# Effectiveness of Embedded Game-Based Instruction: A Guided Experiential Approach to Technology Based Training

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## ABSTRACT

Game-based technologies are being increasingly leveraged by the military for training purposes. However, despite their perceived contribution, games are rarely empirically evaluated for their training effectiveness nor used to their full potential. Instead games are often implemented as practice environments alone, lacking instructional capabilities that are known to lead to more effective training (Clark, Yates, Early, & Moulton, 2007). In an effort to integrate evidence-based instructional design into serious games, effectively "bringing the classroom into training games," the U.S. Army Research Institute collaborated with Soar Technology to develop a training game for course-of-action analysis (COAA) based on the Guided Experiential Learning (GEL) Model (Clark et al., 2010). Course of Action Analysis ("Wargaming") involves step-by-step human simulation and evaluation of a course of action. The game-based instruction (GBI) COAA prototype includes part/whole task practice, field-based problems, demonstrations, and guided practice. These methods are prescribed by GEL, which is based on Merrill's principles of instruction (Merrill, 2006). To explore the effectiveness of this approach, Soldiers were run through a study to compare the use of the GBI COAA prototype to a control that approximates how games are typically used in simulation centers (i.e., upfront instruction, practice without guided feedback, AAR/post-training feedback). Assessments included usability, attitudes toward technology, and training effectiveness/efficiency (e.g., number of errors). The goal of this evaluation was to determine whether the method used in the COAA tool is more effective and efficient when compared to current training practices. Findings support the use of embedded instruction in games; a significant decrease in the number of errors was found for Soldiers exposed to game play that featured the GEL model of instruction compared to Soldiers who had traditional training. These results will help guide future development of game-based instruction environments and provides support for the continuing use of games in training.

## ABOUT THE AUTHORS

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## INTRODUCTION

Game-based technologies are being increasingly leveraged by the military in an effort to integrate more interactive, blended learning approaches into traditional, lecture-based instruction typical of brick and mortar schoolhouses. In the Army, there is a great deal of variability in how technology-based training is applied in general, but game-based technologies are typically implemented in simulation centers to supplement classroom learning. For example, following some type of didactic or lecture-based training, small collectives will gather in a simulation center to practice using Virtual Battlefield 2 (VBS2), a first-person shooter virtual sand box, or Follow Me, a small unit tactical trainer. However, despite their perceived contribution, game-based technologies are rarely empirically evaluated for effectiveness nor used to their full potential. Games are often implemented as practice environments, lacking instructional capabilities that are known to lead to more effective training (Clark, 2007). For example, VBS2 is often used as the environment to practice coordination and room clearing or land navigation techniques, while the instruction on how to do those tasks takes place in the classroom with most if not all feedback pushed to after action reviews (AARs). The system itself is simply a mechanism by which to practice instead of a fully realized instructional tool, lacking explicit feedback or intervention capabilities, despite the fact that the science of learning and instructional design literature specifically highlight the need to link instructional features like feedback to practice (Merrill 2002; Shute, 2008).

In addition to simply being capable of incorporating instructional features into practice, the technology of games lends itself specifically to provide instructional support. For example, the technology in games does not just allow feedback, but it already is designed to facilitate its inclusion since entertainment games already contain rubrics for scoring and feedback but for different purposes. These rubrics and design features may simply be harnessed to promote learning. While it could be argued that the technology is still being developed to implement a fully realized, truly intelligent tutor able to approximate humans, current applications of expert and pedagogical models allow for assessment and feedback during game play in real time to support principles of instructional design. The trick is to merge instructional and game design to target learning. In an effort to integrate evidence-based instructional design into serious games, effectively "bringing the classroom into training games," the U.S. Army Research Institute collaborated with Soar Technology to develop a training game for course-of-action analysis (COAA) based on the guided experiential learning (GEL) Model (Clark et al., 2010). This paper discusses the results of an experiment designed to examine the impact of the resulting prototype, which integrated instructional principles into a game-based environment for training, on performance during training for Soldiers.

### Motivation and Context: Instructional Game Design Principles

Games in and of themselves offer state-of-the-art, inexpensive, portable training environments that are representative of real world situations and tasks and provide highly motivating practice. However, the old adage of "practice, practice, practice" is incomplete. Practice is not an efficient, nor effective, way to learn. Based on the science of learning and instructional design principles, practice must be supported by instruction, guidance, and feedback. While there is definite support for this to be generally true, there is also evidence in the literature that the current practices in game-based training may not be all that effective, lending support for a better way to apply games to training. For example, Clark (2007) provides a review of evidence on the value of games for learning from both military and civilian research states, "There is no evidence in the existing studies that games teach anyone anything that could not be learned some other, less expensive, and more effective way." Clark's findings seem clear that the current generation of training games is not appropriately grounded in pedagogical methods. Clark asserts

that serious games *could* provide effective and motivating instruction for complex knowledge *if they were adequately designed for learning*.

Again, the way games are typically applied is just to enable practice without any other instructional intervention. While the task focus enabled by games is key to learning, Merrill's (2002) principles of learning hold that practice (or "application") is only one of four phases that are needed to structure task-centered learning effectively. Relating new concepts and skills to prior experiences (activation), demonstration, and integration (enabling students to demonstrate their learning) are also important. Additionally, guidance and corrective feedback during performance of the task is also critical for efficient learning. Therefore, in order to be truly effective, game based instruction (GBI) must integrate evidence-based instructional design into serious games.

**Instructional and Game Design Principles**

There are a number of models of instructional design in the literature, and we do not go into an exhaustive description of each as those resources already exist and are readily available (e.g., Andrews & Goodson, 1980; Clark, 2009; Dick & Carey, 1978). However, some of the most widely cited and applied include the Analyze-Design-Develop-Implement-Evaluate (ADDIE) model and the Dick and Carey model. See Table 1 for a brief description of some of the models discussed here.

**Table 1: Instructional Design Models**

| Model | Description | Steps | References |
|---|---|---|---|
| ADDIE | One of the most well-known ID models likely due to its generality. It is a systematic model in that the steps are to be followed in order such that the output of one step serves as the input for the following step. | 1. Analyze the content and learners to develop learning objectives<br>2. Design lesson plans around the learning objectives<br>3. Develop specific materials and procedures as laid out in lesson plans<br>4. Implement materials and procedures to deliver training<br>5. Evaluate the learners' mastery of learning objectives and make revisions to the materials and procedures as necessary | Molenda, 2003 |
| Dick & Carey | This model stresses the relationship among the various components of instruction: the instructor, learners, materials, instructional activities, delivery system, and context. The steps of the model are to be executed in parallel and iteratively. | 1. Identify instructional goals<br>2. Conduct an instructional analysis to determine what skills are necessary to achieve goals<br>3. Identify KSAs of learners that they bring to the task<br>4. Translate needs and goals into specific and clear objectives<br>5. Develop criterion-referenced tests<br>6. Determine how to best use instructional strategies for learning<br>7. Select instructional materials<br>8. Conduct formative evaluation<br>9. Conduct summative evaluation to study effectiveness of system as a whole. | Dick & Carey, 1978; Dick, 1996 |
| Guided Experiential Learning (GEL) | GEL is a comprehensive model of instructional design that encompasses a process for developing training for any media platform and a set of procedures to follow for each step of the process. | 1. Select course and subject matter experts<br>2. Identify many job and mission problems<br>3. Cognitive task analysis<br>4. Gather information on concepts processes, and procedures within the domain<br>5. Design the learning materials (gives prescriptions about how to sequence information)<br>6. Select delivery media<br>7. Design evaluations (at 4 levels: reactions, learning, transfer, impact) | Clark, 2005 |

These models are very useful in guiding development of training based on the science of learning, ensuring designers will focus on training objectives and assessments and any number of them would be useful in guiding game-based instruction. However, models of instructional design often lack the specific prescriptive guidance on how to implement training. For example, while ADDIE discusses the stages of training development that should be included, it does not describe necessarily provide specific guidance on how to implement the different stages (Reiser & Dempsey, 2007). Instead, many instructional models, like ADDIE, leave the actual application of the steps up to the instructors. This results in maximum flexibility to apply different methods of training, but offers no guidance on how to instruct their students. This may be an appropriate approach with the human instructor in the loop, since they can make changes and adjustments on the fly, in real time. However, a more systematic, prescriptive approach is often needed when interventions need to be scripted, like with adaptive computer systems.

GEL is an example of a detailed approach to instructional design that specifies "how to instruct" as well as "what to instruct" (Clark & Feldon, 2008; Clark et al., 2010). According to the GEL model, all trainees in a course must receive: 1) realistic, field-based problems to solve; 2) analogies and examples that relate trainee's relevant prior knowledge to new learning; 3) clear and complete demonstrations of how to perform key tasks and solve authentic problems; 4) frequent practice opportunities during training to apply what is being learned (by performing tasks and solving problems) while receiving corrective feedback; and 5) application practice that includes "part tasks" (practicing small chunks of larger tasks) and also "whole tasks" (applying as much of what is learned as possible to solve the complex problems that represent challenges encountered in operational environments). These five training methods are based on Merrill's principles (2002). Games are important (but not sufficient) for presentation of realistic problems, immersive demonstrations, frequent practice, and practicing part-task and whole-task skills.

Therefore, we developed a training game that adheres to Clark's (2010) GEL instructional model while also incorporating design features from successful games. Regarding game design features, although rigorously-controlled, there is little empirical evidence of the allure of games. However, theoretical analysis and case studies suggest that a recurring feature in successful games couples fast-paced, interactive challenges with positive feedback cycles at multiple time scales (Chatfield, 2010; Koster, 2004; McGonigal, 2011). Therefore, a hypothesis motivating our work is that successfully capturing both interactivity and positive feedback in an instructional game will increase engagement and sustained learner participation in a training experience in comparison to standard computer-based training environments. Table 2 summarizes the instructional game design principles that guided the development of the training game. Rationales and further discussion of these principles may be found in Wray, Woods, and Priest (2012).

**Table 2: Brief Summary of Instructional Game Design Principles (adapted from Wray, Woods, and Priest, 2012)**

| Instructional Design Principles | Game Design Principles |
|---|---|
| Training lessons and experiences should include: | |
| 1) realistic, field-based problems to solve; 2) analogies and examples that relate trainee's relevant prior knowledge to new learning; 3) clear and complete demonstrations of how to perform key tasks and solve authentic problems; 4) frequent practice opportunities during training to apply what is being learned (by performing tasks and solving problems) while receiving corrective feedback; and 5) application practice that includes "part tasks" (practicing small chunks of larger tasks) and also "whole tasks" (applying as much of what is learned as possible to solve the complex problems that represent challenges encountered in operational environments). | 1) **Interactivity:** A principle of game design is to give the player interesting choices. Good choices require tradeoffs be made and have repercussions on game experience. Choices are core to interactive user experience, allowing the player to participate in the experience and "own" decisions and their consequences and to feel more connected or "immersed" in the experience.<br><br>2) **Positive Feedback Cycles**: Deliver frequent rewards. Reward cycles are surprisingly prevalent across many different game genres and settings. Rewards can keep a player engaged and moving forward in the game, presenting challenge in the moment while offering even greater benefits if the challenges are met. |

A core feature of the technology development was to enable instructors to create general instructional content (e.g., conceptual overviews and demonstrations) and to create practice exercises for students that included overt guidance and timely feedback. The technology developed to support this effort is outlined as well in Wray, Woods, & Priest (2012). This paper focuses not on the technology but on an evaluation of the impact of an instructional game that came from that technology development. That is, do we see evidence of the benefits of following the principles outlined in Table 1 for a specific instructional game?

**Course of Action Analysis/Wargaming Instructional Game**

We developed an instructional game focused on the Course of Action Analysis (COAA) process used by the United States Army (as defined in U.S. Army Field Manual 5.0). The game includes part/whole task practice, field-based problems, demonstrations, and guided practice with feedback and is referred to as GBI COAA.

COAA(also called "Wargaming") involves mental simulation of a candidate course of action via a step-by-step process and subsequent evaluation and comparison of candidate courses of action (COA). In actual wargaming, human role players represent different aspects of warfighting, such as maneuver, artillery, intelligence, logistics, etc. The wargaming process begins with the side with the initiative taking actions as defined in a candidate course of action (moving into position, directing fires, etc.) and the opposing side then reacting to the action, and then the initial side responding to the reaction. This action-reaction-counteraction process then repeats until the course of action is determined to be infeasible or measures of effectiveness of the course of action can be assessed. The wargaming process is also important for helping to identify crucial points of coordination and threat mitigation during the conduct of a plan and facilitates the creation of a synchronization matrix for order generation that calls out coordination expectations.

The COAA instructional game (GBI COAA) introduces the purpose of wargaming, the roles of the two primary role players at the battalion level (maneuver and intelligence), and the action-reaction-counteraction sequence. Each instructional topic is organized into a self-contained "lesson" that provides overview descriptions of the topic, a demonstration of the skills or concepts presented in the lesson, and an opportunity to practice. Screenshots from these lesson elements are shown in Figure 1. Practice (and demonstrations) take place on a map overlaid with military symbology. Practice goals are described and then the learner receives interactive guidance as the practice develops. If the learner makes a mistake, a brief, descriptive error message is displayed and practice restarts. The design assumption for simple, part-task lessons is that it will be easier for a student to restart a practice than to attempt to repair a faulty step.

Once the GBI COAA Wargaming prototype was developed, evaluations focused primarily on the usability and utility of the tools, with content developers and subject matter experts providing input on the features and capabilities of individual GBI tools. For the experimental approach, ARI researchers conducted user testing and effectiveness evaluations with Soldiers at two installations over a two week period. Specifically, the GBI COAA tool was compared to a control (e.g., upfront instruction followed by COAA practice and AAR/post-training feedback) to assess usability, attitudes toward technology, learning and training efficiency/effectiveness. We predicted that participants in the GBI COAA condition would 1) have fewer errors during practice, 2) have higher post-test scores, and 3) have higher usability scores for the system than participants in the control condition. The goal of this evaluation was to determine if the method used in the GBI COAA tool is more effective and efficient to current training practices. These results will help guide future development of the GBI COAA tool, as well as other game-based instruction environments. Below is a description of the methodology, results, and a discussion.

**METHOD**

In order to evaluate the effectiveness of this GBI methodology, Soldiers at two Army Posts in the United States were targeted for data collection. A very simple between subjects design was employed to compare learning in games with instruction to practice-based game play.

**Procedure**

Participants were recruited in groups of four to eight for 2-hour sessions. Groups of participants were assigned to conditions and assignments were counterbalanced based on time of day. Once the participants arrived, they were set

at a computer and asked to fill out a demographic questionnaire that also contained questions regarding their education on the Military Decision Making Process (MDMP), which contains Wargaming, and their experience as a Soldier in general and with COAA specifically. Participants were then asked to complete a knowledge pre-test on the content to be trained (e.g., questions regarding blue and red action, reaction, and counteraction). They were provided with COAA training and practice depending on their condition (Practice Only vs GBI COAA, described below). Following completion of training and practice, all participants were asked to complete a post-knowledge questionnaire and usability questionnaire. The participants were then provided a debrief form and excused.
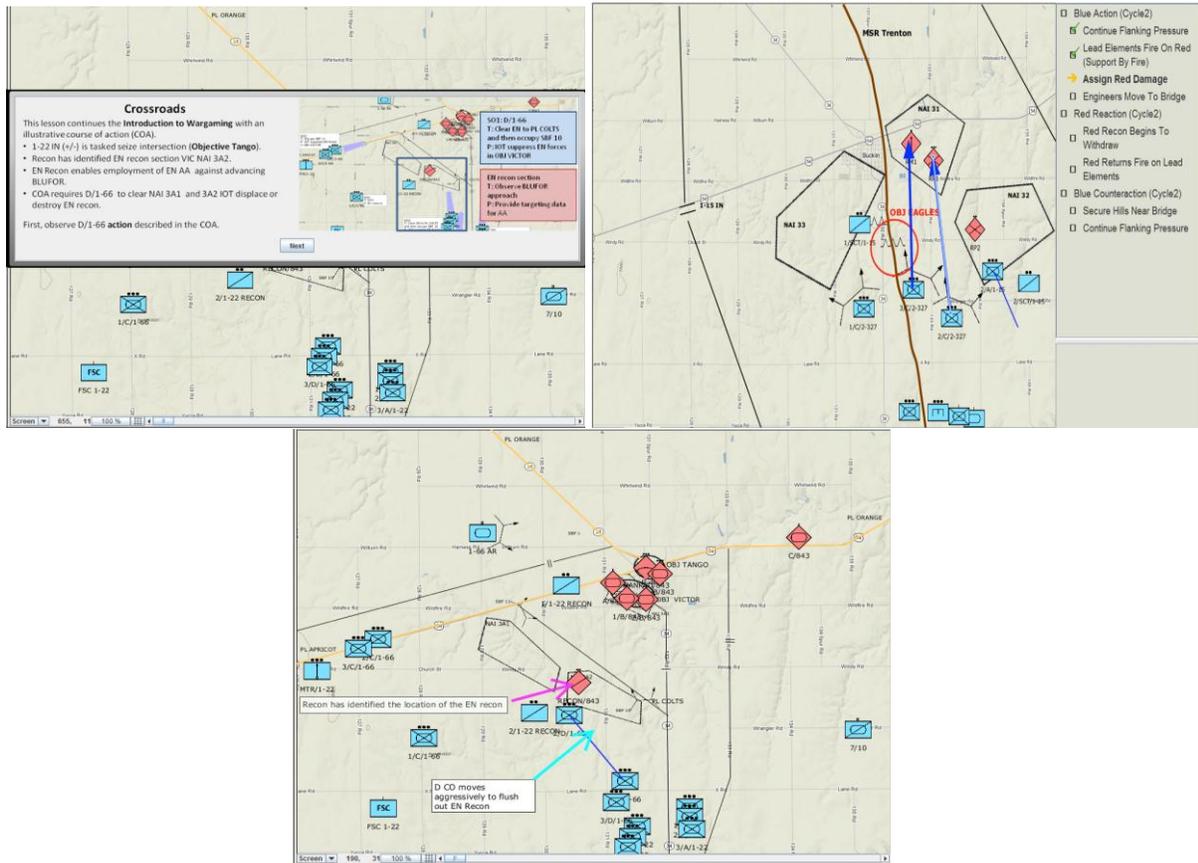


**Figure 1. The GBI COAA Instructional Game provides an overview of concepts (top left), demonstrations of concepts and procedures (middle right) and interactive guidance during practice (bottom)**

## Participants

There were a total of 40 participants in the evaluation, including ten Second Lieutenants and 30 First Lieutenants with an average of 4 years in the Army ($M$ = 3.72, SD = 3.37). Soldiers had a variety of Military Occupation Specialties (MOS; e.g., Armor, Chemical Operations, Information Systems, Infantry), with the largest concentration falling under the Logistics and Support MOS (N = 11). Seventy-five percent of Soldiers had been previously deployed, with a majority having served deployments in Afghanistan (N = 25). Only 6% of Soldiers had multiple deployments. Less than half of the sample (N = 18) had experience on a tactical operations center (TOC) staff during deployment, decreasing the likelihood that they had been exposed to COAA at all. While the Soldiers in this sample were considered novices at COAA Wargaming, most (N = 32) reported a basic understanding of the military decision making process (MDMP) and less than half (N = 16) reported some experience with COAA Wargaming.

## Conditions

Participants were randomly assigned into one of two conditions; *Practice Only* (i.e., the control) and the *Instructional Game*, GBI COAA. The *Practice Only* condition consisted of an introduction to COAA Wargaming via a PowerPoint (PPT) presentation that was self-paced. We designed the *Practice Only* PowerPoint materials to use the same text and graphics as the overview materials used within the game; for comparison, see Figure 2. Following the completion of the presentation (i.e., didactic, information based training), participants were given a brief training on how to use the COAA Wargaming practice environment. The participants were then given time to practice the Wargaming process with some specific guidance on the goals of the five practice sessions. Feedback in the *Practice Only* condition consisted of a screen shot of the correct COAA after they indicated they were done (similar to the top right picture in Figure 1). Because later practice exercises built on earlier ones, participants had some (if indirect) opportunity to gain feedback on their performance which would then be applicable in the next lesson.
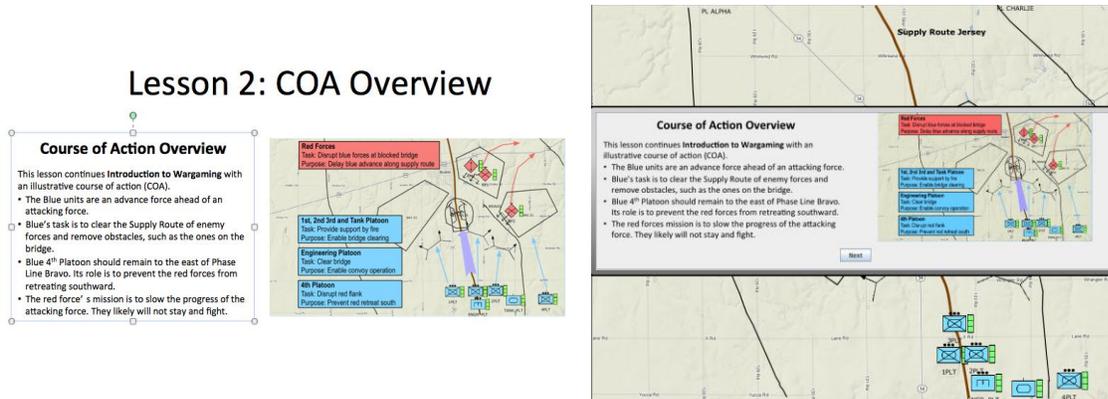


**Figure 2. Participants in the Practice Only condition received PPT overviews of Course of Action Analysis (left). The same overview content was presented within the instructional game in the Instructional Game condition (right)**

For the *Instructional Game* condition, participants were given similar training on how to use the COAA Wargaming. Participants then were given time to use the COAA instructional game, which provided overviews, demonstrations, and five practice exercises. For the practice exercises, participants received guidance (as in the bottom of Figure 1). In addition to the immediate positive feedback on their steps in COAA as illustrated by the green checkmarks in Figure 1, they also received corrective feedback on errors, as shown in red in
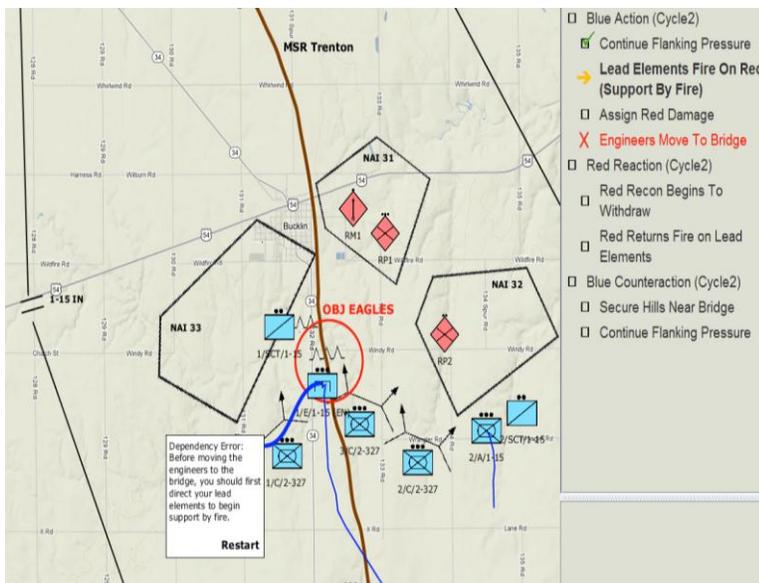


**Figure 3. The GBI COOA group receives immediate feedback when subjects make errors during practice, while the Practice Only group received none**

**Measures**

**Errors during Practice Exercises**
Participants were also scored on the errors during practice. The experimental condition was coded automatically by the system in order to provide feedback. However, since the control condition did not have a built in/automated error model, scores had to be coded by hand by watching replays of the participants' actions in the game. Two researchers coded the replays using a coding scheme based on SME input that was the same as the scheme used in GBI. Errors were classified as errors of omission, errors of commission, context errors, and dependency errors. Errors of omission occurred when a participant left out a step specified in the instructions. For example, in Practice 1, the student ordered a red unit to fire but did not have a red unit move. Errors of commission happened when a student added a step not specified in the instructions at any point in the practice (including steps specified in later phases). For example, in Practice 1, the student ordered a blue unit to fire. If the student takes a step that is specified in a later phase, we score that as a context error (next). Context errors occurred when a student performed an action in one context that is valid/specified in another (subsequent) context. In the examples in this practice unit, all contexts map onto the Wargaming phases (action, reaction, counteraction), so a context error occurs in these examples when the student performs an action in a subsequent phase before the current phase is complete. For example, in Practice 3, having blue units move or fire (counteraction) before red reaction steps are complete is scored as a context error. Dependency errors reflect when a student takes an action that is specified in the instructions, but has not completed all the preconditions that led up to the action. For example, in Practice 5, having 1PLT shoot the red mortar before moving into firing position is a dependency error because the move enables line of sight of the mortar to the target. When examining the scoring of the system, it was determined that some errors could be classified in multiple categories (e.g., a context and dependency error). The model specified a hierarchy (e.g., context error overrules a dependency error), so the human raters followed the same hierarchy.

**Knowledge Tests**
Participants were given pre- and post-tests to assess their knowledge on COAA Wargaming. The pre and post-tests consisted of questions covering different knowledge from the same material. Questions consisted of short answer, true false, matching, and fill in the blank. A percentage correct was calculated for scores ranging from 0-100%.

**Usability Measures**
The usability and reactions measure consists of 10 Likert scale questions from the System Usability Scale (SUS; Brooke, 1996), as well as 8 more questions (4 Likert scale ratings and 4 open-ended questions) that were used to target user reactions to the system and training.

**Results**

Results showed a highly significant effect of condition on the number of errors participants made during practice. The total mean errors for participants in the Practice Only condition ($M$=14.53; $SD$=9.99) were significantly higher than participants in the GBI condition ($M$= 2.00; $SD$=2.11) over the five practice scenarios, t(38)=5.87, $p$<.001 (See Figure 4).

Most errors for the Practice Only condition seem to have been made in errors of omission (i.e., occurred when a student left out a step specified in the instructions) and commission (i.e., occurred when a student added a step not specified in the instructions at any point in the practice). The total mean errors of omission for participants in the Practice Only condition ($M$= 7.41; $SD$=6.34) were significantly higher than participants in the GBI condition ($M$= 0.22; $SD$=.42) over the five practice scenarios, $t$(38)=5.45, $p$<.001. The total mean errors of comission for participants in the Practice Only condition ($M$ = 5.59; $SD$=4.43) were significantly higher than participants in the GBI condition ($M$ = 0.44; $SD$=.79) over the five practice scenarios, $t$(38)=5.49, $p$<.001.
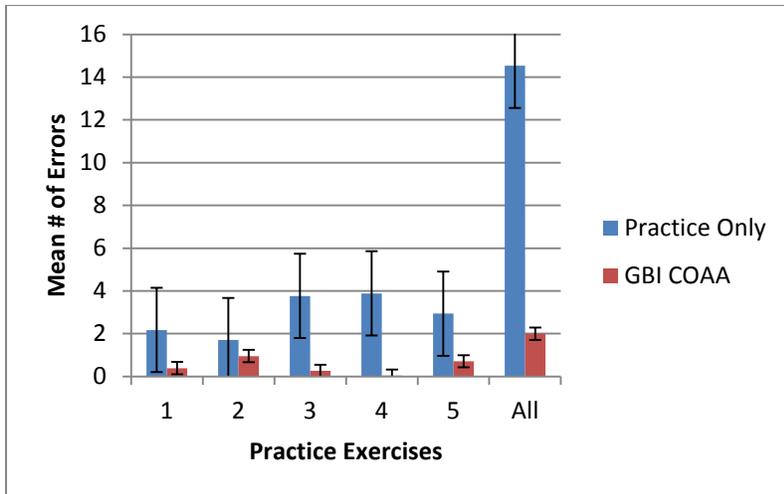
**Figure 4. Mean errors by condition across practice exercises**

For the errors of omission, the biggest differences between conditions were in the more difficult scenarios (i.e., scenarios 3, 4, and 5). In scenario 3, participants in the Practice Only condition (*M*= 2.53; *SD*=2.53) were significantly higher than participants in the GBI condition (*M* = 0; *SD*=0.0), *t*(38)=4.82, *p*<.001. In scenario 4, participants in the Practice Only condition (*M*=1.83; *SD*=1.85) were significantly higher than participants in the GBI condition (*M* = 0; *SD*=0.0), *t*(38)=4.76, *p*<.001. In scenario 5, participants in the Practice Only condition (*M*= 2.00; *SD*=2.85) were significantly higher than participants in the GBI condition (*M* = 0 *SD*=0.0), *t*(38)=3.38, *p*<.001 (See Figure 5). For the errors of commission, the biggest differences between conditions were in the first and third scenarios. In scenario 1, participants in the Practice Only condition (*M*= 1.59; *SD*=2.58) were significantly higher than participants in the GBI condition ( *M*=0 *SD*=0.0), *t*(38)=2.97, *p*<.001. In scenario 4, participants in the Practice Only condition (*M* = 1.71; *SD*=1.87) were significantly higher than participants in the GBI condition (*M* = 0 *SD*=0.0), *t*(38)=4.31, *p*<.001 (see Figure 6).
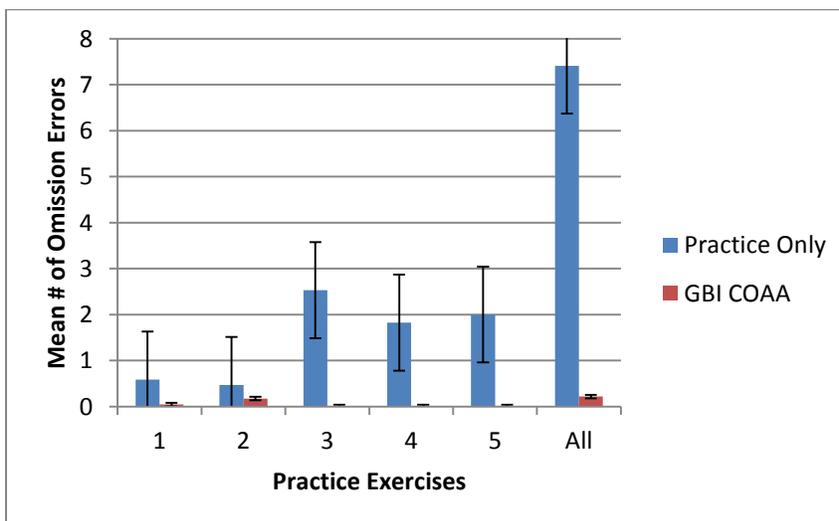


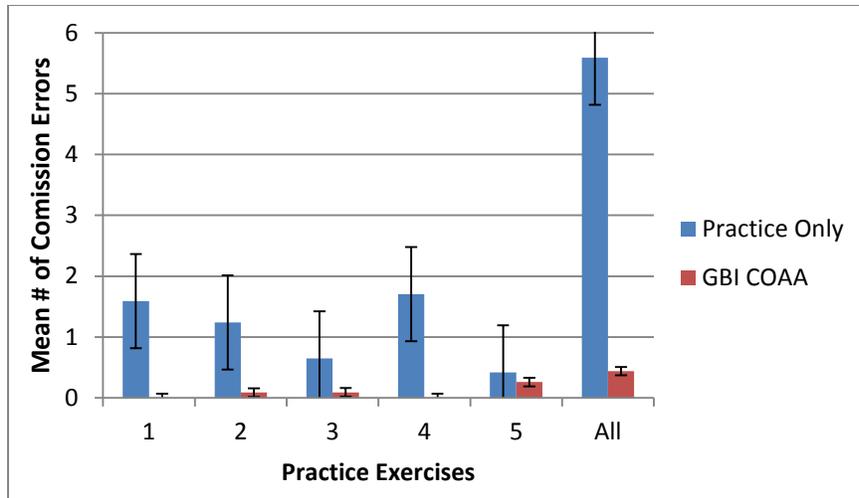**Figure 5. Mean omission errors by condition across practice exercises**

**Figure 6. Mean commission errors by condition across practice exercises**

The authors' predictions for the effect of condition on post-test performance and usability ratings were not supported. Regarding the learning exhibited during the post –test, there was no significant difference between conditions on performance on the post-test and participants had a great deal of variability in score, although participants did improve from pre-test ( $M$ =34.91; $SD$=17.42) to post-test ( $M$ =42.83; $SD$=16.02). Regarding usability, the post-training usability scores were uniformly high for both GBI COAA ( $M$ =41.31; $SD$=7.00) and Practice Only ( $M$ =41.10; $SD$=3.45) conditions and were not significantly different.

**CONCLUSION**

**Discussion**

This effort investigated the use of instructional design principles and strategies from the GEL model embedded within a game-based practice environment. The primary hypothesis was that training that incorporates instructional interventions (e.g., feedback and in-game assessment) would lead to more efficient and effective training as opposed to the more traditional use of games as practice only environments. This study generally supported this hypothesis in that participants who used the GBI COAA tool to train exhibited significantly fewer errors during training than did those who used the practice only COAA environment. However, there were no significant differences in learning as assessed by the declarative knowledge tests nor were there significant differences in usability ratings. While errors during training are not in and of itself an indication of more efficient or effective training, the number of omission errors (i.e., errors that occurred when a student left out a step specified in the instructions) and commission errors (i.e., errors that occurred when a student added a step not specified in the instructions at any point in the practice) for participants in the control condition indicated an inability to self-diagnose and correct for those types of errors based on static, after-practice feedback. Furthermore, in coding, raters observed that participants were making the same errors over and over, indicating that these errors were a sign of trainees not learning from their mistakes but replicating them. Participants in the GBI COAA conditions were able to virtually eliminate errors of omission and commission from later, more complex scenarios, indicating a learning effect.

The initial evidence lends a great deal of support for guided instruction within game-based practice environments. These initial efforts provide a good foundation for future research to identify the implications of more integrated game based learning environments that we can continue to build on in future studies.

*Future Studies.* While more significant learning effects were expected, one possible explanation for the lack of significance may lie in the declarative knowledge measure itself. While participants did significantly improve between pre-and post-tests across conditions, they were largely very low scores before and after training, with means less than 50%, indicating the tests may have been too challenging for the 'beginner' material presented in the content. Refinement of the declarative knowledge measures to more accurately reflect the training objectives for beginners would likely benefit future studies. In addition, the type of learning promoted by the application aspect of GEL supported by GBI COAA would not necessarily come out through declarative knowledge paper and pencil

tests. Future studies should target a transfer or application test to assess whether deeper learning took place using GBI COAA compared to traditional game-based training methods. Regarding usability, the similarity of usability rankings across conditions is not entirely surprising as both conditions used the basic COAA Wargaming game as a practice environment. Largely both groups were happy with the technology itself as it was a marked improvement over what they had previously experienced as novices (e.g., field manuals or observations in the field). Another factor was that each group was only exposed to one condition based on the design, so that participants who had the full GBI COAA experience would not rate in comparison to the traditional, practice only version and, therefore, not report whether they judged it as superior to more 'traditional' game-based training. Anecdotally, Soldiers who were shown both versions of the system following participation in the formal study reacted positively, requiring us to rethink future designs to include opportunities for comparison.

While this research only presents an initial step in answering the question of when and how to implement instruction into games, it provides significant support for moving away from practice only environments. Future efforts are needed to identify how to most effectively implement instruction into game-based training for long-term retention and transfer. Overall, this first effort supports the inclusion of instruction and game design into practice-based training environments.

## Acknowledgments

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