals across all proficiency levels in every content domain relevant to the JEM training. To achieve this goal, we first reviewed the JEM ISD Map and, based on the subordinate learning objectives, synthesized the content into four main content domains: Terminology and Specifications, Functionality/Basic Procedures, Complex Procedures, and Troubleshooting. A test plan for each domain was developed based on the enabling learning objectives identified in the JEM ISD Map. This plan was used to guide the development of test items. For each domain, we developed a subset of draft items that varied in difficulty (easy, medium and difficult). Then, instructors at Ft. Gordon rated the relative level of difficulty of each item on a 7-point scale from very-low to very-high; these ratings served as the item-level parameters in the CAT. Items were further validated in a subject matter expert (SME) review workshop, finalized, and then loaded onto the CAT technical platform for implementation into the training.

Checks on Learning

In addition to the CAT, we developed a series of interim assessments (check on learning activities) to track learning within the mobile and virtual classroom applications. The purpose of the check on learning activities was to measure understanding of the previously presented training material, provide an opportunity to practice applying the knowledge, and provide feedback as the learner completed the training. The check on learning items were developed with the same technology used in the mobile and virtual classroom trainings, including a 3D model of the JEM. One goal in creating these assessments was to leverage simulation technology to create higher-fidelity assessment items than more traditional formats (like multiple-choice) often afford. For example, the assessment item displayed in Figure 6 requires students to program a virtual JEM radio. Students interact with the virtual radio in much the same way they do a real radio; they press and hold buttons and manipulate the radio's attachments and positioning. The technology assesses student performance and provides feedback an incorrect answer is submitted.



Use the keypad to complete each of the following actions. Click submit after you complete each individual action.

- Open the Mode Select screen.
- Clear the screen to return to the default screen.
- Open the programming menu.
- Return to the default screen and lock the keypad.

Figure 6. Example Check on Learning Item

Development of mobile checks on learning. For each enabling learning objective in the mobile training, we created a bank of check on learning assessments. These assessments were administered at roughly equal intervals throughout the mobile and training and varied in length from 2 to 11 items. Each check on learning assessment only focused on content covered in the training that immediately preceded that assessment, and learners were not allowed to go back to previous training content after beginning a check on learning assessment. The assessment items were developed in seven different formats. These formats were designed to provide learners with a variety of item types, force learners to think about the content in different ways, practice applying their knowledge in varied and unique ways, and utilize the available technology. Table 1 provides a listing of the different item formats and a description of each.

Table 1. Check on Learning Item Formats and Descriptions

Item Format	Description
Multiple Choice	Learner selects the one best response from a list of options. Some items include pictures in the item stem or response options.
Choose all that apply - Multiple Choice	Formatted like a multiple choice item, except the learner can select as many options as desired. Some items include images.
Interactive Multiple Choice	Item includes a bar with arrows or a movable icon that the learner can slide to indicate the answer.
Matching	Two or more items are presented together with multiple response options. Each item has only one correct answer. When an option is dragged, it should disappear from the option list. Example items may include a virtual JEM that require the learner to click on the JEM to identify specified components, to drag labels to the appropriate location on the JEM, or to connect external components to the JEM
Choose all that apply – Matching	Two or more items are presented together. Response options are displayed underneath. Learner can drag option(s) up to applicable item. When an option is dragged, the option remains below so it could be used again for the other item. Some items include images.
True or False	Learner clicks on 'True' or 'False' in response to the item.
Virtual JEM Programming	Items include a virtual JEM that the learner must program using the radio's keypad.

Most items are worth one point each; however, several items included multiple parts and are therefore worth multiple points. Following each item, the learner receives feedback that provides useful information about the correct answer. The feedback, a key feature of assessment approach, reinforces learning. At the end of a check on learning assessment, the learner can review a summary of the items they answered correctly and incorrectly.

Development of virtual classroom checks on learning. The check on learning activities were similar for both the mobile and virtual classroom applications. The key difference between the two resulted from the difference in the terminal objectives between the mobile training and virtual classroom training. Specifically, the mobile training included a stronger focus on the recall of declarative knowledge (i.e., facts, rules, concepts), whereas the virtual classroom required learners to apply that knowledge. Therefore, the virtual classroom included a greater ratio of items that incorporated the Virtual JEM Programming format. These items simulated hands-on practice with the JEM. The ability to demonstrate learning on a simulated JEM was a key feature of our assessment approach.

Theoretical rationale for aligning assessment types with training platforms. The decision to use more multiple choice, matching, and true false items in the mobile training and more interactive assessments in the virtual classroom was based the theoretical alignment between the learning objectives and learning outcomes for each training platform. As mentioned previously, there is a stronger focus on declarative knowledge in the mobile training. Declarative knowledge forms the foundation for more advanced knowledge such as procedural knowledge and critical thinking (Anderson, 1982). Because of this, measuring the retention of declarative knowledge is most appropriate in the initial stages of training (Kraiger, Ford & Salas, 1993). An additional benefit of measuring declarative knowledge in the early stages of training is that declarative knowledge assessments help to identify knowledge gaps that may hinder individuals from formulating higher-order knowledge.

As knowledge advances beyond declarative knowledge, several interrelated changes in processing occur. First, learners begin to focus less on rules and facts and more on the nuances of applying that knowledge (Anderson, 1982). Second, individuals begin to develop more meaningful schemas that describe the task. Such schemas, referred to as mental models, allow individuals to describe the functions and inter-dependences among task elements (Kraiger et al., 1993). Based on this notion, we designed the virtual classroom items to assess how well trainees could perform tasks on the virtual radio and troubleshoot problems as they occurred.

Collaborative Scenario

The goal of the collaborative scenario is to give learners an opportunity to apply what they have learned in a team-based capstone exercise. Thus, this module essentially functions as an assessment. The concept for this exercise involves three players proceeding through a virtual "day in the life" turn-based scenario together. The exercise entails a series of vignettes that focuses on the operation of the JEM radio in real-life contexts (e.g., preparing the radio for mission, troubleshooting when encountering unusual circumstances). Each vignette requires team members to program and troubleshoot the radio. The radio control is rotated among players throughout the exercise – for any given vignette, only one player is in charge of the radio while the other two players watch the actions of the player-in-charge in real time (i.e., all players will see the same screen but only one player will be able to be able to "use" the radio while the other two players will be in "view only" mode). During the action periods, there is an open communication channel (i.e., chat function) that allows for discussions among the players as they proceed through the game so they can make decisions collectively.

There were several advantages to this approach. First, the "day in the life" approach offers an opportunity for learners to apply what they have learned from the mobile and virtual classroom trainings, preparing them for knowledge and skill transfer to the real world. It also adds a decision-making dimension (i.e., "when to do what") in addition to the knowledge and skill dimension (i.e., "how to"). This is especially important for assessing critical-thinking skills. Second, the training technology was leveraged to provide a simulated operational environment that is contextualized and high-fidelity. Third, the setup of the exercise provides both structural and emergent components of collaboration (for a comprehensive discussion on formal structures versus emergent processes, see Kozlowski and Klein, 2000). The structural component (i.e., the radio being passed from one player to the next) ensures task interdependency because all players need to succeed in their scenarios for the team to accomplish the overall goal. The emergent component (i.e., how the players will work together over the open communication channel) reflects natural team processes and may provide rich data to answer a variety of research questions.

Development of collaborative scenario. To develop the content of the collaborative scenario, we first collected critical incidents (see Flanagan, 1954) from instructors at Ft. Gordon that described in detail a real-to-life battlefield scenario that would involve using the JEM. Our goal was to elicit information on the real-world contexts around which certain JEM procedures or troubleshooting techniques covered in our training would occur. In addition to collecting these situational examples, we also elicited information regarding appropriate art assets, virtual environment components, player actions, and non-player character (NPC) actions to ensure the scenarios included an appropriate level of physical and psychological fidelity. Based on the information collected, we were able to confirm vignettes within one scenario story of a Personnel Security Detachment (PSD) mission where a Colonel is visiting a local village to check on the progress of a new school under construction. Various tasks related to the use of the radio are required of Soldiers accompanying the Colonel.

Building on the critical incidents collected, we developed detailed vignettes for the collaborative scenario. We used several key considerations to guide the vignette development process. First, we ensured that the situation players encountered did not result in repeated task execution. In other words, the tasks required in the vignettes were mostly independent to avoid over-penalizing the same mistake (e.g., performance on one task would not affect performance on another task). Second, we referred to the subordinate objectives in the JEM ISD Map to ensure that a variety of tasks were covered throughout the vignettes. Finally, the vignettes were written to not involve any tactical decision-making outside of the scope of radio use so that the assessments strictly adhered to the learning objectives and training content.

In conjunction with the collaborative scenario development, we embedded scoring into the exercise itself. Two types of assessments were developed: individual-level knowledge check questions and team-level radio manipulation tasks. Individual-level knowledge check items were developed as single-answer multiple-choice questions. Each player completes these individually without communication with other players (i.e., the chat function would be disabled until everyone completes the knowledge check questions). Team-level radio manipulation tasks were developed as a series of steps each player in charge of the radio must carry out in order to successfully complete a vignette. For scenarios that involve troubleshooting procedures, players must first identify the problem and determine the correct course of action, and then perform the mechanical manipulation steps to correct the problem. The team does not receive credit for a vignette if the radio manipulation steps are performed correctly, but an incorrect course of action is identified (e.g., if the battery is malfunctioning, the team will not receive credit for correctly replacing the antenna). In other words, the course of action and the radio manipulation must both be correct to receive credit for the vignette.

At the end of the development process, we derived seven vignettes. In each vignette, players are first presented with a video clip that advises them about the situation and radio setup for the task. Then players are prompted to answer several individual-level knowledge check questions in relation to the preceding video. Once all knowledge check questions are completed, the player assigned as the active player for the vignette is granted control of the simulated radio; the other players watch the active player's actions and offer advice and input. Some radio manipulation tasks involve multiple-choice questions that the active player must answer correctly in order to proceed. For example, when connecting or disconnecting parts of the radio, a question may appear prompting the active player to select the correct physical motion. Team members may offer the active player advice and the active player may make repeated attempts. The radio manipulation tasks are scored based on whether the overall goal of the task is completed successfully within the time limit. If the team is unsuccessful, they are given demonstration-based feedback in the form of animated videos of how to correctly perform the task.

The finished vignettes were presented to a group of SMEs at Ft. Gordon for validation purposes. SMEs reviewed each vignette and their corresponding assessments and provided input and feedback regarding their realism and feasibility. The final version of the collaborative scenario was based upon this feedback.

BETA TEST

After we developed full versions of the mobile training, virtual classroom, and collaborative scenario, we conducted a beta test with Soldiers at Ft. Gordon, GA. The beta test was an opportunity for Soldiers (most with prior experience using the JEM) to review the training and provide feedback on the content, appearance/features, functionality, and organization of the trainings and assessments.

Participants and Method

A total of 21 Soldiers participated in the beta test and each Soldier completed at least one of the three modalities. In total, the mobile training was completed by 18 Soldiers, the virtual classroom was completed by eight Soldiers, and the collaborative scenario was completed by nine Soldiers. The Soldiers had an average tenure of 10 years in the Army, an average of one year in their current rank, and had an average of 3.4 deployments. The ranks of the participants were split between Sergeant First Class (SFC) (nine total) and Staff Sergeant (SSG) (12 total). The military occupational specialties (MOS) of the participants varied between 25U (12 total), 25C (seven total), 25B (one total), and 25M (one total).

Participants were assigned to a training modality based on the time in which they were available to participate. Only two trainings could take place at a time (there were only two rooms) and only three Soldiers could complete the collaborative scenario at a time. Participants were brought to a room with either iPads or desktop computers. Those with the iPads were administered the mobile training, and those in the room with desktops were either administered the virtual classroom or collaborative scenario.

After participants were familiarized with the technological features, they proceeded with the training and assessments and documented any comments and/or suggestions based on their user experience. Upon completion of each training modality, participants completed an anonymous online survey designed to measure their reactions to the training. Specifically, the survey captured participants' satisfaction with various dimensions of the prototype training, including the overall enjoyment, usability of technology, instructional design, and perceived training utility and learning transfer. Once the survey was completed, participants were debriefed and final comments on the trainings were collected.

Results of the Beta Test

Analysis of the learner reaction measure revealed that overall, the training was perceived positively. The majority of participants indicated that they enjoyed the training and would recommend it to others. With regard to the ease of use, accessibility, functionality, and satisfaction with the training technologies, over 80% of participants indicated favorable attitudes towards the mobile and virtual classroom modalities across all questions on this topic. Attitudes were less favorable for the collaborative scenario modality with only 60% of participants endorsing it. During observations and post-training debriefs for the collaborative scenario modality, we uncovered some usability issues that were likely explanations for the lower ratings. These issues were later addressed to improve the user-experience.

In terms of instructional design, over 80% of participants endorsed the course design for the mobile and collaborative scenario modalities. Attitudes were less positive on the virtual classroom modality – only approximately 70% of participants indicated favorability over the course design for this modality. During post-training debriefs, participants raised concerns about some of the virtual classroom content containing unnecessary details, especially on topics that were basic and had already been covered in the mobile training. As a result the length of the virtual classroom modality was too long, which could lead to learner fatigue and loss of attention. This information was used to later shorten the virtual classroom.

When asked about learning as a result of these training modalities, the majority of participants in the mobile modality and in the collaborative scenario modality and less than half of participants in the virtual classroom modality indicated they "learned a lot." In addition, with regard to training utility and learning transfer, over half of the participants endorsed the practical value of the training and its application on the job across all modalities.

CONCLUSIONS AND FUTURE RESEARCH

The purpose of this effort was to create a training and assessment prototype that was consistent with the objectives set forth by the ALM and that leveraged the capabilities of mobile and SLE/VLE technologies. Foundational to our approach were an adherence to sound instructional design principles, integration of employed technologies, and alignment of assessment strategies with learning objectives and technological affordances. After creating an ISD map based on the current training materials and SME input, our project team matched training objectives to training platforms (i.e., mobile, virtual classroom, and virtual environment), based on the alignment of the objectives and the affordances of the delivery method. Our project team then developed the training environments, training content, and assessments in close coordination with each other and with SMEs at the Signal NCO Academy at Ft. Gordon. The prototype trainings built upon one another and included a mobile application, a virtual classroom, and a collaborative scenario-based exercise that served as a capstone event. The suite of assessments included a CAT administered at three points over the course of training and interim assessments that were administered periodically throughout the training. It also included both individual and team-level scoring embedded in the collaborative scenario. The training modules and assessments were designed and implemented as separate, yet integrated, applications. The overarching framework was designed to share content, assessments, and scores across the three platforms. Finally, we tested our prototype with a sample of Army Soldiers in an institutional setting to assess reactions to the prototype training. Generally speaking, the results demonstrated that the Soldiers expressed a positive view of the training technology, instructional design, and overall training exercise.

The prototypes developed for this effort are currently being used to answer several interrelated questions related to the efficacy of different assessment strategies. This line of research specifically seeks to determine if:

- The prototype training is at least as effective as the traditional classroom method.
- CATs provide value over non-adaptive assessments in an Army training contents
- Embedding check on learning activities into mobile and virtual classroom training effect learning and retention.
- Performance in the simulation translate to better performance with a real radio

- There any negative effects of practicing on a simulated radio.

Answers to these questions will inform implementation of the ALM and will increase our understanding of the most appropriate ways to use existing technologies for training and assessment. As the Army continues to transform their training approach, these and similar questions will need to be answered in order to create effective Soldier-centered training.

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