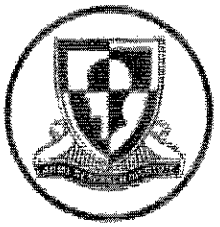

Research Product 2012-06

Enhancing Digital Skills Training: Interactive Multimedia Instruction

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May 2012

United States Army Research Institute for the Behavioral and Social Sciences

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Electronic File Characteristics: 31 files; 1.29GB. PHYSICAL DESCRIPTION: 1 DVD, 4 ¾ in. and 1 separate hard-copy document.. A task-centered instructional strategy was adapted to help digital system trainers apply principles of learning to enhance training. The task-centered strategy is derived from the work of David Merrill and has been used for many domains of training. This task-centered approach differs from training typically seen in digital system classrooms in that it encourages more active engagement by the students. Additionally, the strategy incorporates five training principles to maximize training effectiveness. These principles are that training be presented in the context of real-world tasks, that learners activate relevant prior knowledge, that learners observe a demonstration of the skill to be learned, that learners apply their new knowledge and skill, and that learners integrate their new skill into their daily activities. A train-the-trainer approach was developed into an interactive multimedia instructional package (IMI). The IMI consists of six modules that cover how learning and memory work, how to overcome classroom challenges, understanding principles of training, a training example based on the five examples, and a review. The IMI DVD is attached to this report.

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The creation of this multimedia trainer would not have been possible without the hard work of Diadra Swinson and Nancy Riffe. Nancy was the graphic artist responsible for taking the concepts in the story boards and creating many of the graphics and layouts found on the hundreds of slides that comprise the interactive multimedia instruction (IMI). Diadra was the multimedia specialist responsible for assembling all of the text and graphics into a working interactive multimedia instruction package. Both jobs required hundreds of hours of work and the final IMI reflects their skill and artistry. Thanks also go to Jean Dyer and Rich Wampler for their invaluable input in developing the concepts and examples included in the final IMI and for reviewing many versions of the IMI's story boards.

ENHANCING DIGITAL SKILLS TRAINING: INTERACTIVE MULTIMEDIA INSTRUCTION

EXECUTIVE SUMMARY

Research Requirement:

Observations of digital system training revealed that instructors primarily utilize demonstration and practice when training specific digital system skills. These techniques are effective ways to train, but research on skill training has shown that there are many other techniques that could be used. Furthermore, there are strategies for effectively incorporating many different principles into skill training. This research product is designed to help digital system instructors understand and employ a strategy for incorporating many different training principles into their classrooms.

Procedure:

Principles of learning explain why people learn and retain skills. These principles serve as the basis for training techniques that instructors use in the classroom. Although many instructors simply choose techniques that they find appealing or effective, some educational researchers have developed strategies for applying these techniques in a way that maximizes training effectiveness. One such researcher is David Merrill who has developed what he calls a task-centered strategy for instruction. His strategy applies five principles of learning. These principles suggest that training is enhanced when:

- Training is in the context of real-world tasks
- Relevant existing knowledge is activated
- The task is demonstrated
- The student has opportunities to apply new knowledge
- Tasks are integrated into the student's job

These principles were incorporated into an interactive multimedia instruction (IMI) package to train digital skills. That is, skills needed to operate digital systems like those in the Army Battle Command System (ABCS). Concepts were built into storyboards which were then converted into the multimedia package.

Findings:

The IMI illustrates how to apply a task-centered strategy for training complex skills needed to operate Army digital systems. The learner is involved a structured process that starts with a worked example and then progresses through increasingly complex examples of the task. As training progresses through increasingly more complex versions of the task, instructor guidance is faded away. In this way, the student's skill level increases while at the same time the student becomes increasingly independent of guidance from the instructors. The IMI includes six modules that explain and illustrate this process and provides examples and additional multimedia resources and scenarios for trainers.

Utilization and Dissemination of Findings

Instructors and training developers for digital system courses are the primary audience for this IMI. This IMI has been presented to digital trainers at Fort Benning, GA. Instructions for using the IMI on a computer are in the disk case and are in a readme file on the Digital Versatile Disc (DVD).

ENHANCING DIGITAL SKILLS TRAINING: INTERACTIVE MULTIMEDIA INSTRUCTION

CONTENTS

Page

ENHANCING DIGITAL SKILLS TRAINING: INTERACTIVE MULTIMEDIA INSTRUCTION 1
PRIOR RESEARCH ON DIGITAL SYSTEM TRAINING 1
THEORIES OF INSTRUCTIONAL DESIGN 2
PRINCIPLES OF LEARNING USED IN DIGITAL SYSTEM TRAINING IN THE ARMY. 4
DEVELOPMENT OF THE "ENHANCING DIGITAL TRAINING" IMI 6
USING THE "ENHANCING DIGITAL TRAINING" IMI 8

REFERENCES 13

LIST OF TABLES

TABLE 1. EXAMPLES OF PRINCIPLES OF LEARNING AND ASSOCIATED TRAINING TECHNIQUES FROM SANDERS' (2001) REPORT 2

TABLE 2. FIRST PRINCIPLES OF INSTRUCTION 3

TABLE 3. TRAINING MODULES FOUND IN THE ENHANCING DIGITAL TRAINING MULTIMEDIA INSTRUCTION 7

TABLE 4. COMPARISON OF TRADITIONAL TRAINING TO TRAINING DESCRIBED IN THE ENHANCING DIGITAL TRAINING IMI. 9

LIST OF FIGURES

FIGURE 1. OVERALL FREQUENCY OF THE SEVEN INSTRUCTIONAL ACTIVITIES, BY TYPE OF COURSE (FROM LEIBRECHT, GOODWIN, WAMPLER, & DYER, 2007) 5

FIGURE 2. RECOMMENDED PROCESS FOR EVALUATING AND ADOPTING TRAINING PRINCIPLES DESCRIBED IN THE IMI 11

Enhancing Digital Skills Training: Interactive Multimedia Instruction

Digital systems are employed for command and control, and these systems are increasingly being pushed to lower and lower echelons. Soldiers currently entering the Army can expect to operate multiple digital systems throughout their careers. Just as in the civilian sector, the Army has found digital systems to be useful for an increasing number of tasks. As the Army procures more and more digital systems, Soldiers will need to be trained to operate them. For this reason, the Army Research Institute (ARI) has pursued a line of research examining the training and retention of digital system skills (e.g., Bink, Wampler, Goodwin, & Dyer, 2007; Dyer, et al., 2000; Goodwin, 2006; Leibrecht, Goodwin, Wampler, & Dyer, 2007; Tucker, et al., 2009). The development of this interactive multimedia instruction (IMI) is an effort to capture the lessons learned through this research in a train-the-trainer product. This product report describes the basis for the development of the IMI and ways to use the IMI to improve digital instruction.

Prior Research on Digital System Training

Sanders (2001) conducted earlier ARI research on the principles of learning applicable to the training of digital systems. Principles of learning are the primary determinants of learning according to a specific learning theory. Sanders described how principles from three theories of learning (behaviorist, cognitive, and constructivist) could be applied to enhance the training of digital skills (see Table 1). To apply these principles of learning, Sanders described various training techniques that he derived from each principle. For example, a cognitive principle is that associating new material with prior knowledge benefits learning. A training technique derived from this principle is to explain the similarities and differences between the analog and digital ways of performing a task.

Sanders used tasks from the Force XXI Battle Command Brigade and Below (FBCB2) system to illustrate how these principles could be applied, but his focus was on listing techniques derived from various learning principles. He did not present a strategy on how to integrate these training techniques into the classroom or provide guidelines on the circumstances when each might be most appropriate. Furthermore, his analysis did not take into account current theories of instructional design which suggest strategies for optimally combining training principles from all three theories of learning (e.g., Ertmer & Newby, 1993 Merrill, 2002).

Unfortunately different theories of learning do not always agree on how to best train specific skills. For example, the cognitive approach says that the instructor should organize the material to optimize assimilation by students, whereas the constructivist approach says it is better for students to organize the material in a way that is unique to each one. While these theoretical divides are perfectly okay from a researcher's perspective, they are problematic for the training community that needs to know the optimal way to train.

Table 1

Examples of Principles of Learning and Associated Training Techniques from Sanders' (2001) Report

Principle of Learning	Training Technique
Behaviorism	
Reinforcement impacts performance	System cues will serve as a reward when action is successful
Deliberate practice will ensure a strong stimulus-response association	Identifying critical system cues that prompt specific actions will help students to form stimulus-response associations
Cognitive Theory	
Encourage students to make connections with previously learned material.	Compare analog and digital ways of performing a task
Structure, organize, and sequence information to facilitate optimal processing	Use outlines, summaries, and advance organizers to help students assimilate information
Constructivist Theory	
Promote case-based reasoning	Incorporate realistic vignettes for digital system use that require unique solutions
Use coaching rather than lecture to promote problem solving by the students	Incorporate adaptive thinking scenarios that require the student to think about how they would manage digital communications

Regarding the disagreement between the cognitive and constructivist points of view, it is possible that both are correct. Specifically, it may be good for the instructor to provide organization of the material for novice learners but better for advanced learners to organize the material for themselves (Clark & Wittrock, 2000). For example, an ARI research effort examined modes of instruction for a digital map interface using two groups of Soldiers: infantry officer basic course (IOBC) and one station unit training (OSUT) Soldiers (Dyer, Singh, & Clark, 2005). The IOBC students had college degrees and generally a higher level of military knowledge than the OSUT Soldiers who mostly had only completed high school. In this experiment, IOBC Soldiers did better than the OSUT Soldiers in an exploratory training condition (constructivist approach to training) but both groups did equally well in a structured mode of training with lessons and exercises (cognitive approach to training).

Theories of Instructional Design

Theories of instructional design attempt to provide coherent strategies for training developers that are based on principles of learning. The present research adopted Merrill's (2002) instructional theory and designed the IMI according to five key principles of learning (Table 2).

Table 2

First Principles of Instruction

Learning Principle	Description
Task Centered	Learning is promoted when learners acquire concepts and principles in the context of real-world tasks.
Activation	Learning is promoted when learners activate relevant previous knowledge.
Demonstration	Learning is promoted when learners observe a demonstration of the skills to be learned.
Application	Learning is promoted when learners apply their newly acquired knowledge and skill.
Integration	Learning is promoted when learners integrate their new skills into their job performance.

Merrill (2006) proposed a strategy for applying these principles for the training of complex, real-world tasks. To illustrate his strategy, he compared it to an information only strategy commonly found in a wide variety of courses in which the instructor just presents material. He found that using an information only approach (what he also refers to as level zero (0) instruction) to training complex tasks, resulted in low levels of skill proficiency (Merrill, 2002). Merrill's strategy consists of three levels of instruction. With each level of instruction added, according to Merrill, student skill proficiency will improve. Merrill developed this strategy by identifying the common elements of other existing instructional strategies.

Merrill (2006) described the first level of his strategy, what he calls level one (1) instruction, as the addition of demonstration to level zero (0) instruction. According to Merrill, demonstration involves presenting a worked example that shows all or part of a task to be performed. It goes beyond simple information in that it shows the relevant application of the information. Demonstration helps students to understand how to apply their knowledge in novel situations.

Level 2 instruction is that which includes information, demonstration, and application. When students are given the opportunity to apply what they have learned to real world tasks, they are able to confirm that they successfully learned from the information and demonstration. If they have difficulty applying this knowledge, instructor feedback should help them to improve their performance on subsequent attempts. Merrill (2006) recommended that instructors not just have students repeat the task under the same conditions, but rather students should repeat tasks under novel conditions so that their skill can generalize too many conditions.

In level 3 instruction, a task-centered strategy is used along with information, demonstration, and application. A task-centered strategy introduces the learner to the whole task from the beginning. Often instructional strategies start by teaching pieces of a complex task under the assumption that the whole task will overwhelm learners (part-to-whole approach). Only after they are taught all the pieces, learners are shown how the pieces fit together to make the whole task. Merrill believes that this approach is actually more complicated from the

learner's standpoint because learners cannot assimilate the pieces into their knowledge base until they see how all the parts fit together.

Merrill's process is a structured approach to training in which the student is shown a worked example of a simple version of a task and is then given an opportunity to practice (apply) what is learned. If the task is highly complex, it may be necessary to focus on parts of a task, but they should never be taught in the abstract. They should always be taught in the context of the whole task. As the learner performs progressively more complex versions of the task, the instructor should provide progressively less instruction. Each new version of the task should provide the learner with opportunities to practice previously learned skills and introduce new skills/task components. The goal of this strategy is to enable the student to perform the complex, real-world task without instructor guidance.

The last two principles, activation and integration, can enhance all three levels of the instructional strategy. Activation primes the learner to think about his or her own relevant knowledge. By retrieving relevant knowledge, learners encode the new information into existing cognitive structures. That is, by retrieving knowledge and experience, learners better organize and understand new information. Sometimes, however, learners may not have prior experience they can retrieve. One way to overcome this problem is to provide students with a framework in which to organize the new information.

Finally, providing opportunities for students to integrate the new skills on the job will increase the effectiveness of the instructional strategies. In addition to practicing the skill in the job, students may integrate the new skill through simple reflection. That is, by thinking about ways in which they could apply this skill in novel situations, they can integrate it into their daily work activities. Another strategy is to require students to publicly demonstrate the skill. Merrill (2006) suggested that this latter strategy can be a powerful motivator as students do not want to fail in front of their peers.

Merrill (2006) points out that although the first principles seem obvious, in practice many domains of training utilize only one or two of these principles of learning. Indeed, this is what was found in prior research investigating digital system training in the Army as described in the next section.

Principles of Learning Used in Digital System Training in the Army

To gain an understanding of the methods and training techniques employed in digital system training in the Army, operator courses for Maneuver Control System (MCS), All Source Analysis System (ASAS), Army Field Artillery Tactical Data System (AFATDS), and FBCB2 were observed as well as shorter, familiarization training for FBCB2 and MCS (Leibrecht, Goodwin, Wampler, & Dyer, 2007; Tucker et al., 2009).

These on-site observations of digital training have shown that many principles of learning are not incorporated into the training of the software interfaces for the Army's tactical systems. The most prevalent activity found in classroom training was guided demonstration. In guided demonstration, the instructor performed each step as the students repeated the steps at their work

stations (Figure 1). This technique most closely matches what Merrill (2006) described as a level 2 training strategy in which there is both demonstration and application of the skill.

That is not to say that the training lacked elements of the other principles of instruction. For example, in the FBCB2 courses that were observed, instructors frequently related training tasks to military operations. This might help activate relevant experiences for some Soldiers and could provide a framework for inexperienced Soldiers to integrate the tasks being trained.

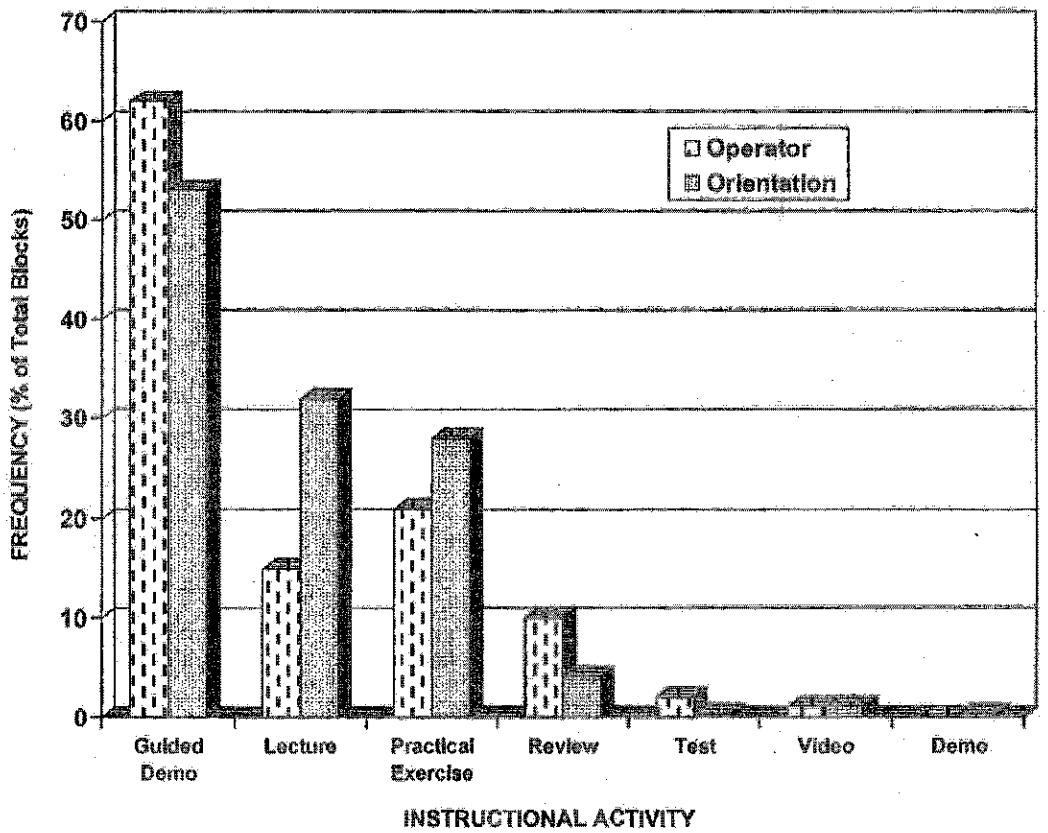

Figure 1. Overall frequency of the seven instructional activities, by type of course (from Leibrecht, Goodwin, Wampler, & Dyer, 2007).

Although the training focus is clearly on performing specified tasks within the system (e.g., troubleshooting, creating and sending messages, navigating, etc.; for a complete review of the tasks trained in the courses see Leibrecht et al., 2007), the approach used by the instructors is not task-centered in the way that Merrill (2006) described it for a couple of reasons.

First of all, in the primary mode of instruction, guided demonstrations, the students simply mirrored the instructors' actions. The instructors rarely acted like coaches, trying to get students to actively apply what they had learned. Neither did practical exercises require students to solve novel problems. Rather, they were typically repetitions of the instructor-demonstrated

tasks (Leibrecht, et al., 2007). In Merrill's (2006) view, with each repetition of a task, the instructor should introduce more complex versions of the task and coach when needed.

Second, the concept of a complex task in Merrill's view is more expansive than performing single software functions. During a mission, FBCB2 would be used for planning routes, tracking vehicle locations, sending digital messages, troubleshooting, and any other relevant functions. Thus a truly task-centered instruction by Merrill's definition would train each of these component software functions as a part of the larger complex task of using a vehicle-mounted FBCB2 on a mission. By training tasks separately and out of context, students do not fully understand how these functions might fit within the context of actual missions.

Even in practical exercises the focus was on what to do rather than how or why. For example, students would execute multiple software functions during a practical exercise, but they were told explicitly which tasks to perform (e.g., write this message and address it to these people, include this information, and save it in this folder, etc.). Training rarely focused on issues like how to determine what should be included in a message, how to determine who should receive the message, or how to determine what type of message to send.

This is not to say that digital skills training is poorly designed or executed in the Army. In a survey of operational use of FBCB2, for example, deployed Soldiers who had completed the 40-hour operator course, used more functions and were more likely to see functions as mission critical than those who did not receive this training (Bink, Wampler, Goodwin, & Dyer, 2007). Furthermore, it was estimated that Soldiers who completed 40 hours or more of formal operator training would achieve the same level of proficiency as Soldiers with nine or more months of combat experience using FBCB2 but who had no formal training (Bink, et al., 2007).

We believe that by using the task-centered approach of Merrill (2006) to design classroom instruction for digital skills, training will increase both the acquisition and transfer of those skills. To help instructors understand how to implement this approach in the classroom, we developed the "Enhancing Digital Training" IMI."

Development of the "Enhancing Digital Training" IMI

The target audience for this multimedia package is trainers and training developers of Army digital systems. These individuals are typically active duty noncommissioned officers (NCOs) or civilian contractors with prior military experience and are usually subject matter experts on the digital systems they teach. They have often taken Army instructor training courses (e.g., Army Basic Instructor Course, Methods of Instruction Course) which are general train-the-trainer courses, but their training on the specific methods and techniques used to teach digital skills comes from the other instructors. As noted above, this primarily includes guided demonstrations, lectures, and practical exercises.

The goal of the IMI is to provide instructors with some tools and techniques to enhance the way they train. In most regards, the IMI does not recommend changes to the content of courses (Programs of Instruction) but rather suggests different methods of training. Instructors can adopt the techniques presented in this IMI to train any or all portions of a course. One

approach for instructors would be to first try out the new instructional techniques on a small portion of a course before adopting them more broadly.

The IMI is organized into six main modules. The recommendation is to complete the modules in the order in which they appear, but the material is designed so that it can be completed in any order. The six modules are summarized in Table 3 and described in more detail below.

Table 3

Training Modules Found in the Enhancing Digital Training Multimedia Instruction

Module	Description
How learning and memory work together	In this module, memory is discussed from the standpoint of information processing theory. Ways to help students avoid information overload and to more effectively encode information based on this theory of memory are discussed.
Digital classroom training challenges and opportunities	This module covers challenges such as varied experience levels of students, gaining and maintaining student attention, ways to effectively ensure student understanding, and ways to deal with poor system design.
Classroom activities and principles to improve learning	This module introduces Merrill's First Principles of learning and discusses training techniques that are associated with those principles. It also explains how to develop training using these principles.
A training example	This module provides an example of how to apply Merrill's First Principles for training on the FBCB2 digital system.
Resources for the trainer	This module provides brief vignettes and scenarios and some multimedia samples that instructors can use to develop training
Summary and Review	This module is a brief summary of the main points covered in the IMI.

The "How Learning and Memory Work Together" module looks at short- and long-term memory from the standpoint of information processing theory. An explanation of the way in which information is moved into long-term storage serves as the basis for understanding how to improve the retention of information. Chunking similar information together to overcome limitations in short-term memory capacity is an example of an instructional technique given in this module of the IMI. This module also explains how information is encoded in long-term memory (by association with existing knowledge). Thus, relating course content to information that students already know should help learners effectively encode that information so that it is more likely to remain in long-term memory and more likely to be recalled when needed.

The "Digital Classroom Training Challenges and Opportunities" module looks at four types of challenges faced by instructors and provides guidance on ways to overcome them. The first challenge type is having students with varied experience levels in the classroom. Varied experiences discussed both in terms of student performance and peer coaching.

The second challenge type is gaining and maintaining student attention. The IMI covers ways to configure the classroom environment to promote attention. It also discusses using vignettes and role playing exercises to help students achieve the learning objectives.

The third challenge type is ensuring student understanding. These topics include techniques for clearly presenting material, the use of worked examples to show students what right looks like, and the importance of encouraging note taking.

The final challenge type is overcoming poor system design. Solutions include providing students with easy to remember mnemonics, calling attention to critical visual prompts or signals in the software, and providing students with take-home memory joggers.

The "Classroom Activities and Principles to Improve Learning" module reflects Merrill's (2006) first principles of instruction. This module has two main sections. The first is a review of the most common classroom training techniques (e.g., lecture, discussion, videos, demonstrations, practical exercises, and reviews). Good and bad examples of each technique are presented, and the strengths and weaknesses of each technique are discussed. The second section, which is the core of this module, reviews Merrill's five first principles. Examples of several training techniques are presented, and the instructor must judge them as either good examples or violations of each principle.

The "A Training Example" module goes through an example of how to train a complex FBCB2 task using a level 3 training strategy. This example demonstrates how to train a complex real-world task by building complexity and reducing the amount of instructor guidance. The example is a patrol that encounters several significant events. Students must send chemical, obstacle, and MOPP reports and request medical evacuation support. Students are not only encouraged to think about how to send messages but also about which messages to send and why and what information to include.

The final two modules are the "Resources for the Trainer" module and the "Summary and Review" module. The resources module includes multimedia resources like videos and graphics that trainers can incorporate into training. It also provides additional instruction on how to train tasks in context and provides vignettes that instructors can use for training various digital systems. The review module focuses primarily on the first principles and how to apply them for training digital systems.

Using the "Enhancing Digital Training" IMI

The training approach in this IMI differs from typical digital skills instruction in several ways, so instructors will need time to understand how these changes will affect the way they teach (Table 4 summarizes key differences and implications for instructors).

Table 4

Comparison of Traditional Training to Training Described in the Enhancing Digital Training IMI

Traditional Classroom Training	Enhancing Digital Training IMI	Implications for Trainers
Tasks are trained in a sequence that makes sense from the standpoint of the system. For example, menu items might be taught in the order in which they appear on a menu.	Tasks are trained in a sequence that makes sense in the context of the real world task. For example, messaging and navigation tasks may be taught dynamically based on the execution of a real-world mission.	Time and effort will be needed to develop scenarios and develop new lesson plans.
Focus is on demonstration and application. Students primarily repeat the performance of the instructor.	Instructors initially provide much guidance. Instructors' roles as coaches increase as students can perform the tasks independently.	Instructors have to learn how to coach rather than tell students how to perform tasks. Students may get frustrated that instructors will not just tell them the answer. Time management will be more difficult because students will achieve objectives at different rates.
Tasks are often introduced in the context of combat operations, but the students are told what task to perform and how to perform it.	A realistic context is provided so that students must figure out what tasks need to be performed at certain times as well as why the tasks need to be performed.	Students and instructors will have to be comfortable with training that develops more problem-solving skills and less procedural skills.
Training objective is on how to operate	Training objective is on how to employ	Different assessment techniques are needed to ensure new objectives are being met.

First of all, instructors will have to reorganize course material. Traditionally, training on digital systems is organized from the standpoint of system design (e.g., Dyer, et al., 2000). For example, training may start off on system start-up, then messaging, then navigation, etc. When training in the context of a complex real-world task like a patrol mission, messaging and navigation training may be mixed together.

Another change will be that students will spend more time learning through the process of problem solving. This means that instructors will have less control over the pace at which students move through the material. Furthermore, supplemental course materials may be needed for students who are able to complete additional exercises within the allotted time.

Another challenge for instructors using the Enhancing Digital Training IMI may be adopting a coaching approach to training rather than the more traditional "sage" or "expert" approach. The goal of a coach is to allow students to solve problems on their own and provide cues or information when needed. In a more traditional approach, the instructor is an expert who simply answers the students' questions. Knowing when to provide information rather than solving the problem for the students is being a good coach.

Finally, questions about when, how, and why to employ a system reflects complex decision-making processes which often have more than one right answer. This training focuses on "how to think" rather than "what to think." Discussion of these topics will make students aware of the importance of knowing things like commander's intent and unit standing operating procedures.

Although adopting all the training principles and techniques described in this IMI would mean substantial revision of many digital system courses, one approach would be to try a few techniques at a time, evaluate them and then decide whether to continue using them. For techniques that involve reorganization of course material, it is recommended to first try them out on a small portion of a course.

The process in Figure 2 is suggested as a simple way to evaluate training principles. Examining these techniques through two or three iterations of a course should provide an adequate basis for deciding whether to adopt the technique and expand its use throughout the course or whether to reject the technique. Techniques can be evaluated on different dimensions including instructor demands (the time and effort needed to develop and use the technique), student engagement, and finally student performance. Evaluations can be based on both objective (e.g., student questionnaires or exam scores) and subjective indicators (e.g., instructor impressions, informal student feedback). How these dimensions are weighted in the final decision should be up to the instructor. Although these techniques will work for all instructors, how a given instructor implements any particular technique can vary. All instructors have different strengths and weaknesses and instructors should implement these techniques in ways that favor their strengths.

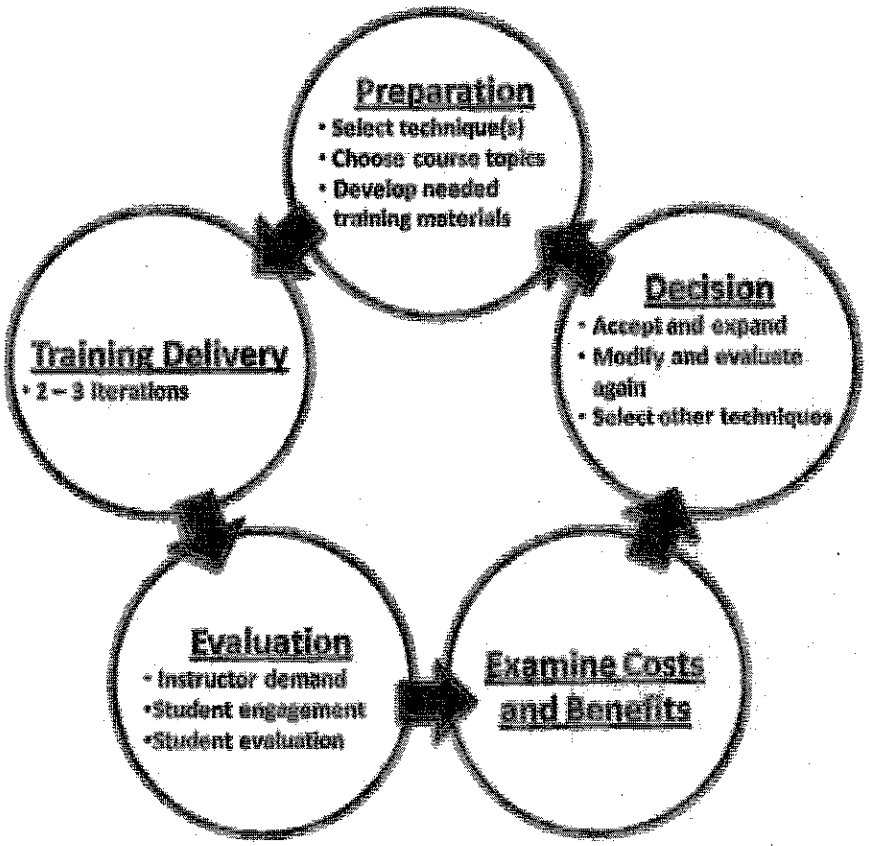

Figure 2. Recommended process for evaluating and adopting training principles described in the IMI.

We chose the strategy of Merrill (2006) to develop the IMI because we know it to be very applicable to digital skills training. The five first principles are common to many instructional strategies as well as the principles put forth by Sanders (2001). Merrill's level three instructional strategy described above is a proven and reasonable way to train complex tasks and we believe it is well suited for training digital system tasks. It is our hope that the Enhancing Digital Training IMI provides instructors of digital system courses with a tool to implement these principles and strategy into their teaching.

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