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Working Memory and Exploration in Training the Knowledge and Skills Required by Digital Systems

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14. ABSTRACT *(Maximum 200 words)*: Variations in computer-based training (CBT) procedures were compared in training the skills and knowledge required of a prototype map interface for the Land Warrior system. Soldiers from four Infantry courses participated, representing the chain of command within an Infantry platoon, from platoon leader to rifleman. Soldiers were first trained on codes that uniquely identified individuals and units on the map. Then soldiers learned how to use map functions such as pan, zoom, determine range, and find individuals and units. Lessons that contained a large volume of information before soldiers could apply that information and commit it to memory resulted in low scores on both the code and map exercises. Breaking up the content into smaller chunks of information tended to be more effective. Although soldiers who learned the map on their own via an exploratory condition had the lowest map performance, exploratory learning may have potential as these soldiers spent relatively little time "exploring." The results demonstrate the importance of adapting to individual differences in the learning rate of soldiers. They also provide insights regarding how to design effective and efficient CBT for digital systems.

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FOREWORD

The research presented in this report was conducted by the Infantry Forces Research Unit (IFRU) of the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) under its TRAINMOD: Training Modernization (#204) work package. TRAINMOD involves addressing training issues associated with new Infantry systems. New Infantry systems, such as the Land Warrior (LW), have computer software that soldiers and leaders must use to execute their mission. It is anticipated that much future training on these and similar "digital systems" will be done with some form of interactive multi-media or computer-based training (CBT). Under TRAINMOD, a series of experiments was begun on how to develop CBT to train the target population on these systems. This report describes the results from the first experiment. It examined the impact of the amount of information presented in a lesson as well as the effectiveness of an exploratory mode of learning.

The results provide insights into the design of effective and efficient CBT for digital systems. A training technique that divided instructional content into relatively small chucks and then presented training exercises was more effective than a technique that presented large volumes of information before soldiers had training exercises. In addition, an exploratory mode of learning showed promise as it required the least time, but it did not yield the highest performance. Variations in exploratory modes of learning that incorporate more traditional training techniques may be more effective. The different training techniques were applied to two different domains: learning "facts" and learning "software interface procedures." Soldiers who participated in the training had diverse military backgrounds and were representative of the chain of command within an Infantry platoon, from the platoon leader to the rifleman. The research also showed how CBT could be designed to incorporate tactical system software for background instruction and demonstration screens, and as interactive screens for performance exercises, yielding a high-fidelity training environment.

The results were briefed to the LW Training Working Group, the Project Manager-Soldier Electronics/Land Warrior (PM-SE/LW), and the LW Manpower and Personnel (MANPRINT) Working Group in May, June, and August of 2001 respectively. The findings provided the PM-SE/LW with needed information on how computer-based training could be incorporated in the design of future training for the Land Warrior system.

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WORKING MEMORY AND EXPLORATION IN TRAINING THE KNOWLEDGE AND SKILLS REQUIRED BY DIGITAL SYSTEMS

EXECUTIVE SUMMARY

Research Requirement:

Much future training for equipment in the Army's digitized forces will be done with some form of interactive multi-media or computer-based training (CBT). Knowing how to develop effective CBT for the diversity of soldiers and leaders employing these digital systems is critical. When designing CBT, instructional designers make important conceptual decisions that influence the learning process. One decision is how much material to include in a lesson. Another decision is the extent to which the training should be highly structured as compared to giving individuals the flexibility to learn on their own. The research described here examined these issues within the context of prototype software for the future Land Warrior system. It provided guidelines and insights into how to design CBT programs that will be successful with the diversity of soldiers and leaders in the Army.

Procedure:

Soldiers, a total of 168, from four Infantry courses at Fort Benning, GA participated, including those in basic training, noncommissioned officer courses, and the basic officer course. Within each course, soldiers were randomly assigned to the training conditions. All training was conducted via CBT; there was no instructor. Soldiers progressed at their own rate. The experiment had two phases. In the first phase, two variations of CBT were developed to train soldiers to learn unique codes for identifying units and individuals displayed on a digitized map. One condition placed high demands on soldiers' working memory by presenting much information before soldiers had an opportunity to apply this information. The other condition placed low demands on working memory, by breaking up the lessons and exercises into smaller chunks. In the second phase of the experiment, soldiers were trained on map skills. Low and high demand conditions were implemented again, and an exploratory condition was added. In the exploratory condition, soldiers were informed of the map functions they had to learn, but not how to execute the required steps.

Findings:

Consistent differences in the soldiers from the different courses occurred in both experimental phases, with officers typically achieving the highest scores in the shortest amount of time, and Infantry trainees scoring the lowest, taking the most time. In both training phases, differences in favor of the low working memory demand condition occurred for the instructional segments where the amount of information presented was the most discrepant between the high

and low demand conditions. On the map final exam, soldiers in the exploratory condition had the lowest scores, with those in the low demand condition achieving the highest scores. However, those in the exploratory condition completed their training and testing in half the time required in the low and high working memory demand conditions. In summary, the low demand condition was the most effective for code and map skills.

Utilization of Findings:

Not unexpectedly, too much information can be included in a block of instruction. But blocks of instruction should not be made small just to reduce the error rate. They should not fragment content or ignore the need to consolidate and integrate information. The exploratory mode of training showed potential, particularly for the interactive skills and insights needed by soldiers in working with tactical system interfaces, but might be more effective when combined with some traditional modes of instruction. The experiments showed how CBT could be designed to incorporate tactical system software as background instruction and demonstration screens, and as interactive screens for performance exercises. High-fidelity training is a positive by-product of this technique. Although the multi-media instruction was effective, the medium per se is not an automatic panacea for training the digital skills required of soldiers and leaders. Measurement techniques and procedures are needed that account for the multiple, yet valid approaches a soldier can use to accomplish a task. In addition, challenges lie in developing problem-solving scenarios that require soldiers to go beyond demonstrating technical skill proficiency to demonstrating effective employment of digital skills in combat-like settings.

WORKING MEMORY AND EXPLORATION IN TRAINING THE KNOWLEDGE AND SKILLS REQUIRED BY DIGITAL SYSTEMS

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Working Memory and Exploration in Training the Knowledge and Skills Required by Digital Systems

Introduction

The Army is now automating the battlefield, creating what is known as digitized forces. Computer software is being embedded in vehicles, to include tanks, command and control vehicles, and Infantry fighting vehicles (General Accounting Office [GAO], 2000). In addition, the dismounted soldier will eventually have a wearable computer, such as that in the Land Warrior (LW) system (Goodman, 1999). Soldiers and leaders must use this software to execute tasks such as sending messages and orders, and creating overlays; tasks which were formerly conducted without a computer. In addition, these computer technologies give soldiers and leaders additional capabilities; for instance, real-time monitoring of the location and movement of units using digitized maps. In this report, we refer to this equipment as "digital systems," and the required soldier skills as "digital skills."

This large-scale fielding of computer technologies raises training questions. In particular, we need to know how to best train the diverse population of soldiers and officers who employ these systems. One approach is to use computers as a means of delivering training. Much is known about learning and cognition, yet questions remain regarding designing for interactive multi-media training systems. Issues exist about how tasks "should be broken down into practice activities, what activities the student should engage in first, how the activities should be organized, how much practice the student needs in each of the activities, and so on. Poor instruction often arises from the guesswork in the specification of these details" (Woolf & Regian, 2000, p. 353). Theories of learning and training provide general guidance (Sanders, 2001), but not the technical details required for the designers of interactive multi-media (computer-based) training. Empirical work, however, can address these unknowns, and reduce some of the guesswork involved during the actual creation of these training programs.

The experiment described in this report focused on three factors that can influence the design of computer-based instruction for digital systems.

- The type of task to be taught/trained: Declarative and procedural knowledge
- The instructional techniques: The volume of information presented before the user works with the material and the degree of instructional guidance provided
- Learner characteristics: Differences in Army experience and knowledge

Featured in many of the Army's digital systems is a computerized map that displays the battlefield locations of units as well as tactical overlays (Sanders, 2001). This is true of the computer display in the Land Warrior (LW) system. A unique feature of the LW system's map is that it must show individuals, down to individual squad members, as well as units. In order to use the map effectively, soldiers must know the codes or the means by which units and individuals are depicted. A challenge with the instruction described here was to develop a

coding scheme that would uniquely and graphically identify individual soldiers, as such a scheme does not currently exist within the Army.

An early prototype of the map display and layout proposed for the LW system was simulated. Some modifications were made to the prototype for purposes of the experiment, but basic functions such as panning and zooming, displaying individuals, and determining distances on the map were retained, and are similar to the most recent version of the system software. The experiment provided insights into the particular interface that was simulated. More important, it allowed an examination of the generic training issues mentioned previously. Participants were soldiers with differing Army backgrounds and experience.

Purpose

The training experiment had several purposes that have general applicability to many Army digital systems. Participants in the experiment represented the soldiers within an Infantry rifle platoon (young soldiers, noncommissioned officers, and lieutenants). Thus the research provided information on how soldiers from these different populations, who vary considerably in Army experience and training, would learn and apply the concepts taught about a digital map. Would one group of soldiers learn the information and procedures faster and to a higher level of proficiency than the other groups?

Different computer-based training procedures were also compared. In reality, many instructional applications are characterized by intense production schedules and limited resources (Lohr, 2000), leaving little or no opportunity for research on comparing the effectiveness of training alternatives. The research reported here examined the impact of the demands placed on working memory, and the impact of an exploratory mode of training. Soldiers were faced with two types of knowledge requirements. One was learning the unique symbols that represented individuals and units on the map. The second was learning how to manipulate the map interface to solve tactical problems representative of those required in the field. With both types of knowledge requirements, the amount of information presented before soldiers had an opportunity to apply it was varied. In other words, some soldiers were confronted with large amounts of information prior to any practical exercises (high demands on working memory). For others, the same information was divided into smaller chunks of information prior to practical exercises (low demands on working memory). How much information could be presented within a training session without overloading the soldiers?

With the map interface, some soldiers used an exploratory mode of learning the map functions. Basically, they had a period of time to determine how each function worked, without any exercises or feedback on whether they had learned all aspects of each function. Would soldiers learn the map functions by working on their own as well as soldiers given formal instruction?

A corollary to the above issues was whether the different soldier populations participating in the research would benefit more from one training approach than another. If that were the case, then training on digital systems should be designed to adapt to these differences.

Types of Knowledge

Anderson (1980) distinguished between declarative knowledge (knowing that), and procedural knowledge (knowing how). Declarative knowledge reflects the facts, concepts, and principles we know; while procedural knowledge reflects the skills we know how to perform, to include problem solving, reasoning, and means-ends analysis. For Anderson, procedural knowledge or cognitive skill learning occurs in three stages: a cognitive stage where the description of the procedure is learned, an associative stage where the method for performing the skill is worked out, and an autonomous stage where the skill becomes more and more rapid and automatic. Procedural knowledge can have both motor and cognitive components. A specific task, obviously, can be primarily motor (riding a bike) or primarily cognitive (programming a computer). Both forms of knowledge were included in the experiment.

The first phase of the experiment involved learning a coding system for uniquely identifying individuals and units; that is, facts or declarative knowledge. This system combined standard Army symbols with the battle roster (BR) numbering system. The second phase focused on learning the procedural skills to manipulate a digital map interface, specifically how to manipulate the software interface to solve tactical problems in locating personnel and ground features, and to determine range and azimuth. There was no intent to train these procedural skills to an autonomous stage.

Both phases compared training that placed differing demands on working memory. With the procedural knowledge in the map phase, it was also possible to use an exploratory training mode where there was minimal instructional guidance.

Demands on Working or Short-term Memory

One of the challenges for instructional designers of computer-based training is to present new information so it can be kept in short-term or working memory for a sufficient period of time to be processed and retained and retrieved as meaningful material in long-term memory. We know that if information in short-term memory becomes inactive, it will be lost unless it is also in long-term memory. As pointed out by Anderson (1980), it is helpful to "think of short-term memory as a working memory holding only knowledge currently in use" (p. 166). But our short-term capacity is limited. When new information exceeds the short-term memory capabilities of learners, they cannot hold it in short-term memory long enough for it to be processed, elaborated upon, and transformed into long-term memory. "For example, if we lose track of the telephone number, we are unable to dial it (Anderson 1980, p. 166)."

Andrews and Bell (2000) made a similar point in discussing simulation-based military training. "Structural models focus on identifying the mental structures, such as working, short-term and long-term memories that play roles in information storage and retrieval. One of the difficulties in designing virtual learning environments is understanding how much new information should be presented at one simulation session before learning overload occurs. Because simulation-based training can present so many new environmental cues at once to the learner, it is important that a solid understanding of learner's capacities be taken into account during the instructional design phase. If too much information is presented too quickly, the

learner's cognitive structures can be overwhelmed to negative effect (p. 380)." In computer-based training experiments on combat vehicle identification, Dyer, Westergren, Shorter, and Brown (1997) found that when too many vehicles were presented (8 vehicles each with 8 aspect angles for a total of 64 images), the training time increased and soldiers did not reach criterion easily. In this context, the recommendation was that no more than 6 vehicles, preferably 4 to 5, should be presented in a training session. In quite a different context, Trafton and Reiser (as cited in Atkinson, Derry, Renkl & Wortham, 2000) examined the effects of alternating examples and practice to a blocked condition where all examples were presented followed by all practice conditions. They hypothesized that the alternating condition allowed the participants to maintain an example in working memory during the practice session. Results showed that the alternating example and practice condition was more effective.

The concept of meaningful chunks. Miller (1956) argued in his classic article on "*The magical number seven, plus or minus two*" that short-term memory was limited not by the number of physical units (letters or words), but by the number of meaningful chunks. The number of chunks that could be held in immediate memory was postulated to be seven, plus or minus two. This span of immediate memory limits the amount of information that individuals can receive, process, and remember. But it can be expanded through recoding or grouping information into larger chunks that make the information more meaningful. Miller acknowledged in that article, as have others (Anderson, 1980), that it is difficult to define what constitutes a chunk of information. Nonetheless, the amount of information we can hold in short-term memory represents a limitation on our mental capacity.

Since Miller's (1956) article, more is known now about short-term memory, and slightly different theoretical frameworks have been proposed. The extent and nature of recoding depends on previous learning (Anderson, 1980; Baddeley, 1994; Ye & Salvandy, 1994). The number of chunks is dependent on the degree to which the material within each chunk is integrated or related (Baddeley, 1994). Short-term memory paradigms now involve retrieval from both long-term and short-term memory (Shriffin & Nosofsky, 1994). Many other factors such as attention, interference from similar inputs, and decision-making affect an individual's short-term processing of information (Baddeley, 1994; Shriffin & Nosofsky, 1994).

Applying the concept of chunks. In light of the substantial amount of research on short-term memory capacity, the many factors that can influence processing of information, and the difficulty in defining "chunks" (Simon 1974), it may seem unrealistic, and it probably was simplistic, to try to design experimental conditions that specifically varied the amount of material to be learned, based on the concept of chunks. Nonetheless, the concept was used to help structure the experimental conditions. It must be noted that most of the material presented in the experiment was unfamiliar to the soldiers. They did not know the coding scheme we presented; they had never seen the map interface that was presented to them. From that perspective, they had had no prior opportunity to "recode" this material, which would have helped them process larger amounts of information. On the other hand, the material was not equivalent to the nonsense syllables and strings of digits or words used in much of the work on short-term memory. The soldier's military background was relevant to the training content. The experiment should not be considered as a formal attempt to psychologically define or measure chunks. But it was hoped that the results would provide some guidelines, but certainly not a

formula, for instructional designers working with computer-based training programs, when faced with a similar issue of how much information to present in a "lesson" and when it is assumed that most of the information is unfamiliar to the learner.

We wanted to know how much information could be presented within a training lesson without overloading the soldier, without giving him too much to remember and process at once, and therefore creating problems in learning. Within each phase of the experiment, two working memory demand conditions were generated, based, in part, on the concept of Miller's number seven. The Low working memory demand condition (called Low Demand) contained lessons that typically presented about seven or fewer new concepts or codes to learn. The High working memory demand condition (called High Demand) had lessons with more than seven concepts or codes. More details are in the Method section on how we "quantified" the number of chunks.

Four groups of soldiers from Fort Benning, GA, with differing degrees of Army experience and knowledge, participated in the experiment. The most inexperienced were the soldiers from Infantry One Station Unit Training (OSUT). These were young soldiers in the midst of their basic and advanced individual training, who had not been assigned to an Army unit. Two groups of noncommissioned officers (NCOs) also participated. One group was enrolled in their Basic Noncommissioned Officer Course (BNCOC); the other in their Advanced Noncommissioned Officer Course (ANCOC). Lastly, there were soldiers enrolled in the Infantry Officer Basic Course (IOBC). These soldiers could have been commissioned through the U.S. Army Military Academy, through the Reserve Officers' Training Corps (ROTC), or through Officer Candidate School (OCS). OCS commissions NCOs as officers.

Working memory is influenced by the meaningfulness of the material (Anderson, 1980). The more meaningful the material, the greater the memory capacity. The more familiar soldiers are with weapon symbols, the battle roster system, or the Army's organizational structure, then the more meaningful the coding scheme and the fewer demands placed on their working memory. Of the four soldier populations participating in the research (IOBC, BNCOC, ANCOC, and OSUT), the OSUT soldiers have the least Army experience. The hierarchical structure of the Army and even the structure of an infantry rifle squad are not ingrained concepts for those in OSUT. On the other hand, ANCOC soldiers are senior noncommissioned officers with typically 12 years in the Army. Based on these differences in Army experience, the material was expected to be most challenging for the OSUT soldiers.

In addition, it was reasonable to expect that some soldier groups would be affected more strongly than others by the High Demand condition. Aptitude-treatment interactions have long been of interest to researchers (e.g., Berliner & Cahen, 1973; Corno & Snow, 1986). With respect to cognitive load and instructional design, Kalyuga, Chandler, and Sweller (1998) demonstrated that integrated diagram and text presentations of electrical circuits were needed to reduce cognitive load for inexperienced individuals, but the diagram only format was more effective for experienced individuals.

Aptitude-treatment interactions were not the primary focus of the experiment. However, as the soldiers in OSUT had the least military knowledge, it was expected that differences between the Low and High working memory demand conditions would be greater for them than

for the other soldier groups (BNCOC, ANCOC and IOBC). The soldiers' knowledge of Army symbols, the battle roster numbering system, and map reading was assessed, and provided objective indices of relevant prior knowledge. Yet not all dimensions that could affect the soldiers' performance (e.g., knowledge of the structure of military organizations) were assessed. Nor was there any attempt to directly assess differences in how the groups structured their military knowledge as has been done with other knowledge domains (e.g., computer programming, Ye & Salvendy, 1994).

Exploratory Modes of Learning and Training - Problem-solving

The map functions allowed comparison with another approach to training. Instead of explaining or describing how the functions worked, we wondered what would happen if we let the soldiers discover how these functions worked with no guidance, instruction, or feedback. In other words, treat the map tasks as problem-solving tasks. Present the interface, state what each function does, but not describe the procedures involved. Explore – figure it out on your own with no hints or guidance on what to do. The goal was to determine how each function worked. The individual worked with the map interface until personally satisfied that he understood each function. Then he progressed to the map final exam.

The map functions in the experiment did not require great insight or creativity, although it was presumed that soldiers had the basic computer skills required to work with menus and icons. However, even when a computer environment is relatively simple, the level of complexity can increase significantly if the user makes an error, venturing down an incorrect path. Greif (1994) suggested that the complexity of a computer environment is not a stable characteristic. Instead, level of complexity may be altered by user error, task novelty, and slight modifications in system configuration.

There were several reasons for having an exploratory training condition for the map interface (procedural skills). One, it is often stated that soldiers can and will figure things out on their own. If you just give them the opportunity, they will decipher how a software package works. Two, if successful, an exploratory mode would provide more training flexibility and an alternative that might work very well for some soldiers. Third, research on exploratory training had shown potentially positive and negative aspects, which were important to investigate in the soldier populations of interest. Fourth, computer software seemed an appropriate content domain for exploratory learning,

Research on exploratory learning has revealed both advantages and disadvantages over traditional training. One reported advantage is improved transfer of learning (Carroll, 1997; Egan & Greeno, 1973; Kamouri, Kamouri, & Smith, 1986). This improvement in transfer is believed to result from the use of analogical reasoning and hypothesis testing when acquiring procedural knowledge. It has also been reported that exploratory learning can be accomplished in the same or less amount of time as instruction-based training (Carroll, 1997; Kamouri, Kamouri, & Smith, 1986).

The reported drawbacks of exploratory learning include so called "exploration traps" (Payne & Howes, 1992) where learners may select inefficient methods to accomplish a goal, or

fail to remember the procedures they used to complete a task. Individuals may not possess the appropriate information-seeking skills (Wallace, Kupperman, Krajcik, & Soloway, 2000). Even when students had to use web technologies to solve problems, their information-seeking behavior was simplistic (Wallace et al., 2000). Although using the web was enjoyable, information seeking evolved into a search to find a good Web site. Students did not use search engines well nor relevant information they found during the search.

In addition, individuals who lack experience with a task may not possess the metaknowledge to recognize what they do not know. It has been reported that diversity of experience has a positive influence on information seeking during exploration (Briggs, 1990). High ability individuals may do well in an exploratory environment, but those with lower ability apparently require more learning support (Shute, Lajoie, & Gluck, 2000). Some research has addressed methods of providing a "supportive" exploratory environment in which potential "traps" are minimized and the benefits of exploratory learning are optimized (DeMul & Van Oostendorp, 1996; Trudel & Payne, 1995, Van Oostendorp & De Mul, 1999). For example, Trudel and Payne improved exploratory learning of a computer simulated digital watch by restricting the number of keystrokes allowed during a learning session.

Individual Differences in Exploration Tendency

Within the context of research on exploratory behavior and curiosity, computer software systems have been referred to as the "modern labyrinths for humans," and are ideal for research on exploratory behavior (Greif, 1994, p. 287). Research in this area (e.g. Carroll, 1997; Carroll, Mack, Lewis, Grischkowsky, & Robertson, 1985; Greif, 1994; Trudel & Payne, 1995) is still relatively young, and has focused upon issues related to software design (e.g. the complexity of software systems, providing help features to facilitate error management), and instructional design methods (such as minimal manuals, mode restriction, and adaptive task complexity).

Outside the realm of computer research, individual differences in curiosity and exploratory behavior have been studied in a wide variety of settings, using diverse methods and stimuli (Henderson, 1994). Much of this research has been conducted among children, and it is widely accepted that the predisposition to explore differs among children. However, research has also demonstrated that the tendency to explore is influenced by setting and the type of exploratory stimulus involved. For example, a child's tendency to wander and explore a new physical environment does not necessarily predict a tendency to explore other novel stimuli, or a preference for complex over simple stimuli (Henderson, 1994). Research on individual differences in exploring computer systems has focused primarily on the interaction between experience (expertise) and characteristics of the interface such as complexity (see Greif, 1994) and help features (e.g., De Mul & Van Oostendorp, 1996). However, little attention has been given to the question of whether some individuals are naturally more inclined to learn their way around a computer system through exploration of the interface.

As we were planning the present study, we were unable to find a measure of this tendency to bypass manuals and instructions, and learn through active exploration. For the remainder of this report we will refer to this construct as a tendency to work independently. Therefore a scale was developed to assess how participants approach a variety of tasks for which

it would be possible to either follow step-by-step instructions or plunge right in and attempt the task independent of directions. Following our development of the tendency to work independently scale, it was learned that a similar scale has been developed in Dutch by Glasbeek (as cited by DeMul & Van Osstendorp, 1996), who found that individuals with an exploratory learning style were more suited for minimal manuals than traditional manuals. De Mul and Van Oostendorp (1996) modified and administered the scale in an experiment of "exploration-supportive" facilities in a computer interface. We were unable to obtain a copy of the scale. However, a brief description in De Mul and Van Oostendorp indicates that our approach to assessing this construct was somewhat different from theirs. De Mul and Van Oostendorp presented participants with statements that each described an approach to learning a new apparatus, and had them rate the frequency with which they used each approach. In contrast, we presented soldiers with fifteen activities and asked them to indicate which of three learning approaches they would use for each task. A detailed description of our scale is in the method section.

De Mul and Van Oostendorp (1996) found no relationship between scores on their "learning style" scale and performance with a novel computer interface. However, the researchers indicated that the interface may have been too simple for differences to emerge, and observed that they had a ceiling effect in which participants essentially mastered the interface after performing a few tasks. In the present experiment, it was expected that a tendency to work independently would be related to success at mastering the interface for the soldiers in the Exploratory map learning condition. The relationships between tendency to work independently, time spent exploring, and scores on the map final exam were examined.

Computer-Based Training (CBT)

All training in the experiment was computer-based, as it was envisioned that this form of training will eventually be common with the Army's digital systems. Research has shown that CBT can be more efficient and effective than traditional classroom instruction, and that it adapts well to differences in the learner's rate and level of competency (Fletcher, 2000; Gibbons & Fairweather, 2000). Also it was of interest to know the challenges posed in writing courseware for a digital environment.

Of particular interest was prior training research with CBT on the Army's digital systems. Sanders' (2001) identified principles of learning from behaviorist, cognitive and constructivist theories that could be applied to designing computer-based training for command, control, communications, computers, and intelligence (C4I) systems, such as the Force XXI Battle Command Brigade and Below (FBCB2) system. In a follow-on effort, Deatz and Campbell (2001) demonstrated how one might incorporate some of these cognitive principles (advance organizers, chunking, frames, rehearsal, etc.) within CBT. But this was only a demonstration, not a training program. Sanders (2001) referred to a web site that provided training on FBCB2. However, in reality this medium was similar to an electronic version of a technical manual. It was not an interactive training medium where specific skills were taught, practiced and tested within an operational context (hypothetical real-world missions and situations), and where transfer to new situations was examined. Schaab and Moses (2001) cited observations of soldiers using and training with the All Source Analysis System (ASAS), a digital system for

military intelligence personnel, but CBT was not used in that training. In summary, we did not find any research on the training effectiveness of different CBT approaches for training digital skills with the Army's "new" digital systems.

Also of interest was whether any prior CBT research had examined the effects of discovery learning or the role of working memory. Some of the research cited earlier in this report did address CBT-related issues (e.g., Trudel & Payne, 1995), but most did not. Trudel and Payne simulated a commercial digital watch. They found that imposing a keystroke limit during the learning process or forcing subjects to explore one mode at a time were better training techniques than allowing subjects to explore the simulated watch on their own without any constraints. Some additional examples of research that examined CBT in conjunction with working memory are cited below.

Chandler and Sweller (1996) did not examine CBT per se, but did focus on the demands on working memory when learning a computer-aided design software package. They examined the impact of the design and use of computer manuals on cognitive load. When high interactivity with the computer was required, a manual format that required holding text information in working memory while searching and working with the computer screen was less effective than a manual-only approach. When low interactivity with the computer was required, then the format of the training manual did not impact learning. Shute (as cited in Shute et al., 2000) found an aptitude-treatment interaction involving working memory capacity in the learning of a flight-engineering tutor. Individuals with high working memory capacity and high general knowledge consistently performed well; those low on both dimensions performed poorly. The interaction effect occurred with those high on one dimension and low on the other. Specifically, individuals with low working memory capacity but much general knowledge benefited from being assigned to an abbreviated training condition, rather than an extended period of training. Apparently, the extended condition led to either boredom or fatigue. Those with high working memory capacity but low general knowledge performed best in the extended practice condition, as they were able to benefit from the extra practice. In examining the use of computer software for a shopping task (determining which store had the best prices for differing numbers of items), Wright and Lickorish (1994) found that as the number of steps needed to solve a problem increased (more demands on working memory), the more likely participants were to use various memory aids available to them. However, which memory or navigational aids participants were most likely to use was not predictable. The authors concluded that the "cognitive consequences of moving through texts displayed on computer screens are far from trivial" (p. 1003), whereas the cognitive consequences of page turning with books and manuals seem trivial.

Method

Participants

Soldiers from four U.S. Army Infantry School courses participated. These courses were the IOBC, BNCOC, ANCOC, and Infantry OSUT. The Infantry OSUT soldiers were in the 11th week of OSUT, which is a 14- to 16-week course. Both BNCOC and ANCOC soldiers were

mid-way through their courses, which are 7 weeks and 10 weeks, respectively, in length. All Infantry officers, regardless of commissioning source, attend the IOBC, a 16-week course. Some officers had graduated from IOBC; others were waiting to attend. These differences did not affect the results.

The experimental design called for 48 soldiers from each course. The actual number of participants was 48 each from OSUT and BNCOC, 42 from IOBC, and 30 from ANCOC.

There were considerable differences among the soldiers in the courses as reflected in their rank, time in military service, and age (see Appendix C). All Infantry OSUT soldiers held the rank of private. All IOBC soldiers held the rank of 2d lieutenant. All but one of the ANCOC soldiers held the rank of sergeant first class. BNCOC soldiers held the ranks of sergeant (31%) and staff sergeant (69%). ANCOC soldiers had been in the Army a mean of 11.51 years (SD = 2.21); BNCOC a mean of 7.47 years (SD = 2.60), and IOBC a mean of 1.93 years (SD = 2.29). The OSUT soldiers were not asked about their prior service time, as they were trainees. However, they were questioned about their educational background. Over half (65%) had a high school education, one soldier had a general education development (GED) diploma, and the remaining 33% had some education beyond high school (college or technical school). The mean ages of the groups differed significantly, $F(3, 163) = 137.59$, $p = .0000$. OSUT soldiers were the youngest (M = 19.58, SD = 2.36). IOBC was the next oldest group (M = 23.13, SD = 1.92). BNCOC was the next oldest group (M = 27.75, SD = 3.31). ANCOC was the oldest group (M = 31.59, SD = 3.40). Considering all soldiers, the youngest was 17; the oldest was 39.

Procedure

Soldiers within each of the four courses were randomly assigned to one of four experimental training conditions. The experiment was executed four times; once for each group of soldiers. Three multi-media rooms in the Infantry School were used. Each room had 16 computers, allowing a maximum of 48 soldiers to participate at a given time (see Figure 1). Four hours were allowed for the experiment. Software for each of the experimental conditions had been loaded on the computers prior to beginning the experiment.

Before starting, soldiers were briefed on the scope of the experiment. They were encouraged to take a break after completing the code exam and before beginning the map training. They could take other breaks if desired, but only after an exercise or lesson.

Figure 1. Multi-media classrooms where the experiment was conducted.

Experimental Design

The experimental design is summarized in Table 1. Phase I was individual and unit code training. Phase II was map interface training. The same information and concepts were taught and applied in the High and Low Demand conditions. The only difference in the High and Low Demand conditions was how this information was partitioned across the lessons and exercises. The content of the lessons and exercises was identical. Table 1 also shows that the Exploratory condition was only in the Map phase.

Table 1
Experimental Design for the Code and Map Training Conditions

Experimental Conditions			
Low Demand Code & Low Demand Map ⇩	High Demand Code & High Demand Map ⇩	Low Demand Code & Exploratory Map ⇩	High Demand Code & Exploratory Map ⇩
Code Lessons and Exercises: Phase I			
Two common blocks of instruction			
Six blocks of instruction	Three blocks of instruction	Six blocks of instruction	Three blocks of instruction
Final Exam on Codes			
Map Lessons and Exercises: Phase II			
Four blocks of instruction	One block of instruction	Brief explanation of each function; no instruction	Brief explanation of each function; no instruction
Final Exam on Map Functions			

Note. Each block of instruction concluded with practice exercises. There were no exercises for the instruction on range and azimuth map functions.

The coding system. In designing the experimental conditions for training individual and unit codes, we viewed the specific code required to uniquely identify each position as a chunk of information. Admittedly, this was a subjective decision, as the codes were not independent of each other. But this provided a basis for partitioning the instructional materials, as there are no firm guidelines for determining "chunks" of meaningful information. Compared to many memory experiments, the tasks were not simply memory tasks. Specific concepts and rules provided a scheme and format for deciphering the codes. In addition, following the presentation of each block of information, training exercises were provided that allowed the soldiers to work with the particular codes that had just been presented.

Soldiers had to learn a coding system for every individual within an Infantry platoon plus key leaders at the company level. The code or symbol system involved combining the symbols for the primary weapon (Department of the Army [DA], 1997) carried by individuals in each duty position with what is known as the battle roster (BR) numbering system (DA, 1994). These weapon symbol/BR combinations were developed specifically for the research. Figure 2 provides examples of these unique codes. These codes could be considered facts or declarative knowledge (Anderson, 1980).

Five weapon symbols and three unit symbols were taught. The BR numbering system was explained. The system provides for a five-character alphanumeric code that uniquely identifies individual duty positions from the rifleman to the battalion commander. The training focused on selected positions within the battalion. Soldiers learned the BR numbers for all nine members of a rifle squad, all nine members of the weapons squad, the platoon leadership (3 duty positions), plus the company leadership (3 duty positions). In addition, the coding scheme covered unique codes for units at the squad, platoon, and company level. Consequently, for a battalion, soldiers were taught to identify the code for any company commander, executive officer, first sergeant, platoon leader, platoon sergeant, squad leader, rifleman, etc.

The BR roster number itself provides a unique code for each duty position. We added the weapon symbol to help soldiers distinguish among the nine individual squad members. For example, by presenting the M203 weapon symbol, the soldier immediately knew the individual was a grenadier, even though he may have forgotten the unique number for a grenadier (a 3 or a 7). A description of the battle roster system and the weapon symbols used in the training is in Appendix A.

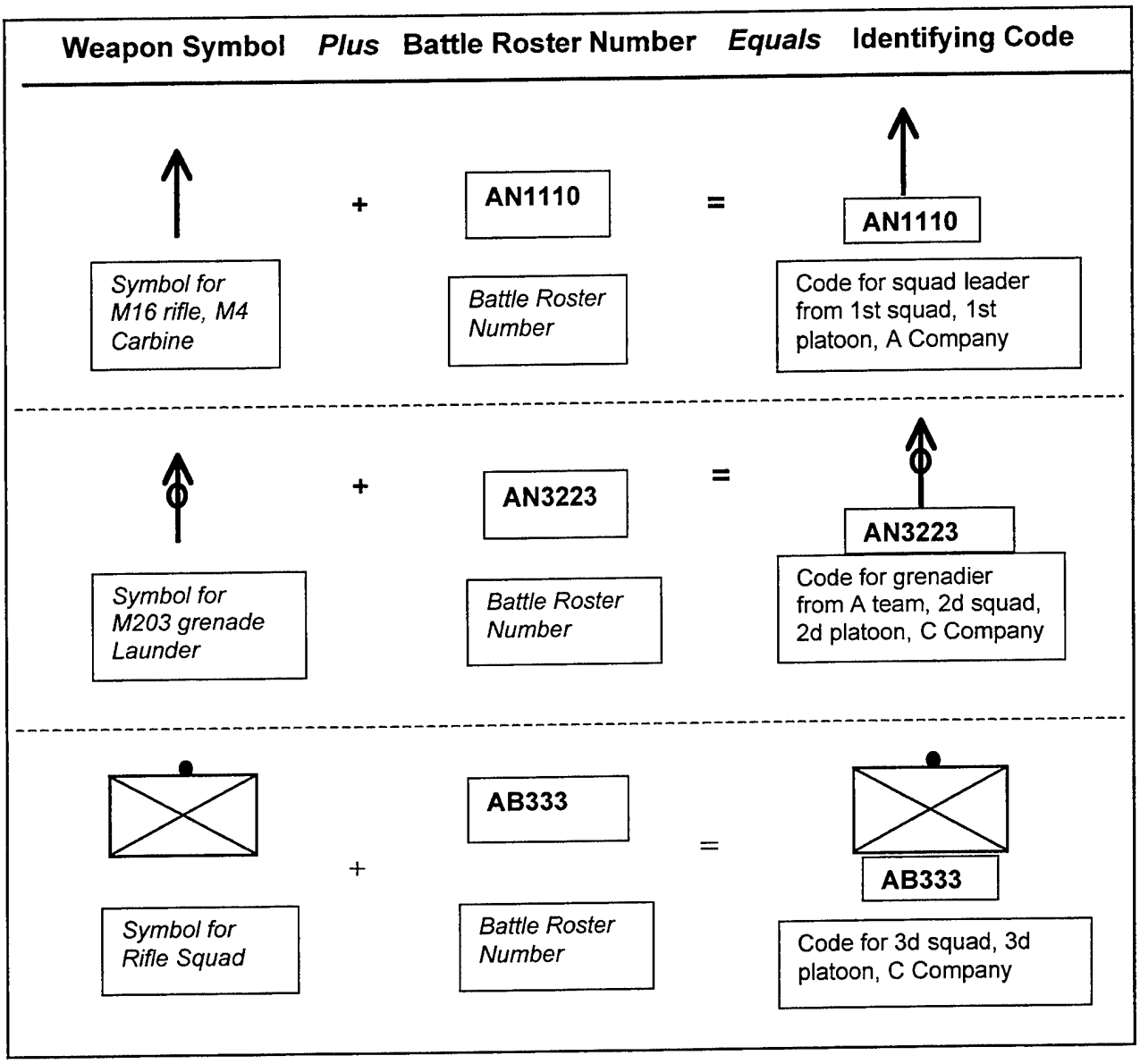


Figure 2. Examples of individual and unit codes resulting from combining symbols with the battle roster (BR) numbering system. [BR: first two letters designate the battalion, 1st number the company, 2d number the platoon, 3d number the squad, and last number the individual within the squad. This last number also indicates whether the soldier is in A or B team. The *first code* shown above is for a squad leader. A zero (0) in the last position with non-zeros in the preceding positions indicates a squad leader. He carries an M16 rifle or M4 carbine. The *second code* is for a grenadier. The *third code* illustrates a unit – the squad. The BR number is truncated at the squad position.]

Table 2 compares the Low and High Demand conditions by lesson. A chunk was defined as a unique weapon or unit symbol (graphic) or as a unique number or position that defined a duty position. Chunks, for purposes of the research, represented uniquely identifiable duty positions or units. The number of chunks for each lesson is depicted. Exercises followed each lesson. For example, with the Low Demand condition, lesson C was presented followed by the

exercises for C. Then lesson D was presented followed by the exercises for D. However, with the High Demand condition, lessons C and D were presented first, followed by exercises C and D. Under the Low Demand condition, less information was presented before soldiers worked on exercises involving application of or memory for the information in the lessons.

Table 2
Operational Definitions of Chunks of Information for the Code Training Conditions

Low Demand		**Content Description**	**High Demand**	
Lesson w/ Exercise	# Chunks		Lesson w/ Exercise	# Chunks
A	8	5 weapon symbols and 3 unit symbols.	A	8
B	5	The 5 positions in the BR numbering system.	B	5
C	5	The 5 numbers for company BR position.	C&D	13
D	8	The 4 numbers for platoon position and 4 numbers for squad position.		
E	9	The 9 numbers for individuals in rifle squad.	E&F	18
F	9	The 9 numbers for individuals in weapons squad.		
G	6	The 3 key leaders at both company and platoon echelons.	G&H	9
H	3	BR number for 3 echelons (units).		

Differences in the High and Low Demand conditions started at Lesson C (see Table 2 and Figure 3). As indicated in Table 2, the information presented in some High Demand conditions was double that presented in the Low Demand conditions.

A summary of each lesson follows. For continuity, the abbreviations in the summary titles below correspond to the abbreviations in Figure 3.

- Lesson A -Symbols (8 chunks): Five weapon symbols (M16 rifle/M4 carbine, M203 grenade launcher, M249 squad automatic weapon, M240B machine gun, and Javelin antitank weapon) and three unit symbols (squad, platoon, and company) were presented. Except for the M249 squad automatic weapon (SAW), all symbols were the same as those in the doctrinal manual on symbols FM 101-5-1 (DA, 1997). As there is no unique symbol for the SAW, one was generated for that purpose. Soldiers were told this was not an approved Army symbol, and was being used strictly for the instruction they were receiving.

- Lesson B – BR (5 chunks). The concept of the Battle Roster (BR) Numbering System was presented with an explanation of the five positions referenced in the letter/number string that uniquely defines individual duty positions. The battalion has a two-letter code; followed by a company single number code; a platoon/section number code; a squad number code; and an individual soldier number code.

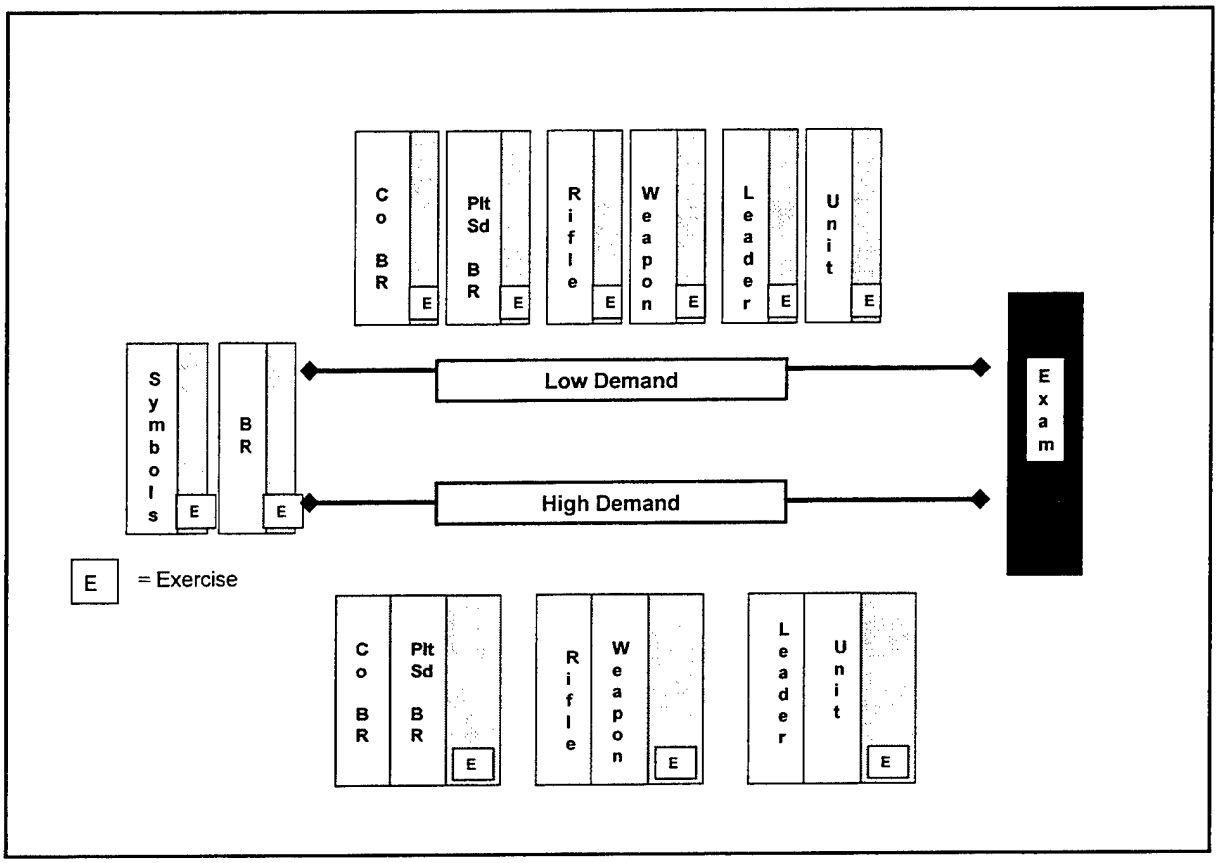


Figure 3. Instructional sequence for code training conditions.

- Lesson C – Co BR (5 chunks). The five numbers used to identify companies within a maneuver battalion.

- Lesson D- Plt Sd BR (8 chunks). The four numbers used to identify platoons were presented first, followed by the four numbers used to identify squads.

- Lesson E - Rifle (9 chunks). The numbers assigned to individuals within a rifle squad (0-8) were presented and defined. These individuals were divided by fire team as well. At this point, the weapon symbol was combined with the BR number, as shown in Figure 2 previously. Soldiers were able to self-test themselves with a sample of codes before proceeding to the exercise.

- Lesson F – Weapon (9 chunks). The numbers assigned to individuals within the weapons squad (0-8) were presented and defined. The weapon symbol was combined with the BR number, as shown in Figure 2. Soldiers were able to self-test themselves with a sample of codes before proceeding to the exercise.

- Lesson G – Leader (6 chunks). The codes for three key leaders at both the company and platoon levels were presented. These were the company commander, executive officer, first

sergeant, platoon leader, platoon sergeant, and radio-telephone operator (RTO). The weapon symbol was combined with the BR number (all leaders had the rifle).

- Lesson H – Unit (3 chunks). The final lesson focused on codes for units, specifically the rifle company, platoon, and squad. Although there are official symbols for each of these types of units (presented in Lesson A), there is an official BR type number as well. For purposes of the training, we simply truncated the BR number at the appropriate point to reflect the unit. That is the squad BR number omitted the individual position (the last number). The platoon BR number omitted squad and individual numbers. The company BR number omitted the platoon, squad and individual numbers, consisting of only the battalion letters and the company number.

If a soldier scored lower than 80% on any code exercise, he was given remedial training on the corresponding lesson. He then retook the exercise.

Map functions. A total of seven map functions was taught: zooming in and out, panning, finding oneself, finding others, displaying others, and range/azimuth determination. Figure 4 illustrates the map display. With the exception of range/azimuth, all functions were on the top toolbar. Range/azimuth was at the bottom of the display. The map tasks reflected procedural knowledge rather than the declarative knowledge of the coding system.

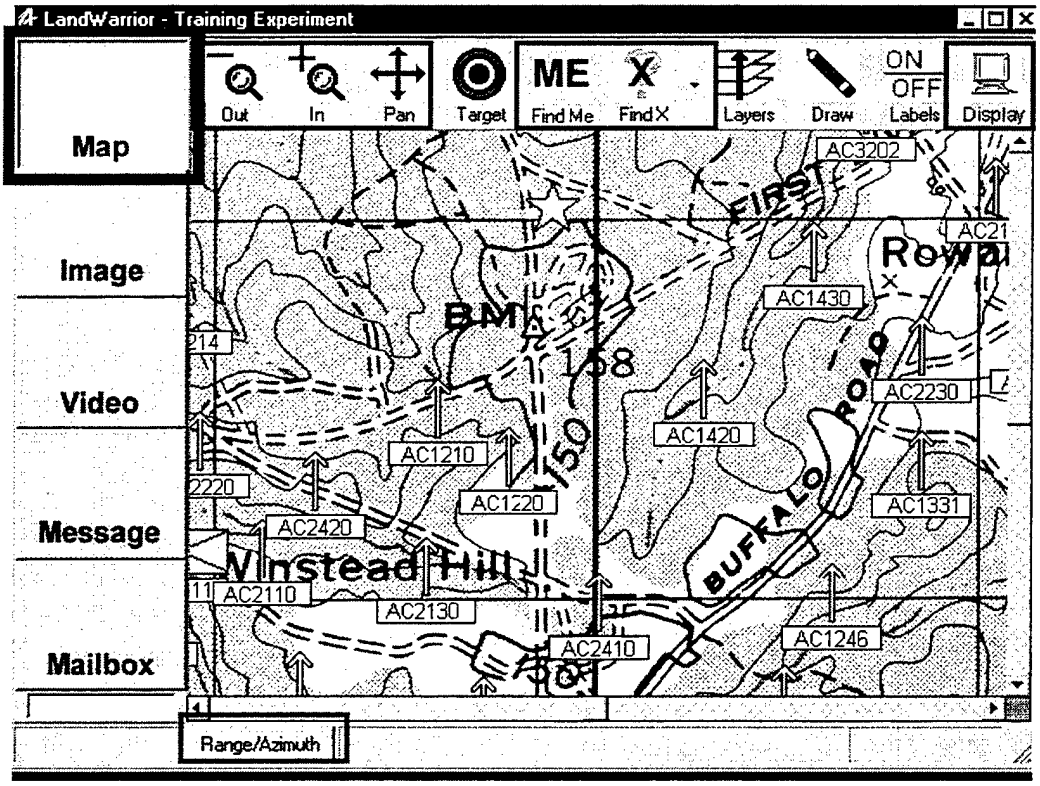


Figure 4. Map display. [Functions included in the experiment have a thick border.]

In the Low Demand map condition, the functions were divided into the four blocks of instruction listed here.

Zoom in and out, pan, and find oneself
Find others (called Find X)
Display others
Determine range and azimuth

In the Low Demand condition, exercises followed each block except for range and azimuth. In contrast, in the High Demand map condition, instruction on all functions was presented first, and then individuals were allowed to practice at the end of this presentation. Again, there were no exercises for range and azimuth.

It was harder to define "chunks of information" with the map functions than with codes. Clearly distinguishable units or entities were harder to define, as some procedural steps were self- cueing. Chunks primarily reflected the number of functions and the number of steps within each function (see Table 3). The button/function itself was always counted as one chunk of information as the soldier had to discriminate it from the other buttons/functions on the map display.

Table 3
Operational Definitions of Chunks of Information for the Map Training Conditions

Low Demand		**Content Description**	**High Demand**	
Lesson w/ Exercise	# Chunks		Lesson w/ Exercise	# Chunks
I	6	Zoom in, zoom out, pan, and find oneself functions. Two functions had one step; two had three steps.	I, J, K, & M	26
J	6	Find X function, with 5 types of menu selections: find unit, go to lower echelon, go to higher echelon, find individual soldiers, & find leaders at specific echelon.		
K	9	Display function. It triggered 3 menu selections; with 3 ways of working within each menu, 2 unique selections within two of the menus, plus a set of procedures covered in Lesson J.		
M	5	Range/azimuth function: 2 clicks to establish points on map, where to click for accuracy and how to cancel.		

As shown in Table 3, the information presented in the High Demand condition was greater than that in each Low Demand condition. Additional information on each lesson follows. The lesson summaries describe the map training conditions. The lesson titles are consistent with

the abbreviations in Figure 5. Figure 5 graphically illustrates the map training and testing sequence for all conditions.

- Lesson I – Zoom Pan (6 chunks). Four buttons or functions were presented (zoom in, zoom out, pan, and find oneself). Two (zoom out and find oneself) were only one-step (e.g., click on the button and the map zooms out). Both the zoom in and pan buttons had two additional steps. After clicking on the button you then had to click on the map to completely activate the function. To deactivate the function, you had to click on the button again.

- Lesson J – Find X (6 chunks). The lesson was on how to find others (units and individuals), called find X. Only one entity (unit or individual) could be displayed at a time with this function. Only one button was used, but it triggered a series of embedded menu selections. In this process, the soldier had to learn five additional critical elements (find unit, go to lower echelon, go to higher echelon, find individual soldiers, find leaders at a specific echelon).

- Lesson K - Display (9 chunks). The lesson was on how to display units and individuals. The function was designed as a pre-planning tool. Individuals could decide who they wanted to display on their map during a mission, and then make these selections during mission preparation. Only one button was used, but it triggered three menu selections (company menu, platoon submenu, and squad submenu). In determining the number of chunks of information, we counted each menu as one chunk of information (3 chunks). Three menu elements were similar to the find X (Lesson J), and therefore were counted as one chunk of information. These were display unit, go to upper echelon, and go to lower echelon. Within two of the three menus (company and platoon), there were two new categories of menu selections: one led to a further breakdown of the unit and the other led to a block of "all" selections. For example, with the platoon submenu, further breakdowns could be found for Co Hqs, 1st platoon, 2d platoon, and 3d platoon. The "all" selections within the platoon submenu were: all platoons, all platoon leaders, all platoon sergeants, and all squads. So within the company menu and the platoon submenu, each of these two sections was considered a critical chunk of information, for an additional 4 chunks of information. (The labels themselves were clear, once you understood the concept). Based on this rationale, the total number of chunks was 9. The rationale for defining the number of chunks for this type of task was consistent, but somewhat subjective.

- Lesson M - Rg Azm (5 chunks). The last instruction was on determining range and azimuth. Again, there was a single button, two clicks were required to establish the points or units/individuals on the map, soldiers had to know where to click to get an accurate reading, and another click was required to cancel the function.

The menus in the find X and display functions were hidden from the soldier's view, so the sequence of selections was not apparent from the map display (see Figure 4). The instruction within the Low and High Demand lessons revealed the various menu contingencies to the soldiers (see Appendix D for illustrations). Thus soldiers were formally taught and shown the different paths available to them with these functions. This technique was found to be particularly beneficial for individuals with low spatial abilities, although the technique also helped those with high spatial abilities (Alonso & Norman, 1998).

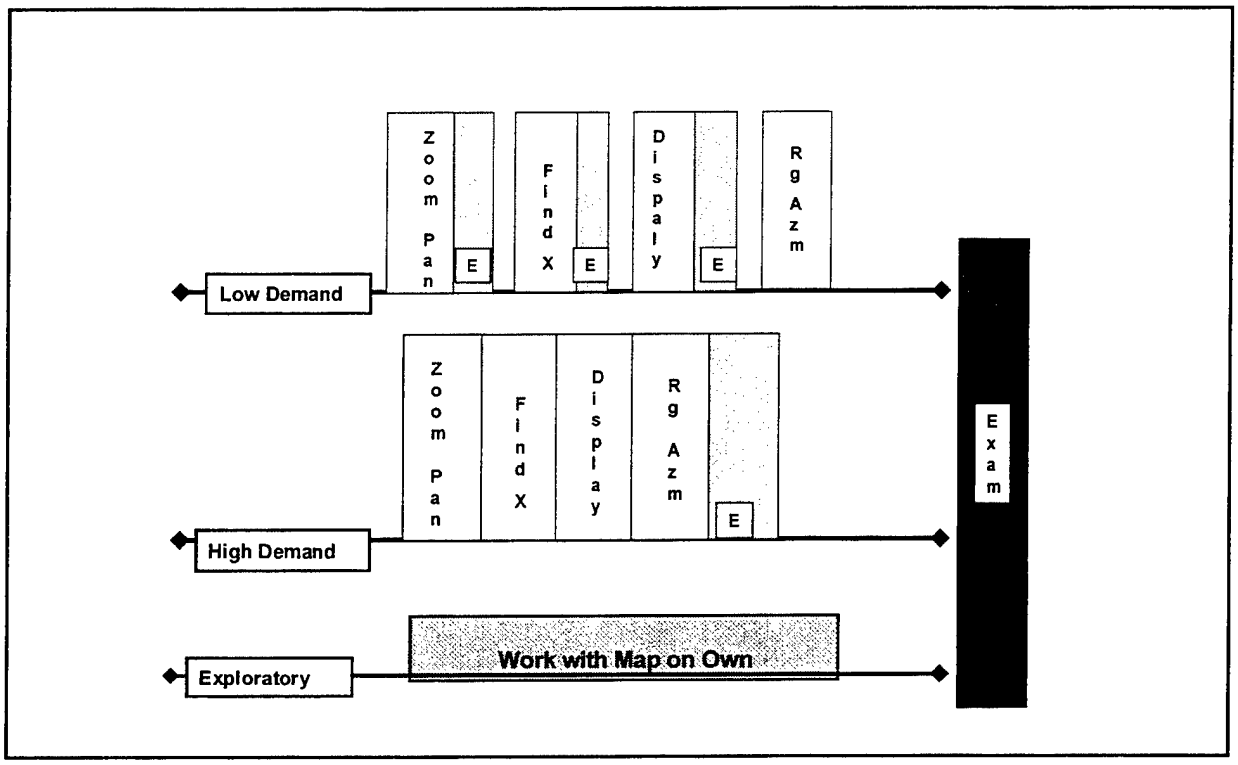


Figure 5. Instructional sequence for map training conditions. [The E refers to an exercise.]

No remediation was provided with the Low and High Demand map conditions. If soldiers scored less than 80%, they proceeded to the next lesson or exercise. Soldiers were told, however, that the desired score was at least 80%. There were two reasons for no remediation. First, there was no requirement for soldiers to learn the map functions as a prerequisite for performing a later task, as was the case with symbols and BR. Knowledge of symbols and BRs was essential to successfully completing the map tasks. Second, experimental time was limited. There was a high probability that some soldiers would not have completed the experiment if remediation had been required. The exercise scores were examined, however, for the numbers of soldiers who achieved the 80% desired criterion.

For the Exploratory map condition, soldiers were given minimal guidance and information. They were informed of the seven functions they had to learn through exploration, shown the location of each button on the map, and told the purpose of each button. There was no instruction on how these functions or the map display worked. They were given a set of tasks they could try to execute during their exploration, but were not required to do these tasks. They had 60 minutes to work with the map. However, they could progress to the final exam whenever they felt confident they knew how each button/function worked. The soldiers in this condition never had any external feedback on whether they fully understood each function. They used their own judgment on when to proceed to the final exam.

Measures

Pre-experiment measures. Before starting the training, soldiers completed a survey on their computer background and experience, and a short quiz on map reading, weapon symbols, and unit symbols. They were asked whether they had ever used the Army's BR numbering system. Participants also answered a series of questions directed at their normal tendency to work independently – to solve everyday type problems without requesting help or assistance. Lastly, they were asked to rate the extent to which they have a "knack" for learning computer programs on their own and a tendency to figure out computer shortcuts. These instruments are at Appendix B.

The computer survey was one that had been given previously to over 2000 soldiers as part of a three-year trend analysis of the computer background of soldiers (Dyer & Martin, 1999; Fober, Bredthauer, & Dyer, 2000). The weapon and unit symbols tested in the quiz were identical to those included in the training, except that the mortar symbol was used instead of the SAW. Thus these measures constituted a test of their current knowledge in that area. The OSUT soldiers were not expected to know these symbols as that is not a subject covered in initial training. In prior research (Centric, Wampler, & Dyer, 1999), it was found that military symbols were not taught in BNCOC. Consequently, high scores from the BNCOC soldiers were not expected either. The map reading skills tested were common to all soldiers, so relatively high scores were expected on these items.

The questions on tendency to work independently were developed in an attempt to identify those individuals who tend to figure things out on their own and therefore might be good in an exploratory learning environment. Many soldiers take this independent approach first, rather than reading instructions or asking for assistance. A search of the literature during our planning for the research showed no prior measures of this tendency. Therefore, a scale was developed in which participants were asked how they would usually "approach" each of fifteen activities for which instructions are typically available (e.g., changing the settings on a new digital watch), or an opportunity to ask for directions (e.g., finding your seat at a ballgame or concert). In order to assess whether individuals possessed a general tendency to solve problems on their own, only three of the fifteen items described computer-related tasks. The remaining twelve activities were quite varied (e.g., putting together a piece of furniture, responding to a survey). The scale used to rate the 15 tasks was as follows:

- *Complete with no instructions:* Complete the activity (or give up) without referring to instructions, a map, or asking for directions.
- *Read instructions only if needed:* Proceed at first without reading instructions, a map, or asking for directions, but will refer to these upon encountering a problem.
- *Read instructions first:* Read the instructions, a map, or ask for help before beginning.
- *Find someone else to do it:* Find someone else to perform the task you (a friend, spouse, etc.).
- *Not applicable*

The first three points on the scale were felt to be indicators of a tendency to work independently, that is, performing the task without instructions or guidance; proceeding at first without instructions, but referring to them if there was a problem; and lastly reading instructions before beginning the activity. Soldiers were also given the option of indicating that they would find someone else to perform a task for them, and they could provide a rating of "not applicable" for tasks that they had never performed. The tendency to work independently items are at Appendix B.

In addition to assessing tendencies toward working independently, the survey also asked soldiers to provide self-ratings of their ability to navigate through a computer program (computer knack) and their ability to identify efficient methods (short cuts) for performing computer tasks. For each ability, soldiers rated themselves on a 10-point scale ranging from "does not describe me at all" (1) to "describes me completely" (10).

Criterion measures. Criterion measures were scores on the practical exercises embedded in the code and map training, final exam scores on the code and map, number of soldiers who did not reach the 80% criterion on the exercises, and time required to complete exercises and training. The composition of these exercises and exams is in Tables 4 through 7.

All code exercises were in a multiple-choice format, with 60 seconds allowed to respond. Prior to each coding exercise and the code final exam, soldiers were shown the type of item(s) they would encounter. They were also told how many exercise items they had to answer correctly, corresponding to 80%, before progressing to the next lesson. If they did not achieve this level, they went through a review and retook the exercise. The reviews were specially developed to highlight the critical parts of each lesson. They were not simply a repetition of the lesson, as is often done with computer-based training.

With the first weapon and unit symbols exercise, correct/incorrect feedback was provided immediately after answering each question. When soldiers answered incorrectly, the feedback also provided the correct response. In addition, upon completing the exercises, soldiers were informed of the percentage of items they answered correctly. With all other coding exercises, feedback was provided only at the end of the exercise. In this case, all items answered incorrectly were displayed, and the correct answer was shown. Again, soldiers were informed of the percentage of items they answered correctly. On the final exam, soldiers were only informed of the percentage of questions answered correctly. Examples of exercise and final exam questions on the coding system are in Appendix D.

Table 4
Description of Coding Exercises

Exercise & Condition	Description of Exercise Items
Low and High Demand Conditions	
Weapon & Unit Symbols (A)	# Items = 24 (each of the 8 symbols presented 3 times). Response was selected from a multiple-choice format of the eight symbol names.
BR Numbering System (B)	# Items = 10. Each item presented two BR numbers. Soldiers had to identify the echelon (battalion, company, platoon, squad, individual) at which the numbers differed.
Low Demand Condition	
Company BR (C)	# Items = 10. Soldiers were shown a BR number and had to identify the correct company, from a list of the five companies: Company A through D and HHC.
Platoon and Squad BR (D)	# Items = 20 in two formats. In the first format, soldiers were shown a BR number and asked to identify the squad or platoon. In the second format, a verbal description of an individual from a specific unit (e.g., "the 1st Squad, 3d Platoon of Company A") was shown. Soldiers had to select the correct BR number from five choices.
Rifle Squad Codes (E)	# Items = 20. Soldiers were shown a code (weapon symbol plus BR number). They had to identify both the individual and his squad. In the first row of response buttons, the three squads were listed (1st, 2d, and 3d) in random order. In the last two rows, all nine duty positions in the rifle squad were listed, in random order (same order for all questions). Soldiers had to answer both parts correctly to "pass" an item.
Weapons Squad Codes (F)	# Items = 15. Soldiers were shown the code of a soldier in a weapons squad. They had to select the correct duty position from the nine positions in the weapons squad (presented in a random order).
Key Leader Codes (G)	# Items = 12 in two formats. In one format, the leader code was shown, and the soldier had to select the description of the leader's position from five options. In the other format, the leader's position was described, and the soldier had to select the correct code from five options.
Unit Codes (H)	# Items = 12 in two formats. In one format, the unit code was shown, and the soldier had to select the correct unit description from one of five options. In the other format, the unit was described, and the soldier had to select the correct code from one of five options.
High Demand Condition Exercise items for High Demand were the same as those for Low Demand.	
Combined Company through Squad BR (C&D)	# Items = 30. The company, platoon and squad code items were intermingled.
Combined Rifle and Weapons Squad Codes (E&F)	# Items = 35. The rifle squad and weapons squad items were intermingled.
Combined Key Leader and Unit Codes (G & H)	# Items = 24. The key leader and unit items were intermingled.

The final exam for codes is described in Table 5. As noted in that table, a single item format was used to test rifle and weapons squad members. The soldier had to identify the individual's squad (1st, 2d, 3rd, or weapons) as well as the individual duty position. The item was scored as being correct only if the soldier answered each part correctly. A "percent correct score" was given upon completing the code final exam. There was no feedback on individual test items.

Table 5
Final Exam on Codes

Description of Code Final Exam Items
• The final exam on codes had 25 multiple-choice items. The number of test items for each code was: Leader – 6; unit – 6; rifle squad – 7; weapon squad – 6. Items differed from those in the exercises. • A single format was used for testing rifle and weapon squad members. The code (weapon and BR) for an individual was presented. The soldier had to identify both the individual's squad (1st, 2nd, 3rd or weapons) and his duty position in the squad. The first row of response buttons displayed the squad options. The last three rows of response buttons displayed the individual positions (both rifle and weapons squad). • For all unit and key leader items, soldiers were presented with a description of the unit or leader, and then had to select the correct code from a total of 5 options.

For most map exercises (Table 6), there were at least three practical applications of each function. Soldiers received performance feedback immediately after each response. They were also informed of the percentage of items they answered correctly at the end of each exercise. Examples of map lessons, exercises, and final exam questions are in Appendix D.

Table 6
Description of Map Exercises

Exercise & Condition	Description of Map Exercise Items
Low Demand Condition	
Zoom In and Out, Pan, and Find oneself (J)	# Items = 12 (3 items/tasks for each of the four functions listed on the left). Soldiers performed tasks that used each of the four functions. For each question, soldiers were told which function they should use. For example, an item on the "pan" function stated: "*The 2d Platoon Company C is north and west of you. Pan the map display until the unit symbol is visible near the center of the map display. Once the platoon symbol is centered on your map display, click on the symbol.*" Soldiers were scored on whether they used the required function. If asked to click on a symbol, they were not penalized if they failed to do so. The immediate feedback told them whether they had correctly used the required function, as well as whether they had clicked the correct map symbol.
Find X (K)	# Items = 12. Soldiers had to use the "Find X" function to locate individuals or units. For example: "*Using Find X, find 1SG Company C. When you find the corresponding symbol on the map, click on it.*" To receive credit in this exercise, soldiers had to click on the correct map symbol once it was located. If they found the wrong individual/unit or failed to click on the symbol, they were told that they had not completed the task successfully.
Display Others (L)	# Items = 16 (only 8 counted toward a score). The 8 tasks that were scored required soldiers to use the "Display" function to display groups of individuals or units. For example: "*You are the commander, Company A. Display all platoon leaders. Click on the 3d Plt Ldr.*" Soldiers were not penalized if they failed to click on the correct symbol, as long as they displayed the correct group of individuals or units. The questions that were not scored asked soldiers to click on a particular unit or individual already displayed on the map. For example, "*You are still the commander, Company A. Click on the 2d Platoon Leader.*" Soldiers did receive immediate feedback for these items.
High Demand Condition Exercise items were the same as those in the Low Demand condition.	
Zoom In/Out, Pan, Find oneself, Find X and display others (J-L)	Soldiers were exposed to all map exercises at a single point in time. The exercises were in the same order as in the Low condition. The items were not intermingled as was done with the High Demand Code condition. Consequently, soldiers received a score for each of the three separate exercises, not a single score across all exercise items.

Note. There were no practice exercises for Lesson M on determining range and azimuth. It was determined that no exercises were required, as the words associated with the range/azimuth button were almost self-explanatory.

The map final exam (Table 7) covered all seven functions/buttons. The questions also required that the soldiers identify units and individuals; the material covered in Phase I of the experiment. Feedback, percent correct, was provided upon completion of the exam. There was no feedback on individual test items.

Table 7
Final Exam on Map Functions

- The map final exam had 22 items, with some two-part questions, for a total of 30 points. Items worth 2 points required soldiers to perform two functions to complete the task. Partial credit was given when one of the two functions was performed correctly on a 2-point item. Test items differed from those in the exercises.

- Of the 22 items, 3 directly tested knowledge of the BR numbering system by asking soldiers to view the codes for nine squad members and identify which, if any, were from a different squad.

- The remaining items asked soldiers to accomplish a variety of tasks such as locating points on the map, displaying and locating individuals and units, and determining range and azimuth between two points. With the exception of the range/azimuth tasks, there was typically more than one way to accomplish a task, although there was clearly a most efficient function for each task. Therefore, soldiers were not graded on the method used. Instead, each task required them to click on a map symbol or location, or to type a response in a text box to indicate their successful accomplishment of the task. The one-minute time limit per question made it difficult for soldiers to respond successfully without using the most efficient function for task completion.

- This was the first time soldiers were required to execute range/azimuth tasks, although those in the Exploratory condition had the opportunity to work with this function.

Results

Pre-experiment Measures

Computer background. In general, the computer backgrounds of the soldiers (see survey in Appendix B) were very similar to that obtained in prior research (Dyer & Martin, 1999; Fober et al., 2000). The major deviation from these previous findings was that BNCOC soldiers in the experiment were lower on subjective and objective measures of computer expertise than the OSUT soldiers. In the prior research, OSUT soldiers were lower than BNCOC.

Table 8 shows the percentage of soldiers who used a computer at some time in their formal schooling, the percentage currently using a computer, and the percentage that own a computer (see also Appendix C). The lack of use of computers in public school settings directly reflects the ages of the soldiers in the different groups. The youngest groups (OSUT and IOBC) were more likely to have been exposed to computers at the grade school, junior high, and high school levels (see Table C-4). On the other hand, the ANCOC soldiers were the least likely to have been exposed to computers even during high school. The picture changed somewhat with college experience as most colleges require students to use computers. The IOBC soldiers were the mostly likely to have used computers in college (95%), followed by ANCOC (52%), then BNCOC (40%) and lastly OSUT (23%).

Table 8
Use of Computers by Soldier Group

Soldier Group	% Used Computer During Their Formal Education	% Currently Using a Computer	% Owning a Computer
OSUT	96%	63%	58%
BNCOC	81%	98%	67%
ANCOC	76%	97%	90%
IOBC	100%	95%	93%

The percentage of soldiers within each group currently using computers was very high, at least 95% for all groups but the OSUT soldiers (63%). For each group, the usage percentages tended to be slightly higher than the percentage of soldiers indicating they owned a computer. As shown in Table 8, the ownership rates were highest for IOBC and ANCOC, lower for BNCOC, and lowest for OSUT. Of interest is that over half the OSUT soldiers said they owned a computer. Both the computer ownership and computer use variables showed significant soldier group differences (see Table C-6).

With regard to all computer features used (mouse, games, internet, etc.), there were no significant differences among the groups (see Table C-7 in Appendix C). The groups did differ on their self-ratings of typing skill, with the IOBC soldiers most likely to say they could type quickly (45%) and BNCOC the least likely to have this skill (8%), $\chi^2(9) = 27.83, p = .0010$.

Both subjective and objective indices of computer skill were derived from the survey. The subjective index was the soldier's own rating of his skill on a six-point scale from "novice" to "Bill Gates would hire me." The other index was based on a quiz that required soldiers to identify 18 icons commonly used in Windows-based software. Significant differences were found among the groups on both indices; self-rating, $F(3, 164) = 7.38, p = .0001$; icon quiz, $F(3, 164) = 7.89, p = .0001$. For both indices, the IOBC soldiers were higher than soldiers in each of the other courses. In addition, on the icon quiz, IOBC scores were higher than BNCOC scores. Table 9 presents summary descriptive statistics on each index. Additional information is in Appendix C.

Table 9
Means on Self-ratings of Computer Skill and on Icon Scores

Soldier Group	*N*	Self Rating		Icon Score	
		M	*SD*	*M*	*SD*
OSUT	48	2.04	0.97	8.92	3.38
BNCOC	48	1.89	0.91	7.97	3.49
ANCOC	30	2.00	0.91	9.53	3,12
IOBC	43	2.76	1.01	11.17	2.58

At the group level, there was agreement between the objective and subjective of indices of computer skill. From high to low, the group order was similar: IOBC, ANCOC and OSUT, and then BNCOC.[1] To illustrate the relationship between the objective and subjective indices at the group level, consider the IOBC group, which was highest on both indices, and the BNCOC group, which was lowest on both indices. For IOBC soldiers 20% indicated they could program in a language such as C++ or Visual Basic, and only 12% rated themselves as computer novices. In addition, 62% of the IOBC soldiers correctly answered over half the items on the icon test. On the other hand, 44% of soldiers in BNCOC rated themselves as novices and only 2% indicated they could program. Only 33% of the BNCOC soldiers correctly answered over half the items on the icon test.

As a summary, Figure 6 graphically illustrates how the soldier groups ordered on four major variables from the computer survey: percent soldiers using a computer, percent soldiers owning a computer, percent soldiers indicating they were not computer novices, and the mean percent correct on the icon test. IOBC soldiers were the highest on each dimension. Of interest is that even though OSUT soldiers had the lowest usage and ownership rates, they were similar to BNCOC and ANCOC with respect to self-ratings and icon scores. The graph also illustrates that high rates of soldiers owning and using a computer within a group did not necessarily translate to high self-ratings for the group as a whole.

[1] This statement should not be interpreted to mean that each group differed significantly from each other group on each of these indices.

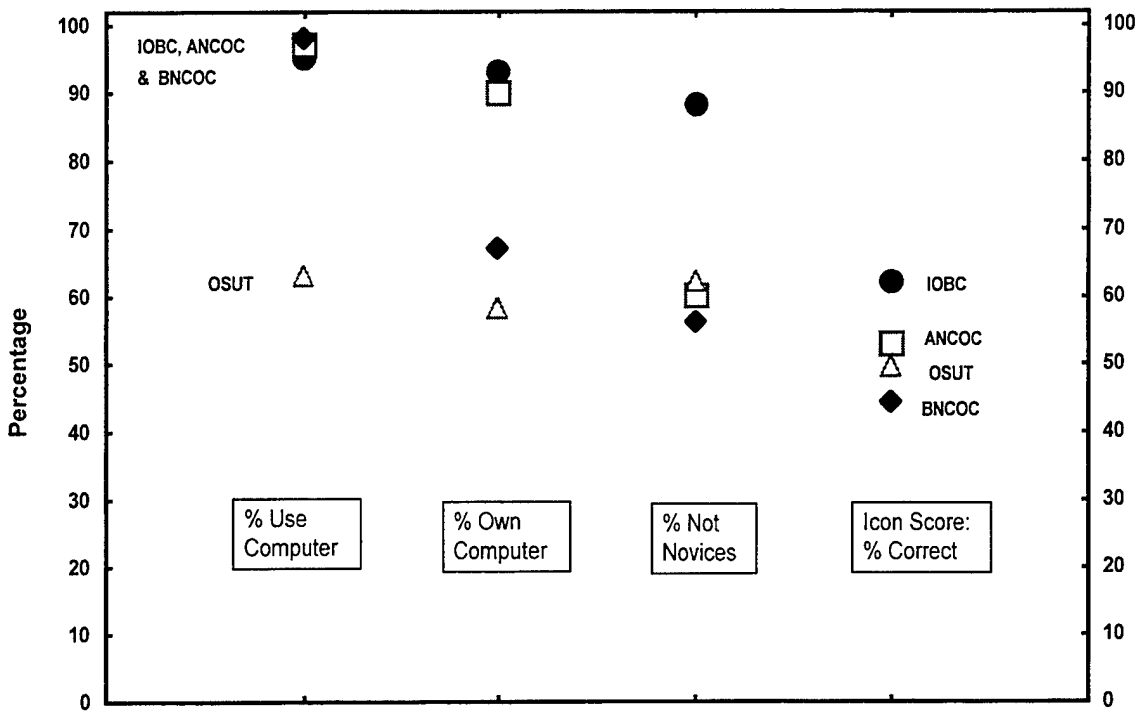


Figure 6. Summary of computer usage and ownership, and subjective and objective indices of computer expertise.

Military Knowledge: Military symbols, the battle roster system, and map reading. OSUT soldiers were expected to score lowest on these initial tests, and ANCOC soldiers were expected to perform better than BNCOC soldiers. It was expected that IOBC soldiers would score as high as ANCOC and in some cases, higher. In general, the test results were consistent with these expectations.

The mean percent correct on each test for each soldier group is in Table 10. Clearly, each group of soldiers was more knowledgeable about map reading than symbols, although ANCOC soldiers performed well on the unit symbol test.

Table 10
Mean Percent Correct on Military Knowledge Tests

Test	Soldier Group				All Groups
	OSUT	BNCOC	ANCOC	IOBC	
Symbols					
Weapon	2%	12%	15%	29%	14%
Unit	1%	15%	73%	54%	31%
Map Reading	55%	86%	85%	78%	75%

As indicated in Table 10, most soldiers did not know the individual weapon symbols. The highest weapon score was for the IOBC soldiers; 45% of them correctly identified the symbol for the M16 rifle. Many soldiers did not even attempt to answer these items (see Table C-13). The non-response percentages were very high for the OSUT soldiers (at least 96%). The percentage of BNCOC soldiers who did not respond to these items was lower, but also high, ranging from 44% to 71%. Even within ANCOC and IOBC, some weapon symbols elicited a high non-response rate. Groups differed significantly on weapons (see Table C-14). IOBC soldiers had higher scores than each of the other groups, and BNCOC and ANCOC were higher than OSUT. Overall, soldiers were most likely to know the symbol for the M16 rifle (19%), and least likely to know the symbol for the M203 grenade launcher (9%).

With regard to the unit symbols, ANCOC and IOBC soldiers exhibited more knowledge of these symbols than weapon symbols. The unit symbol scores for OSUT and BNCOC were low and similar to their weapon symbol scores. As might be expected, there was an inverse relationship for the groups between non-response rates and unit symbol scores (see Table C-15). For example, OSUT soldiers had a very high non-response rate (85%) and averaged less than 2% correct on unit symbols. Again, there were significant differences between groups (see Table C-16). The order from high to low was ANCOC, IOBC, BNCOC, and lastly OSUT.

Map reading scores were generally high (see Table 10). Although OSUT soldiers scored the lowest, their average score was 55% correct. IOBC, ANCOC, and BNCOC soldiers each scored significantly higher than OSUT soldiers (see Tables C-17 and C-18).

With regard to the BR system, only the noncommissioned officers indicated either being trained on or having used this system. These percentages were lower for BNCOC than ANCOC soldiers, with 21% of ANCOC soldiers saying they had been trained and 38% stating they had used the system (see Table C-19). None of the OSUT soldiers had any experience with this system, and less than 8% of the IOBC soldiers indicated experience. No statistical tests of significance were computed on BR data because of the disproportionate numbers of soldiers and OSUT and IOBC without BR experience.

In summary, the soldiers entered the experiment with different levels of military knowledge. All groups showed good map reading skills, with OSUT the lowest in this area. Most ANCOC soldiers and about half the IOBC soldiers knew the unit symbols, but OSUT and BNCOC soldiers did not know these symbols. None of the groups knew all the weapon symbols. About one-third of the ANCOC soldiers had had experience or training with the battle roster system, with the experience of the other soldiers much less or non-existent.

Tendency to work independently. Responses to the fifteen tasks on the tendency to work independently scale were examined to determine if any items should be deleted as not representing "typical" tasks. A breakdown of responses to each item is in Table C-20. Two items were eliminated from further analyses because of atypical response patterns. Responses to the item "take a new, over-the-counter medication" did not vary. More than four-fifths (83%) of the soldiers indicated they would read the instructions before taking a new medication. Another item, "fill out tax forms," generated a unique distribution of responses. One-third (33%)

reported they would find someone else to perform this task for them, while less than 10% responded this way to any of the other tasks. Further analyses were conducted on the remaining 13 items.

To examine whether soldier groups differed in how they responded to the remaining 13 items, five new variables were created. For each soldier, the number of tasks performed in accordance with each response option was calculated. In other words, we tallied the number of tasks completed with no instructions, the number where instructions were read only if needed, the number where individuals found someone else to do it, and the not applicable responses. Since thirteen tasks were analyzed, possible scores for each response ranged from zero to thirteen. Mean scores for each approach are shown in Table C-21 by soldier group.

The tendency to work independently is an individual difference variable that should not relate to soldier group. Nor should this construct relate to the experimental map training conditions. To test for possible differences, a soldier group by map condition ANOVA was performed for each of the five task approaches. There were no significant differences in mean scores for each approach by soldier group or map condition (Table C-22).

On average, the soldiers indicated they would read instructions for 41% of the thirteen tasks ($M = 5.36$, $SD = 3.08$). They would put off reading instructions until a problem arose for 36% of the tasks ($M = 4.69$, $SD = 2.79$). Soldiers only mentioned two to three tasks (19%) that they would perform without referring to instructions ($M = 2.45$, $SD = 2.79$).

A k-means cluster analysis was conducted to determine the percentage of soldiers who would fall into what could be considered an independent style of solving problems versus a more dependent style. The "not applicable" and "find someone else to do it" responses were excluded from the analysis. Two clusters of soldiers emerged. The typical response by soldiers in each cluster to the tasks in the scale was calculated. The results are shown in Figure 7. The figure also shows that fewer soldiers were classified as solving tasks independently than in a more dependent manner (29% vs. 71%).

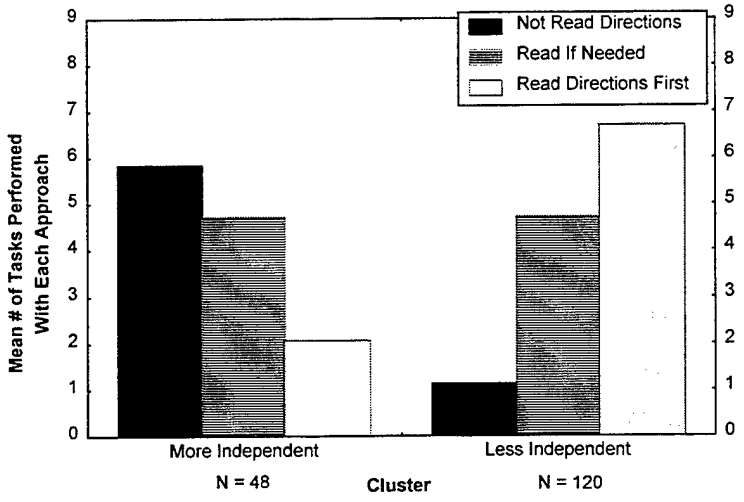


Figure 7. Profile of task completion strategies by soldier tendency to work independently.

Code Training Results

With the code training, the primary interest was in determining whether there were differences between the High and Low Demand conditions and among the soldier groups, as well as any interactions between these two factors. The criterion variables were scores on the exercises and final exam, time to complete the training, and number of soldiers who had to repeat an exercise because of failure to score at least 80%.

Comparisons were made on the following five exercise scores plus the final exam:

- Weapon and unit symbols
- Battle roster system
- Company, platoon and squad codes (for the Low condition, this score combined the company exercise and the platoon/squad exercise)
- Rifle and weapon squad codes (for the Low condition, this score combined the rifle squad exercise and the weapons squad exercise)
- Key leader and unit codes (for the Low condition, this score combined the key leader exercise and the unit code exercise)

Because the first two blocks of instruction (weapon and unit symbols, the BR system) were identical for the High and Low Demand conditions, no differences were expected on these. In addition, because soldiers in each condition had to repeat an exercise if they scored below 80%, differences between High and Low Demand conditions were not expected on the final exam. Consequently, there were only three variables for which differences in the High and Low conditions were likely to occur: Company-squad codes, rifle and weapon squad members; key leader and unit codes. All analyses, unless stated otherwise, are based on the first time soldiers took the exercise.

Scores on code exercises and code final exam. A two-way analysis of variance (training condition by soldier group) was conducted on each exercise score and the final exam score (see Table E-1, Appendix E). There were main effects for both factors, but no significant interactions. There was one significant effect for the Low-High condition, and three significant effects for soldier group.

The only score with a difference between the High and Low Demand conditions was on the exercises involving the rifle and weapon squads, $F(1, 159) = 23.53, p = .0000$. In this case, the soldiers in the Low Demand group scored better than those in the High Demand group. Figure 8 shows the means for both groups on the five exercise scores and the final exam. The graph shows clearly the impact of the High Demand condition on rifle and weapons squad code scores. Descriptive statistics for each condition are in Table E-2.

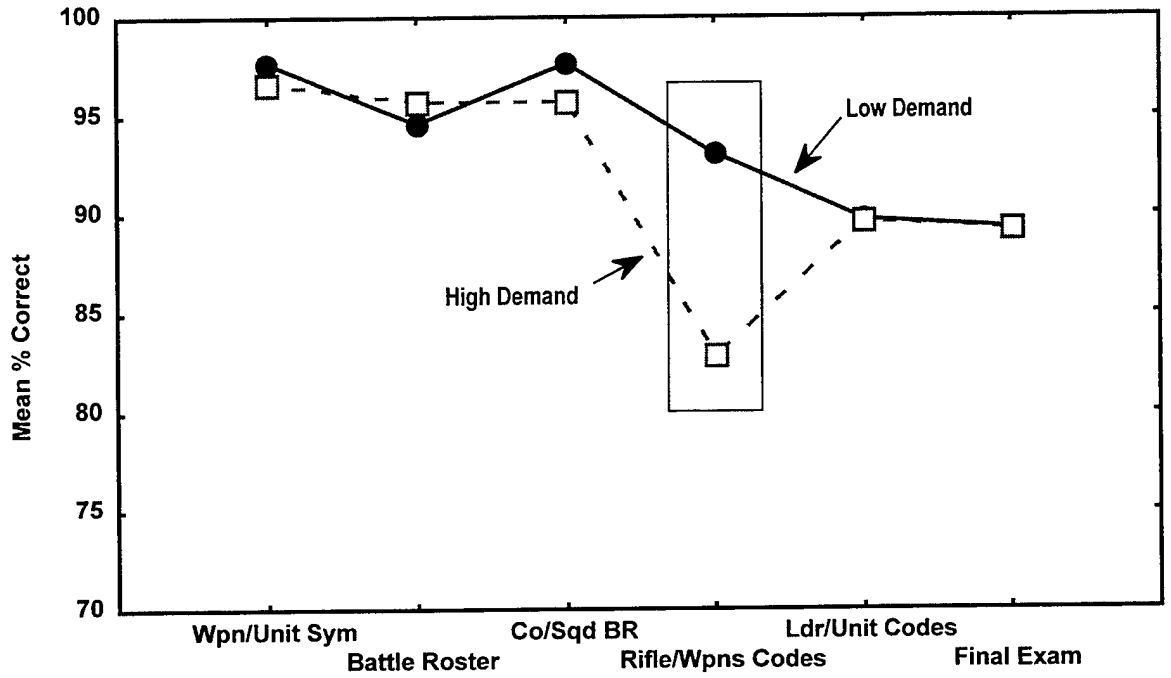


Figure 8. Mean scores on the code exercises and code final exam for the High and Low Demand conditions. (Scores with significant differences between High and Low are highlighted.)

On the rifle and weapon squads score, it is important to remember that the Low Demand score represents the combined score from two separate exercises, as the instruction for the Low condition was divided into two blocks of instruction (rifle and weapon squads codes). This part of the instruction also involved the greatest differences in working demand for the two conditions (an estimated 9 chunks per lesson versus 18 chunks per lesson, reference Table 2), and the greatest potential for confusion. Soldiers had to learn two squad sets of positions, each associated with numbers 0 through 8. In both cases, the squad leader was coded a 0, but, as indicated below, this was the only commonality across the number assignments in the two types of squads.

Number	Rifle Squad Position	Weapons Squad Position
0	Squad Leader	Squad Leader
1	A Team Leader	1st Machine Gunner
2	SAW Gunner, A Tm	Assistant Gunner to 1st Machine Gunner
3	Grenadier, A Tm	2d Machine Gunner
4	Rifleman, A Tm	Assistant Gunner to 2d Machine Gunner
5	B Team Leader	1st Javelin Gunner
6	SAW Gunner, B Tm	Assistant Gunner to 1st Javelin Gunner
7	Grenadier, B Tm	2nd Javelin Gunner
8	Rifleman, B Tm	Assistant Gunner to 2d Javelin Gunner

The weapon symbol associated with each duty position helped to distinguish some positions. However, the rifle weapon symbol was common to five soldiers in both the rifle and weapons squads.

An item analysis was conducted on the rifle and weapons squad exercises to ascertain whether soldiers in the High Demand condition had difficulty with certain items or if the lower performance was spread across questions. The results indicated the lower exercise scores reflected both factors. Questions on rifle squad member codes had two parts. The stem for all items was a weapon symbol/BR code, as shown in Figure 9. The soldiers had to identify the rifle squad (1st, 2d, or 3d) as well as the individual position within the squad. The first three such items in the exercise created more difficulties for soldiers in the High than the Low Demand condition. In particular, those in the High condition tended to identify only the squad member himself, not the squad. The item difficulties or percent correct responses for these first three questions were .48, .72, and .78 for High Demand versus .80, .92, and .84 for Low Demand. This level of difficulty for High Demand did not occur again; the item difficulties showed a learning effect (a recognition by soldiers that they had to identify the squad as well). It is important to note that the High Demand condition's exercise involved both rifle squad and weapons squad questions. In contrast, the Low Demand condition had two separate exercises, one on rifle squad and one on weapons squad.

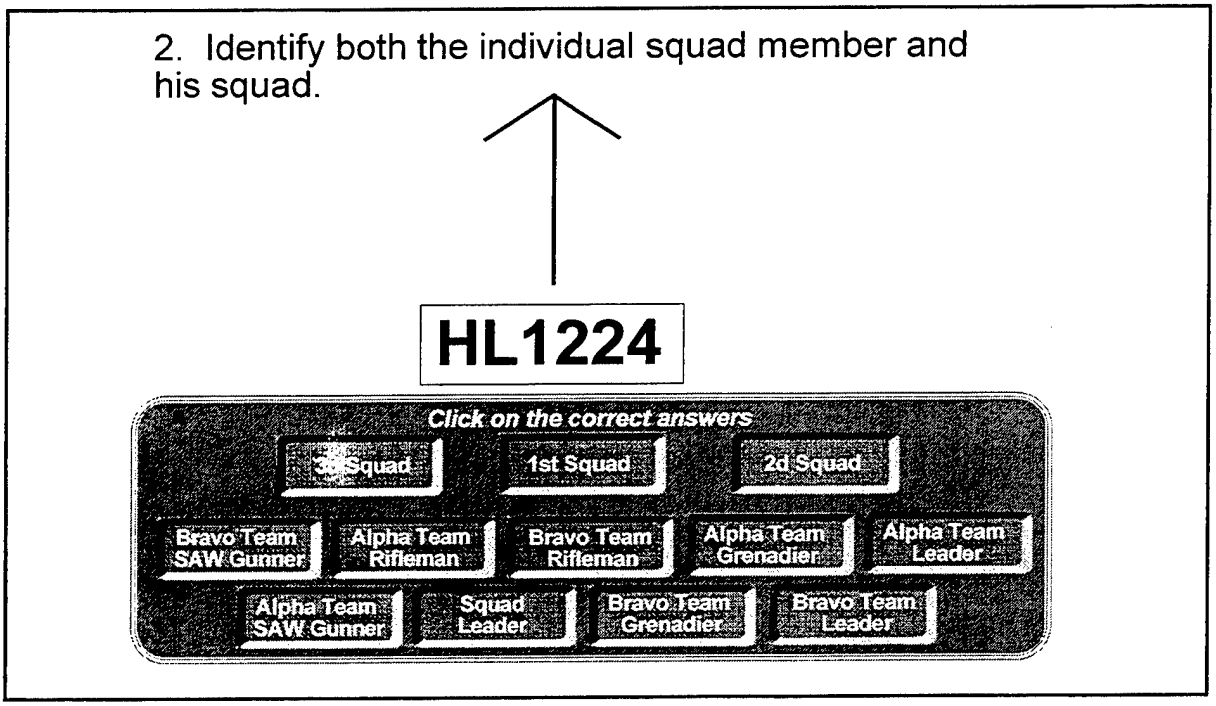


Figure 9. Example of an exercise item on squad member codes.

When the item difficulties for the remaining rifle squad items were examined, the mean difficulty was .83 for High Demand and .93 for Low Demand, indicating a lower level of performance for the High Demand condition. A similar pattern occurred on the weapons squad

items. Here the mean item difficulty was .82 for High Demand and .93 for Low Demand. It appeared that the significantly lower scores for the High Demand condition resulted from soldiers encountering different item formats within an exercise as well as a general lower level of performance, presumably from the higher demands placed on working memory. Lastly, it is important to stress that all exercises were preceded by a presentation of the type of items the soldiers would encounter during the exercises, so soldiers would understand what was required of them.

Significant differences occurred among the soldier groups on two of the five code exercise scores and the code final exam, $F(3, 159) = 6.49, p = .0003$. The two exercise scores with significant soldier group differences were the rifle and weapons squad score [$F(3, 159) = 6.26. p = .0004$] and the key leader and unit score [$F(3, 159) = 5.51, p = .0012$]. For each, IOBC, ANCOC, and BNCOC soldiers scored higher than OSUT soldiers (see Table E-3). On the final exam, IOBC also scored higher than BNCOC.

The means for the four soldier groups on all code scores are in Figure 10. The graph shows the lack of significant differences among the groups on the first part of the instruction. Beyond that point, the lower performance of the OSUT soldiers is demonstrated, as is the lower performance by BNCOC on the final exam. Of additional interest is the general ordering of the soldier groups from high to low as IOBC, ANCOC, BNCOC, and then OSUT.

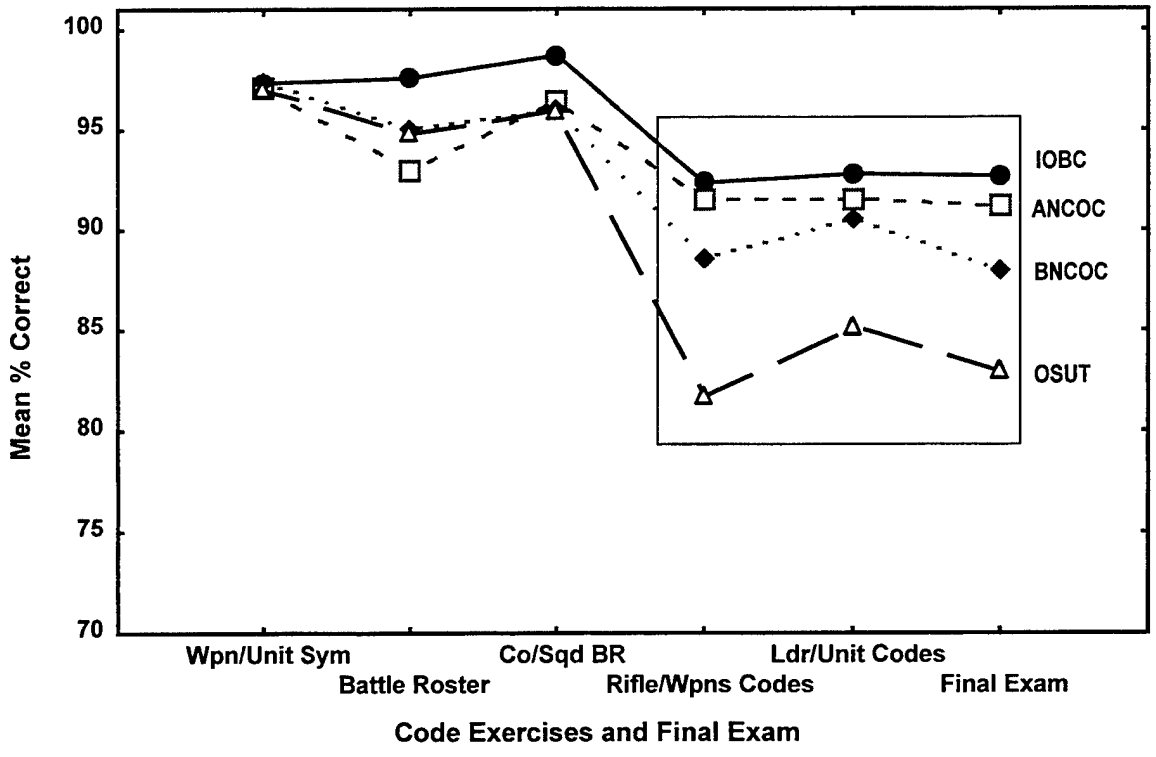


Figure 10. Mean scores on the coding exercises and code final exam for each soldier group. (Scores with significant soldier group differences are highlighted.)

It might be expected that the number of soldiers who had to review a lesson and repeat the corresponding exercise would be reflective of the impact of working memory demands on performance. The number of soldiers who had to repeat each block of instruction is in Table 11.

Table 11
Number of Soldiers who had to Repeat Code Exercises

Block of Instruction/Exercises	**Low Demand** (n = 84)	**High Demand** (n = 83)
Exercises that were the same in both conditions		
Weapon Symbols	1 (1%)	3 (4%)
Battle Roster System	3 (4%)	4 (5%)
Exercises that varied with condition (Information in smaller chunks for Low Demand)		
Company BR	0 (0%)	4 (5%)
Platoon – Squad BR	0 (0%)	
Rifle Squad Codes	2 (2%)	13 (16%)
Weapons Squad Codes	4 (5%)	
Key Leader Codes	12 (14%)	11 (13%)
Unit Codes	17 (20%)	

Note. Number of soldiers who had to repeat exercises within each course regardless of training condition: 34 in OSUT; 20 in BNCOC; 16 in ANCOC; 6 in IOBC.

With respect to remediation, as expected, the first two blocks of instruction showed no difference between the two conditions, as the amount of information presented was the same under both conditions. With the next blocks of instruction on company through squad BR, no soldiers had to repeat the exercise in the Low Demand group, as compared to 5% in the High Demand group. With the rifle/weapons squad instruction, twice as many in the High Demand group had to repeat the exercise. These percentages were consistent with the expectation that the High Demand condition would not enable soldiers to acquire the information as easily as the Low Demand condition. However, this pattern was not repeated on the last blocks of instruction on key leader and unit codes. In fact the percentages of soldiers in the Low Demand condition who had to repeat key leader and unit codes increased. They were 14% and 20% respectively; much different from the 0% to 5% remediation rates for Low Demand in the other exercises.

An item analysis was conducted to try to determine what caused this increase. The analysis showed that the exercise question format in conjunction with the total number of questions in each exercise affected the results, even though the overall item difficulty was the same for both conditions (.89 probability of being correct in both cases). An unexpected item format may have "caught soldiers off guard."

Exercises for the key leader and unit codes had two types of questions. These two formats are illustrated in Figure 11 for the unit questions. In the format shown at the top of Figure 11, the item stem was the unit symbol/BR number combination with the multiple-choice alternatives being word descriptions of possible units. Of the 12 questions, 7 were this format.

In the other format, shown at the bottom of Figure 11, the item stem was a verbal description of a unit; the alternatives were different unit symbol/BR combinations. There were 5 questions in this format. Three had options where the codes had the identical BR number associated with different unit symbols. These three questions created problems for all soldiers (answered correctly by 70% or less within each condition). The item analysis showed the soldiers had the BR number correct, but did not discriminate between the unit symbols. For example, in Figure 11 the correct BR is AB231 for B Co, 3d Platoon, 1st Squad. However, the unit symbol options included squad, platoon, and company symbols. Soldiers often incorrectly checked the code with the company or platoon symbol, vice squad symbols, that also had the correct BR number.

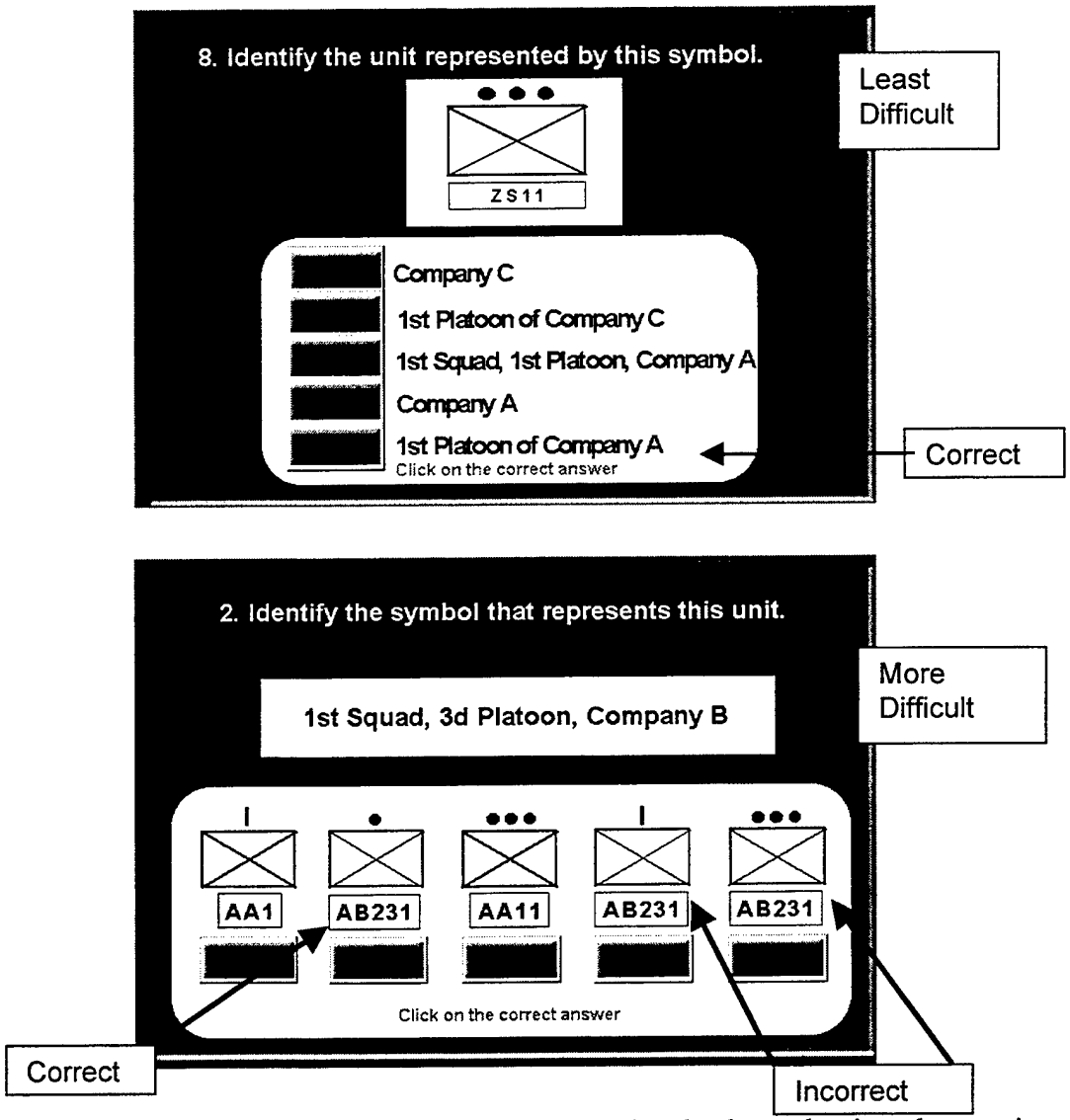


Figure 11. Illustrations of the two question formats in the key leader and unit code exercises.

The single exercise in the High Demand condition had twice as many items as each exercise in the two Low Demand conditions. As a result, two soldiers' overall performance could have been the same in the High and Low Demand conditions, but one would have passed

the exercise the first time and the other failed it. For example, if a soldier missed all three unit items in Low Demand (3 of a total of 12 questions, 75% correct), he would have had to repeat the exercise. If a soldier missed all three items in High Demand (3 of a total of 24 questions, 87% correct), he would have passed.

An analysis of the leader items was also conducted. But there was no distinct pattern associated with the item stem as occurred with the unit questions. There is no readily available explanation for the relatively high percentage of soldiers who had to repeat the leader questions within the Low Demand condition.

Considering all conditions and exercises, OSUT soldiers were most likely to repeat exercises, followed by BNCOC and ANCOC, and lastly IOBC. About half the OSUT soldiers (48%) repeated at least one exercise, compared to 33% of the BNCOC and ANCOC soldiers and to 12% of the IOBC soldiers. This represented a significant difference among the courses, $\chi^2(3) = 13.07, p = .0044$. Of all the soldiers who had to repeat an exercise(s), in two-thirds of the cases they only had to repeat one. In addition, for those who had to repeat exercises, OSUT soldiers were most likely to repeat more than one exercise, while IOBC soldiers were least likely to do so (19% vs. 2% respectively).

Times on code exercises and code final exam. Time to complete each code block of instruction (lessons and exercises) and the final exam was also examined. A two-way analysis of variance (training condition by soldier group) was conducted on time (see Table E-4). The time data included the time spent repeating exercises for those soldiers who did not meet the 80% criterion.

There were main effects, but no significant interactions (Table E-4). The only significant difference between the High and Low Demand conditions on time was on the rifle and weapons squad member blocks of instruction. Soldiers in Low Demand completed the same instruction in less time than those in High Demand, $F(1, 195) = 16.32, p = .0001$ (Table E-5).

For the soldier group, there was a significant effect on four blocks of instruction (weapon and unit symbols; company-squad codes, rifle-weapons squad member codes, and key leader and unit codes). Descriptive statistics are in Table E-6. IOBC and ANCOC were significantly faster than OSUT and BNCOC in each of these blocks of instruction (Table E-6), with OSUT soldiers consistently taking the most time to complete a lesson and exercise and IOBC consistently requiring the least time. The impact of these times on the cumulative time to complete the code training is shown in Figure 12.

Time data were also examined for those soldiers who did not have to repeat an exercise. Although the times decreased for those blocks of instruction when those requiring remediation were eliminated, the same overall effects for condition and soldier group remained.

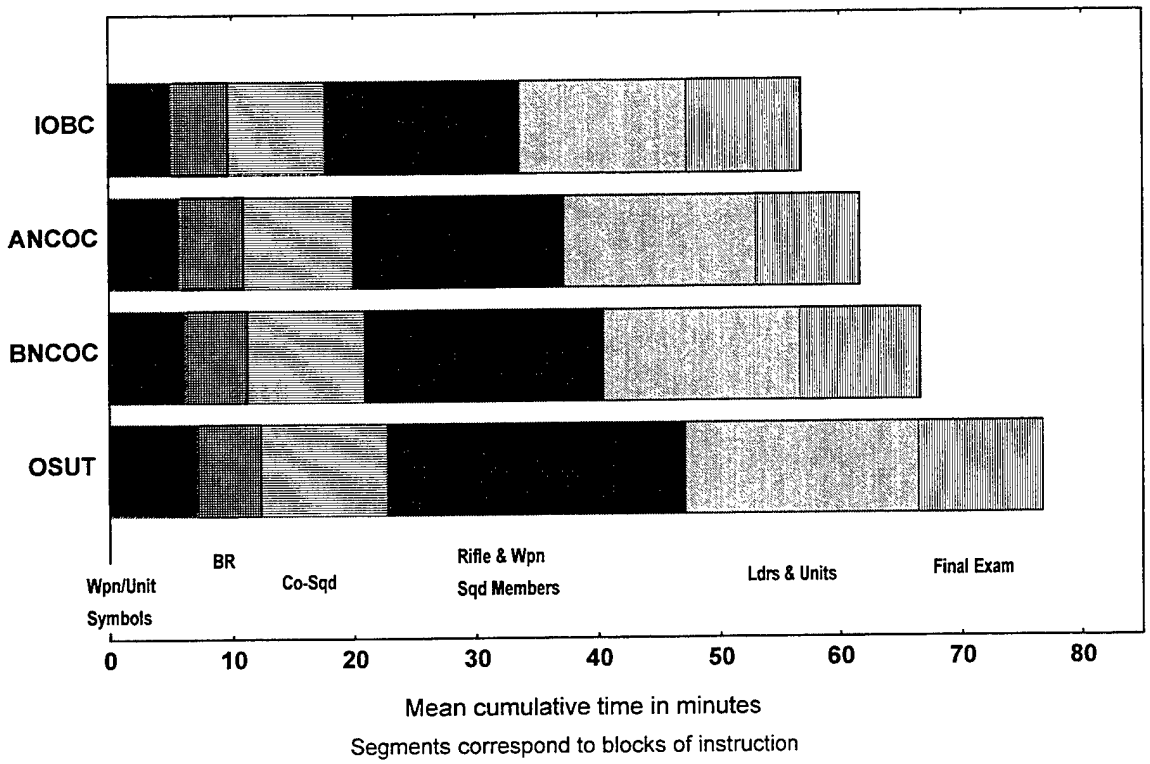


Figure 12. Cumulative time to complete training on codes, and times for each lesson by soldier group (includes soldiers who had to repeat exercises).

Of additional interest was a shift in the relative times for the soldier groups within each condition on the rifle and weapons squad block of instruction. When all soldiers were examined, this interaction approached significance, $F(3, 159) = 117.54$, $p = .0060$, Table E-4. As shown in Figure 13, for all soldier groups except IOBC, soldiers took less time to complete these blocks of instruction when they were in the Low Demand condition than in the High Demand condition. For the IOBC soldiers, the times were the same. However, the discrepancy between the High and Low Demand conditions decreased (see Figure 13) when the analysis was restricted to the soldiers who did not repeat the exercise, since the times decreased for the ANCOC, BNCOC, and OSUT groups. In this case, the interaction effect did not approach significance (see Table E-7). The "interaction with all soldiers" apparently resulted from the additional time required by soldiers who had to repeat exercises in the High condition, and the increased time was in proportion to the number of soldiers within each course who repeated the exercises.

In summary, based on the mean scores and mean times, more time was required when performance was low. For example, the score on the rifle/weapons squads instruction was significantly lower for the High Demand condition than the Low Demand condition, and soldiers in the High Demand condition took significantly longer to complete this section as well. In addition, OSUT soldiers often had the lowest scores, and typically required the most time.

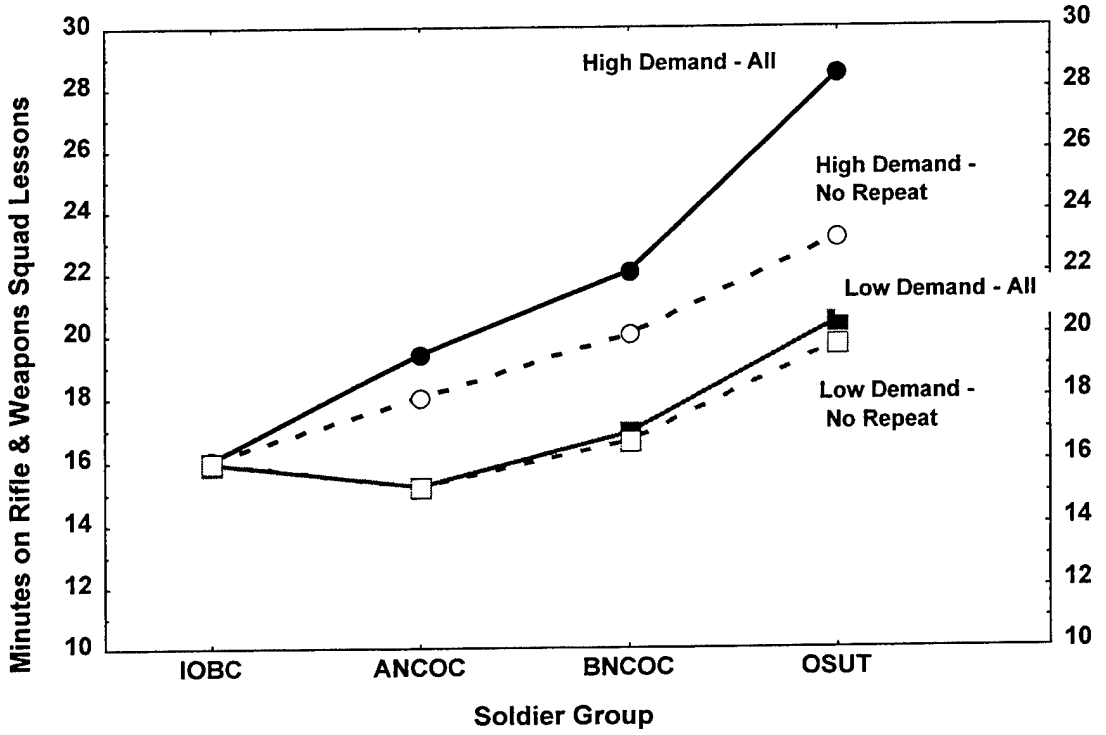


Figure 13. Mean times on rifle and weapons squad code training for soldier group as a function of High and Low Demand conditions.

Map Training Results

With the map training, the primary interest was in determining if there were differences between the High and Low Demand conditions on the exercises, and if there were differences among the High, Low, and Exploratory conditions on the final exam. As with the codes, course differences and interactions with courses were also of interest. The criterion variables were scores on the exercises and the final exam, and time to complete the training. Although soldiers were not required to repeat an exercise if they did not achieve an 80% score, the number of soldiers who did not achieve this level was examined.

Comparisons were made between High and Low Demand conditions on the following exercises:

- Zoom, Pan and Find Me
- Find X
- Display

As described in the Method section, the difference between the High and Low conditions was that soldiers in Low Demand went through each exercise immediately after receiving the

corresponding instruction. Those in High Demand received all three blocks of instruction and then had all the exercises.

Scores on map exercises and map final exam. A two-way analysis of variance (training condition by soldier group) was conducted on each exercise score and the map final exam score (see Table E-10). There were main effects, but no significant interactions. There were two significant effects for training condition, and two effects for soldier group. Means for each training condition are in Table E-11. The means reflect the first attempt at the exercise as no repeats were allowed because of time constraints. Final exam scores include the Exploratory condition.

Due to time constraints in conducting the experiment, not all soldiers were able to complete the map training. For Low Demand, three soldiers did not finish the training. For High Demand, five soldiers did not finish the training. The actual numbers completing each exercise and the map final exam are shown in Table E-11.

Significant differences occurred for training condition on the display exercise and the map final exam, $F(1, 70) = 4.07, p = .0474$ and $F(2, 142) = 6.84, p = .0014$, respectively. These are shown graphically in Figure 14. On the display exercise, soldiers in the Low Demand condition scored higher than those in the High Demand condition. On the final exam, clearly, soldiers in the Exploratory condition had the lowest scores, although the difference between Low and High Demand conditions was also significant. The fact that no remedial training was provided for the Low and High Demand conditions (vice the symbols training) may have affected scores for soldiers in these conditions on the final exam. The overall downward trend of scores, shown in Figures 14 and 15, may simply represent the cumulative effect of working at a computer for several hours learning new information.

Means for the four soldier groups on the three map exercises and map final exam are in Figure 15 and Table E-12. The map exercise means are based on only the Low and High Demand conditions, while the final exam mean includes the Exploratory condition as well. Significant differences among soldier groups occurred on the find X exercise [$F(3, 71) = 2.86, p = .0431$], and the final exam [$F(3, 142) = 3.29, p = .0226$]. With find X, BNCOC did better than ANCOC and OSUT. On the final exam, IOBC did better than BNCOC and OSUT. Thus, on each measure, OSUT scored lower than the top group.

On the display exercise, the difference among courses approached significance, $F(3, 70) = 2.52, p = .0655$. There was considerable variability in scores in BNCOC and ANCOC, which could have contributed to the lack of an effect at $p < .05$.

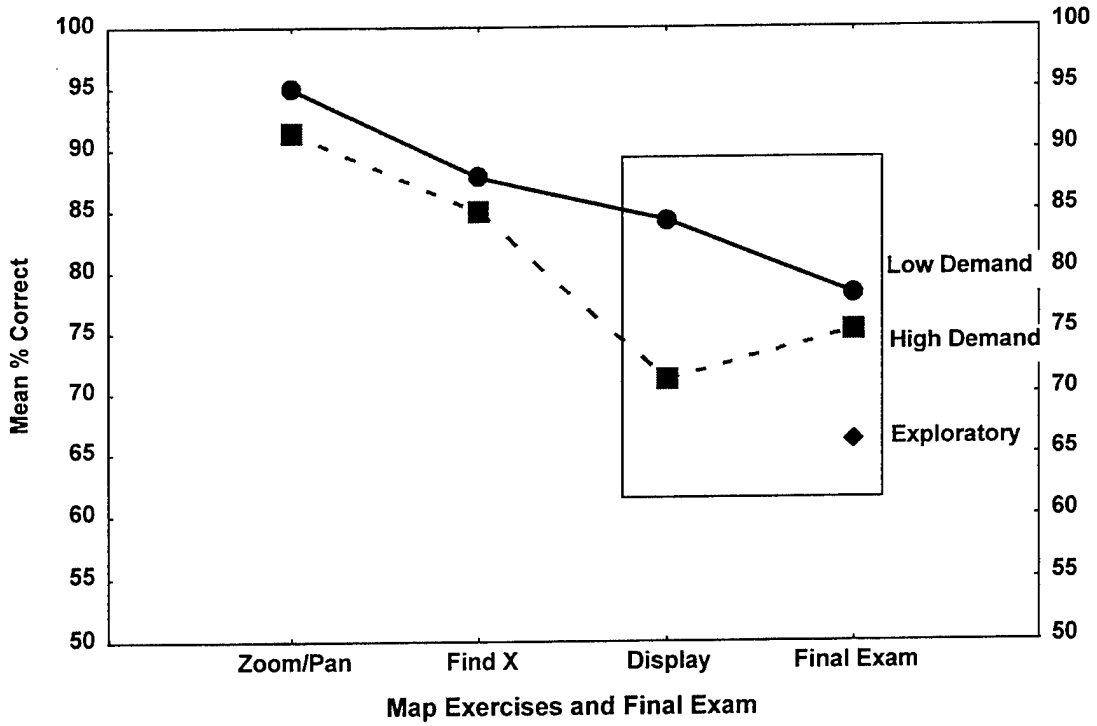


Figure 14. Mean scores for map exercises and map final exam for High Demand, Low Demand, and Exploratory conditions. (Scores with significant differences among training conditions are highlighted.)

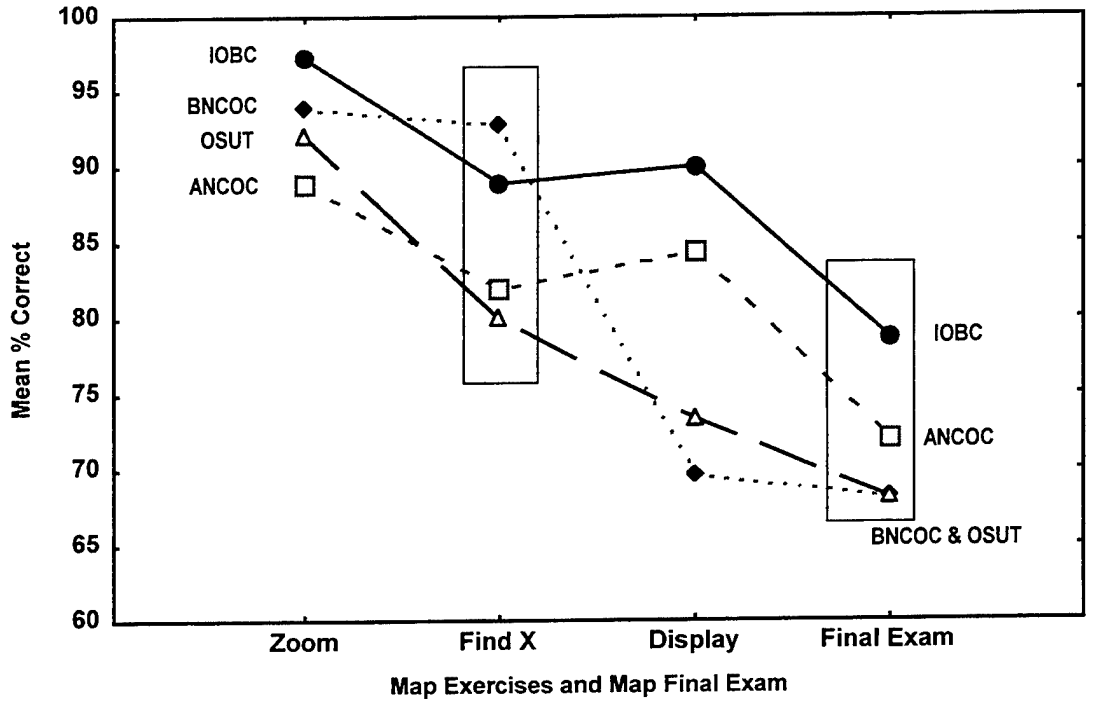


Figure 15. Mean scores on map exercises and final exam for each soldier group. (Scores with significant soldier group differences are highlighted.)

Of interest is the lack of a significant interaction between soldier group and training condition on the final exam. From high to low within each soldier group, soldiers in the Low Demand condition had the highest scores, those in the High Demand condition were next, and those in the Exploratory condition had the lowest scores. Thus the training conditions had the same relative effect on soldiers from all courses on the map final exam. It should be noted, however, that for ANCOC[2] the relative order of the High and Low Demand conditions was reversed; but Exploratory scores were the lowest as was the case in the other courses.

Although soldiers were not required to repeat map training if they scored less than 80% on an exercise, the number of soldiers below this level was tabulated to see if there were differences between the High and Low Demand training conditions. These results are in Table 12. They support the expectation that performance would decrease when individuals were required to master a large amount of information within a block of instruction. The High Demand condition showed the most impact on the display exercise. Information on the display function was the last to be presented in the single block of instruction for the High Demand condition[3]. Thus it was not unexpected that at this point in training soldiers were "overloaded" with information, which had a negative impact upon performance. In terms of the soldier groups, OSUT soldiers were more likely to score below 80% on the exercises than the other groups. On average 33% of OSUT soldiers scored below 80% compared to 11% to 22% for the other groups. We also examined the percentage of soldiers who scored below 80% on the map final exam. This percentage was 41% for High Demand, 45% for Low Demand, and 75% for Exploratory.

Table 12
Number of Soldiers who did not Achieve a Score of 80% Correct on the Map Exercises

Condition	Exercise (in order of presentation)		
	Zoom/Pan/Find Me	Find X	Display
Low Demand	1 of 43 (2%)	8 of 42 (19%)	11 of 42 (26%)
High Demand	5 of 39 (13%)	9 of 37 (24%)	16 of 36 (44%)

Note. Soldiers in High Demand took these three exercises after receiving all map instruction. Soldiers in the Low Demand took the exercises immediately after the corresponding lesson.

Times on map exercises and map final exam. Time to complete the lessons, exercises, and final exam was also examined. A two-way ANOVA (map training condition by soldier group) was conducted on each block of instruction, the map final exam, map training, and total time in the map phase (Table E-13). There were main effects but no interactions. Illustrations of the time results are in Figure 16. Means are in Tables E-14 and E-15.

Several significant differences occurred between the training conditions on map times. First, the soldiers in the Low Demand condition were significantly faster than those in High Demand in the zoom/pan block of instruction/exercises, $F(1, 74) = 5.34$, $p = .0235$, and in the time to complete the range/azimuth instruction, $F(1, 75) = 29.87$, $p = .0000$.

[2] This change in order was not significant, but is pointed out for descriptive purposes.
[3] In reality, the last information presented was on the range-azimuth function, but there was no exercise to assess proficiency on this task.

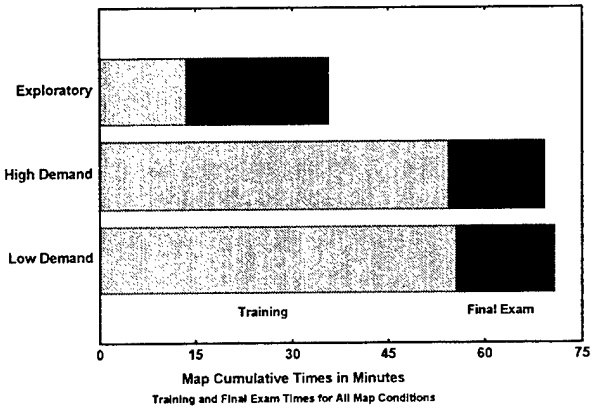
There were also differences when the time devoted to all training (lessons and exercises and exploring the map) was examined. Here, High and Low Demand condition times were four times slower than Exploratory times, $F(2, 143) = 622.65$, $p = .0000$. On average, soldiers in the Exploratory condition spent 12.5 min working with (learning about) the map functions on their own. The fastest time was 2 min; the longest was 35 min (Table E-14). This compares to averages of 54 min for the soldiers in the Low and High Demand conditions to complete all the lessons and exercises.

Although the soldiers in the Exploratory condition completed their instruction very quickly, they took more time to complete the map final exam than the other two conditions (22 min vs. 15 min, see Table E-14). Exploratory times on the final exam were significantly slower than both the Low and High Demand times, $F(2, 138) = 46.43$, $p = .0000$. As illustrated in Figure 16, this increased amount of time was the same for all soldier groups. It appeared that soldiers in the Exploratory condition tried to make up for what they did not learn when taking the exam itself.

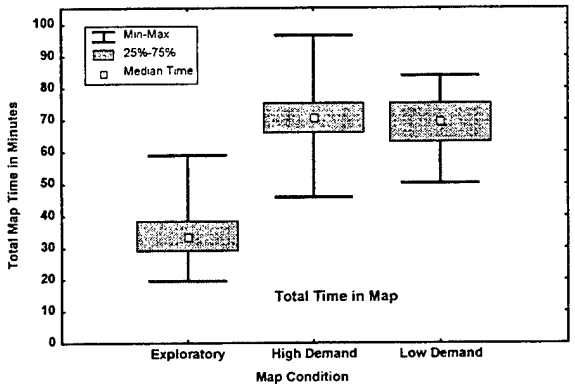
Of additional interest is that data on the final exam indicate the Exploratory group spent more time reading and studying the questions than the other two groups. The map exam had 22 items each with a time limit of one minute. The maximum times in the High and Low Demand conditions were 20 minutes, meaning that all soldiers within these conditions completed all items plus all instructions within 20 minutes. However, the maximum time for the Exploratory condition was 42 minutes, with 59% of the soldiers (47 of 79) taking more than 20 minutes. The only opportunity for additional time during the exam was in examining the questions prior to officially answering a question. It is not known what soldiers were doing while examining the questions --- were they trying to interpret or understand the question or to determine their strategy in how to answer it? Regardless, this increased time reflects a lower level of proficiency for the Exploratory condition.

There were also significant differences in time among the soldier groups. They differed on time to complete three different blocks of map training: zoom/pan, $F(3, 74) = 5.72$, $p = .0014$; find X, $F(3, 71) = 4.50$, $p = .0059$; and display , $F(3,70) = 9.28$, $p = .0000$. On all three blocks of instruction (zoom/pan, find X, display), IOBC soldiers were consistently faster and OSUT consistently slower. In addition, ANCOC was significantly faster than OSUT on find X and display. IOBC was significantly faster than BNCOC and ANCOC on zoom/Pan, and faster than BNCOC on display (Tables E-13 and E-15). On the time to complete training (lessons and exercises for the High and Low Demand groups and the time working with the map for Exploratory), IOBC was significantly faster than BNCOC and OSUT, $F(3, 143) = 5.55$, $p = .0000$. The same pattern occurred on the total time spent on the map phase of training. IOBC was significantly faster than BNCOC and OSUT, $F(3, 138) = 7.66$, $p = .0000$.

In summary and as illustrated in Figure 16, the major impact on time was the training conditions, although soldier groups differed significantly on the map times as well. Soldiers in the Exploratory group did not explore very long, but spent more time on the exam than soldiers in the other two training conditions.

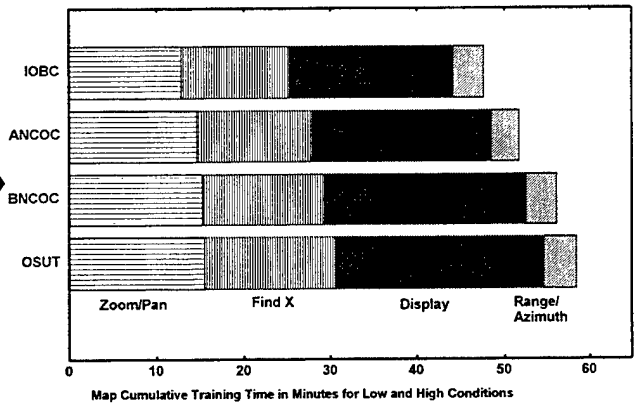


The map training times show that Exploratory soldiers spent 12 minutes working with the map during training, significantly less time than the 54 minutes for those in High and Low Demand. However, those in High and Low conditions spent significantly less time in the map final (15 vs. 22 minutes).



Distribution of total map times by training condition shows where the middle 50% of the times were concentrated for each condition, as well as the extreme times. The minimal overlap between Exploratory times and High and Low Demand times is clear.

Over both Low and High Demand conditions, IOBC soldiers finished training significantly faster than OSUT soldiers.



Times on the map final exam show that Exploratory soldiers in each soldier group took about 5 minutes more on the exam than soldiers in High and Low Demand conditions.

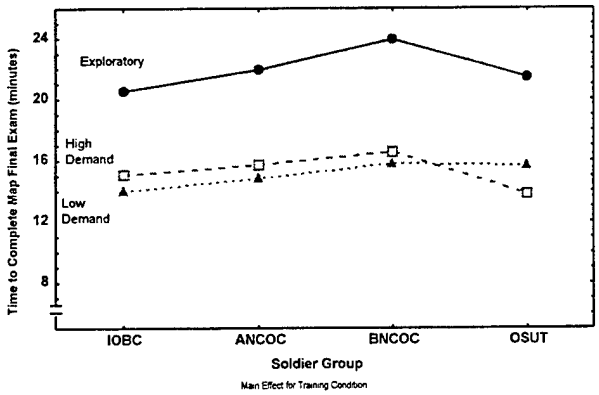


Figure 16. Illustrations of time spent on the map exercises and map exam.

Correlations among Measures

Scores and times. The relationship among the exercise and final exam scores and times to complete the exercises and training was a primary question for both the code and map training. The correlation between the two final exams, for all participants, was .23 ($p < .001$), significant, but not substantial.

In summary, for both the code and map phases of training, the typical relationships among scores and times were as follows:

- Exercise and final exam scores correlated
- Times correlated with each other
- Scores correlated negatively with times (higher scores were associated with faster times).

Specific results for the code and map phases of training are discussed in turn.

Code correlations. Product moment correlation coefficients among all the code scores (exercises and final exam) were calculated, a total of 15. Nine were significant (Table E-16). The highest correlations were between rifle/weapons squads and leader/unit, and between leader/unit and the exam, each $r = .43$). Other significant correlations ranged from .15 to .37. One exercise score, the initial symbol exercise (weapon and unit symbols), did not correlate with any other exercises nor with the final exam. This could have been because soldiers were given immediate feedback on their answers and had an opportunity to learn the symbols as a function of the feedback during this exercise. Each symbol was presented three times, so corrective feedback could have improved soldier performance during the exercise itself.

Correlations among the times to complete the code blocks of instruction (lessons and exercises) and the code final exam were also computed, a total of 15. Each correlation was significant (Table E-17). In addition, the times for each of these blocks of code training were correlated to the total code time. These correlations were also significant. Of the 21 intercorrelations that were computed, 12 were at least .50, with the highest being .86 (rifle/weapons squad time with final exam time). In general, the magnitude of the correlations among the code time measures was stronger than among the code scores.

For code training, separate lesson and exercise times were not available. Only the total time to complete each lesson and exercise combination was recorded in the database. For each block of instruction, the correlation between score and time was both negative and significant, meaning higher scores were associated with faster times (see correlations on the diagonal in Table E-18). These correlations were considered moderate, with four of the five correlations ranging from -.32 to -.46. The correlation between the code final exam score and code final exam time was -.15, also significant but small.

Map correlations. For the map scores and times, the Low and High Demand conditions were examined separately from the Exploratory condition, as the Exploratory condition did not have lessons or exercises. In contrast with the code training, separate times for the map lessons and exercises were available.

As with codes, the map exercise scores and final exam score correlated significantly with each other. The six correlations ranged from .31 to .61 (see Table E-19). Correlations among the map times (Table E-20), computed separately for lessons and exercises, were all significant. But they were typically higher than the map score intercorrelations (12 of the 16 correlations were higher than .50).

Of considerable interest was that the times on the map lessons did not correlate with scores (Table E-21). On the other hand, time spent on the map exercises correlated significantly, but negatively with map exercise scores. The correlations for Zoom/Pan, Find X, and Display ranged from -.35 to -.43. In summary, high map exercise scores were indicative of greater speed on the exercise itself, but did not relate to time spent acquiring knowledge of the map functions.

For the Exploratory map condition, there was a significant but small relationship ($r = .26$) between the final exam score and the time spent exploring (Table E-22). There was no relationship between the map final score and the time to take the final exam.

Scores and background variables. Of particular interest was whether any of the measures of military knowledge, computer experience, and tendency to work independently correlated with the two final exam scores. As cited previously, the 12 background variables were grouped into the three categories listed below.

- Computer background from survey
  - -Computer ownership
  - -Frequency with which soldiers used key computer features
  - -Self-rating of expertise
  - -Icon score
- Military knowledge
  - -Score on weapon symbols
  - -Score on unit symbols
  - -Score on map reading
  - -Prior use of battle roster system
  - -Training on the battle roster system
- Tendency to solve problems on own
  - -Score on tendency to work independently scale
  - -Self-rating on tendency to develop computer shortcuts
  - -Self-rating on tendency to have a "knack" in working with computers

A principal component analysis of these measures was conducted prior to regression analyses on the exam scores. The purpose of this analysis was to determine if any of the background variables could be combined for the regression analysis. Factor scores were not used in the regression analyses, because it was of more interest to examine the contribution of the "original scores" rather than a weighting of scores within a test battery that could change with time. The principal components analysis showed four components, accounting for 67% of the variance (see Table 13), and partially supported the original grouping of measures cited above. As described below, it was possible to combine some variables (add scores), reducing the predictors in the regression analysis from 12 to 9.

Table 13
Factor Analysis (principal components) Results on Background Variables

	Component			
	1 "Computer"	2 "BR"	3 "Military Knowledge"	4 "Work Independently"
Eigenvalue	3.78	1.66	1.54	1.01
% Variance	31.52	13.83	12.84	8.34
Factor Loadings				
Own Computer	.67	.24	.12	.34
Frequency of Use	**.77**	-.04	-.12	.35
Self-rate Skill	**.77**	-.14	.06	.10
Icon Score	**.73**	-.16	.01	-.01
Knack for Computers	**.80**	-.14	-.26	-.05
Use Shortcuts w/ Computers	**.79**	-.10	-.31	-.03
Weapon Symbols Score	.33	-.07	**.71**	-.22
Unit Symbols Score	.45	.28	.53	-.35
Map Reading Score	.03	.48	.47	-.02
BR Use	.09	**.79**	-.27	.07
BR Training	.14	**.77**	-.26	-.09
Work Independently	-.16	.02	.44	**.75**

Note. Factor loadings that were at least .70 are bolded and were used to characterize each factor.

The first and main component clearly reflected computer use and perceived skill, from the computer survey as well as the knack and short cut items, which dealt specifically with a computer. It was not possible to combine the computer survey indices, due to the different scales and measurement procedures for each. However, the 10-point rating scales for knack and shortcut were summed (bivariate correlation between these two ratings was .76, see Table E-23). Thus it appeared that the knack and shortcut variables reflected computer expertise and background more than they reflected a general tendency to work things out independently.

The second factor reflected experience with the BR system and these two items were combined (summed, bivariate correlation was .49). The symbols and map reading scores tended to load on several factors. However, it was decided to combine the weapon and unit symbol scores, yielding one score for knowledge of military symbols (bivariate correlation was .42). The work independently measure appeared to be relatively independent of the other measures, loading most heavily on the fourth component. In sum, for the regression analysis, the original 12 background variables were reduced to 9 variables listed below.

- Computer ownership
- Frequency with which soldiers used key computer features
- Self-rating of computer expertise

- Computer icon score
- Short/Knack (Self-rating on tendency to develop computer shortcuts plus Self-rating on tendency to have a "knack" in working with computers)
- BR experience (Prior use of BR system plus Training on the BR system)
- Symbols (Score on weapon symbols plus Score on unit symbols)
- Map reading score
- Tendency to work independently scale

The relationships between the nine background variables and the two final exam scores were examined separately for each of the training conditions for the codes and the map functions. Initially, all background variables were entered into the multiple regression to establish the maximum value of the multiple R. Next a forward stepwise regression was conducted, to determine which variables contributed the most to the prediction. The regression results are documented in Table E-25. The multiple Rs for the stepwise solutions ranged from .33 to .47, with the highest R for the Exploratory condition on the map final exam (see Table 14). Results showed that only measures from the computer and the military knowledge dimensions contributed to the prediction of the final exam scores. The BR and work independently measures did not predict.

The Exploratory map condition where soldiers learned on their own was of particular interest. Could we predict what type of soldier(s) was (were) best suited for an Exploratory training condition? The computer icon score was the strongest correlate for the Exploratory condition (r = .42), followed by military knowledge of symbols, although this score did not increase the R substantially (see Table 14). Perhaps, experience with computers made it easier for soldiers to know what and how to examine the interface on their own. The tendency to work independently scale did not correlate with the map score for the Exploratory group, even though it was developed for that purpose.

Table 14
Stepwise Multiple Regression Results

	Criterion Measures and Training Conditions				
	Code Final Exam		**Map Final Exam**		
	Low (n = 80)	**High** (n = 83)	**Low** (n = 40)	**High** (n = 34)	**Exploratory** (n = 80)
	Predictor R	Predictor R	Predictor R	Predictor R	Predictor R
	Symbols .26 Map Read .33	Icon Score 29 Map Read .41	Short/Knack .38	Map Read .36 Self-rate .46	Icon Score .41 Symbols .47
R	.33	.41	.38	.46	.47

Note. Probability of F to enter was set at .10. Probability of F to remove was set at .15. Variables are listed in order of their entry. Resulting R value is also shown at each step.

In general, the stepwise Rs were not high (.33 to .47), nor were the full equation Rs (.42 to .52). For each exam, the R for Low Demand was lower than that for High Demand. With the

exception of the code exam score for Low Demand, some measure of computer expertise or background was in the stepwise regression equations. With the exception of the map exam for Low Demand, the score on symbols or map reading (military knowledge) was in the stepwise regression. Battle roster experience never correlated highly, perhaps because so few soldiers had experience with the BR system.

Discussion and Conclusions

Despite substantial differences in military knowledge and experience among the soldier groups as well as the minimal knowledge in some areas by all groups, neither these differences nor the limited knowledge appeared to greatly hinder performance. For instance, soldiers learned the weapon and unit symbols even though many did not attempt to answer these questions on the initial military knowledge test as they had never been exposed to this material in their military training.

For both the code and map training, the blocks of instruction that had the greatest differences in working memory demand were the ones that resulted in differences in performance. For the coding training, this was the rifle and weapons squads block(s) of instruction. In the map training, this difference was ultimately reflected in performance on the Display exercises. In each instance, those soldiers in the Low Demand condition performed better.

Another factor that indicates the Low Demand condition was more effective than High Demand was the variability in scores. We checked for conditions where the variability of scores for a given group was at least 1.5 times greater than another. For both the company-squad BR and rifle-weapons squad code exercises, the scores for the High Demand condition were at least 2.5 times more variable than those for the Low Demand condition. Thus not only did the Low working demand condition result in a higher level of performance than the High condition, it also resulted in more consistent scores.

Those individuals using the unguided exploratory means of learning the map performed more poorly than those with more formal instruction. However, the time devoted to exploratory learning was 70% less than that in the Low and High Demand conditions. Exploratory times were at least twice as variable as those in the Low and High Demand conditions, and the time required to complete the map final exam was longer. Both findings were additional indications of lower proficiency. In summary, exploratory learning, with minimal guidance, was not the most effective mode of digital map training for the diversity of soldiers in the research - the soldiers to receive the Land Warrior system. Although the tendency to work independently scale did seem to identify soldiers who tended to work without guidance, it did not necessarily identify those who were good at employing the appropriate, information-seeking strategies on their own.

Differences in scores and times for the four soldier groups appeared on many measures. Typically, IOBC soldiers scored the highest, then ANCOC, then BNCOC, and lastly OSUT. That OSUT soldiers scored lowest was not unexpected, given their limited military experience and knowledge. Times also varied with soldier group, although the pattern was not as consistent

as was the case for the scores. But in general, IOBC soldiers finished quickest, and OSUT soldiers took the most time. As indicated by the time data and observations made during the experiment, the CBT format adapted well to the differences in learning rate exhibited by the soldiers. The experiment simply reinforces findings from previous CBT research about the efficiency of this training approach, as it avoids the lock-step process inherent in teacher-led classroom instruction. This increased efficiency can be viewed as particularly valuable when the target user population is quite diverse, as it is with many of the Army's digital systems.

Of interest was the lack of statistical interactions between the experimental conditions and the soldier groups. This was not expected. Prior research (Corno & Snow, 1986) indicates that high ability and/or or highly motivated individuals perform well in discovery learning contexts or in situations where they have some degree of control, whereas less able individuals require more teacher direction and instructional support. Although we had no measure of soldier ability per se, the soldier groups did differ substantially in military experience and knowledge. Consequently, it seemed reasonable for the High Demand conditions to have a greater impact on OSUT soldiers than the other groups, given the limited military background of trainees. Instead, when the High Demand condition impacted scores, it had a similar detrimental effect on each group. Also it seemed plausible that the IOBC soldiers might do as well under an Exploratory condition as the other conditions, given their university education. Although they were the highest performing soldier group under this condition, their performance dropped relative to their performance in the Low and High Demand conditions. A similar pattern of results occurred for the other groups.

A very practical question is whether any of the training conditions resulted in satisfactory levels of performance. The criterion was 80% correct. For codes, soldiers in both conditions averaged over 80% correct on the code final exam. The averages for each course were greater than 80% as well. A factor that could have contributed to soldiers meeting the code criterion on the final exam was that they had to repeat a block of instruction if they did not achieve 80% on the exercises the first time.

For the map exam, the final level of performance was not as high, falling below 80% for each training condition and for each group of soldiers. There was no requirement for soldiers in the Low and High Demand conditions to repeat map exercises when they failed to reach the 80% criterion. If this had been required, it is likely that the final scores in these two conditions would have been higher, resulting in an even greater discrepancy with the Exploratory condition.

A second practical question that remains unanswered in the present research is whether the CBT lessons and exercises had a lasting effect. This issue could not be addressed in the context of the current effort.

Given the relatively short time soldiers spent "exploring" the map interface and the small but significant relationship between exploratory time and the final exam score, exploratory modes of training bear further investigation. Exploratory learning should not be automatically rejected as a training approach on the basis of this research. However, the results do support prior research on the limitations of "pure" or "unguided" exploratory modes of instruction. Combining some elements of formal instruction with an exploratory mode might prove very

effective in acquiring the interactive skills and insights required to work with digital interfaces typical of Army systems. Some form of guided exploratory learning could also be a good way of adapting to individual differences in groups of soldiers with diverse military backgrounds.

Not unexpectedly, you can include too much information in a block of instruction. The concept of the number seven can be used as a rough guide to determine when too much new information may be presented. And it should not be viewed as a formula for instructional design. As pointed out by Ausubel (1968), blocks of instruction should not be made small just to reduce the error rate. They should not fragment content, ignore the need to consolidate and integrate information, or fail to provide individuals with the logic of the body of content that is being taught. In addition, chunks of meaningful material can easily vary with the background of the learner. Thus large bodies of material may be easily comprehended by some individuals when familiar information is included, but be overwhelming for others.

The experiments showed how the computer-based training could be designed to incorporate military tactical system software as background instruction and demonstration screens, and as interactive screens for performance exercises. High-fidelity training is a positive by-product of this technique.

Although the multi-media instruction was effective, the medium per se is not an automatic panacea for training the digital skills required of soldiers and leaders who must use the tactical software embedded in new equipment. Measurement techniques and procedures are needed that account for the multiple, yet valid approaches a soldier can use to accomplish a task. In addition, challenges lie in developing problem-solving scenarios that require soldiers to go beyond demonstrating technical skill proficiency to demonstrating effective employment of digital skills in combat-like settings.

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Appendix A

Symbols and Battle Roster System

Individuals

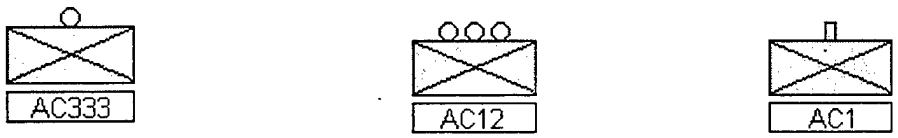
Weapon Symbols

Rifle	Squad Automatic Weapon (SAW)	M203 Grenade Launcher	M60 or M240 Machine Gun	Antitank Weapon Javelin

SAW symbol generated for purposes of the experiment; no official Army symbol existed.

Battle Roster: 1st two characters indicate Battalion, 1st number is code for company, 2nd number is code for platoon, 3rd number is code for squad, 4th number is code for individual. Leaders coded as 0.

Units



Unit Symbols

Squad	Platoon	Company

Battle Roster: Characters and numbers as cited for individuals. Truncated at the appropriate level. This procedure was developed for purposes of the experiment; not an official Army procedure.

Appendix B

Pre-experiment Instruments

Computer Training Research
(U.S. Army Research Institute, Ft. Benning, GA)

Log-In Code:

Name (optional)_____

Please Do Not Begin Until Instructed

PRIVACY ACT STATEMENT

Public Law 93-573, called the Privacy Act of 1974, requires that you be informed of the purpose and uses to be made of the information collected.

The Department of the Army may collect the information requested in this questionnaire under the authority of 10 USC 2358. Providing information in this questionnaire is voluntary. Failure to respond to any particular questions will not result in penalty.

This packet contains the paper and pencil portion of the Computer Training Study. The package is divided into three sections:

Section A: Survey on computer experience
Section B: Survey on problem solving behavior
Section C: Quiz on map reading, symbols, and battle roster system

- We will provide instructions for the computer training portion of the study once everyone has completed Sections A through C. Please do not attempt to log onto the computer until instructed to do so.

Section A
COMPUTER SURVEY

Age: _____ Rank:_____

Years and Months in Army: _____years _____months

Are you returning to the same position you held when you left your unit? Yes____ No ____

If Yes, what is that position? _____
If No, what position are you going to? _____

---

1. When did you use computers in your education? *(Circle all that apply)*
   Grade School Jr High High School Technical School College Did Not Use

2. Where do you currently use a computer? *(Circle all that apply)*

   Home/barracks/BOQ Unit/Work Site Library/Learning Ctr/Training Facility Do Not Use

3. *For each of the following questions, circle the response that best describes you.*

   a. Do you own a personal computer? Yes No

   b. How often do you: (circle how frequently you use each)

•Use a mouse?	Daily, Weekly, Monthly, Less Often, Never
•Play computer games?	Daily, Weekly, Monthly, Less Often, Never
•Use icon-based programs/software?	Daily, Weekly, Monthly, Less Often, Never
•Use programs/software with pull-down menus?	Daily, Weekly, Monthly, Less Often, Never
•Use graphics/drawing features in software packages?	Daily, Weekly, Monthly, Less Often, Never
•Use E-mail (at home or at work)?	Daily, Weekly, Monthly, Less Often, Never
•Use the Internet?	Daily, Weekly, Monthly, Less Often, Never

4. Which of the following best describes your typing ability? (*check √ one*)
   ____ Hunt and peck slowly
   ____ Hunt and peck quickly
   ____ Type slowly while not looking at the keyboard
   ____ Type quickly while not looking at the keyboard

5. Which of the following best describes your expertise with computers? (*check √ one*)
   ____ Novice
   ____ Good with one type of software package (such as word processing or work calendars or slides)
   ____ Good with several software packages
   ____ Can program in one language and use several software packages
   ____ Can program in several languages and use several software packages
   ____ Expert – Bill Gates would hire me

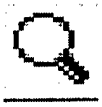
   If you are good with one or more software packages, please list them.

   _____

   If you can program in one or more languages, please name these languages.

   _____

6. What is the function of the following icons?



Section B
Survey on Problem Solving Behavior

Below are 15 activities that you may engage in from time to time. Next to each item, please circle the ONE response that BEST DESCRIBES how you typically approach each activity. That is, do you *USUALLY:*

1. ***Complete the activity (or give up) without referring to instructions, a map, or asking for directions;***
2. ***Proceed at first without reading instructions, a map, or asking for directions, but will refer to these if you run into a problem;***
3. ***Read the instructions, a map, or ask for help before beginning;***
4. ***Find someone else to perform the task for you (a friend, spouse, etc.).***

	Complete task or give up without instructions, map, etc.	Only refer to instructions, map, etc. if there are problems	Read instructions, map, etc. before beginning	Find someone else to do it	Not applicable
Set up a new computer	1	2	3	4	N/A
Change a tire on a new vehicle	1	2	3	4	N/A
Change settings on a new digital watch	1	2	3	4	N/A
Drive an unfamiliar route to a new destination more than 100 miles from home	1	2	3	4	N/A
Cook a frozen dinner	1	2	3	4	N/A
Fill out tax forms	1	2	3	4	N/A
Program a new VCR	1	2	3	4	N/A
Find your seat at a ballgame or concert	1	2	3	4	N/A
Play a new video or computer game	1	2	3	4	N/A
Take a new, over-the-counter medication	1	2	3	4	N/A
Put together a new bicycle	1	2	3	4	N/A
Learn a new computer software application	1	2	3	4	N/A
Put up a new tent	1	2	3	4	N/A
Respond to a survey	1	2	3	4	N/A
Put together a piece of furniture that requires assembly	1	2	3	4	N/A

Please rate how well each of the following statements describes you. Circle any number from 1 to 10.

	Does not describe me at all				Somewhat Descriptive					Describes me completely
I seem to have a "knack" or "feel" for finding my way around a computer program	1	2	3	4	5	6	7	8	9	10
Even if I already know one way to perform a task on the computer, I usually figure out a shortcut that will allow me to do the same task with fewer steps	1	2	3	4	5	6	7	8	9	10

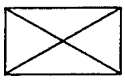
Section C
Map Skills, Operational Symbols and Battle Rosters

Directions: Given the 1/50,000 scale map in front of you and using a protractor, answer the following questions as accurately as possible.

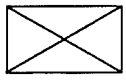
1. What is the 8-digit grid coordinate for the SP? _____
2. What is the 8-digit grid coordinate for the OBJ? _____
3. What terrain feature is the OBJ on? _____
4. If you traveled on a grid azimuth of 80 degrees from the SP, what is the name of the first hard surfaced road you encounter? _____
5. What is the straight-line distance in meters from the SP to the OBJ? _____
6. What is the grid azimuth in degrees from the SP to the OBJ? _____

The remaining questions do not require a map:

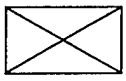
8. Draw in the elements that will complete each unit symbol:



a) squad

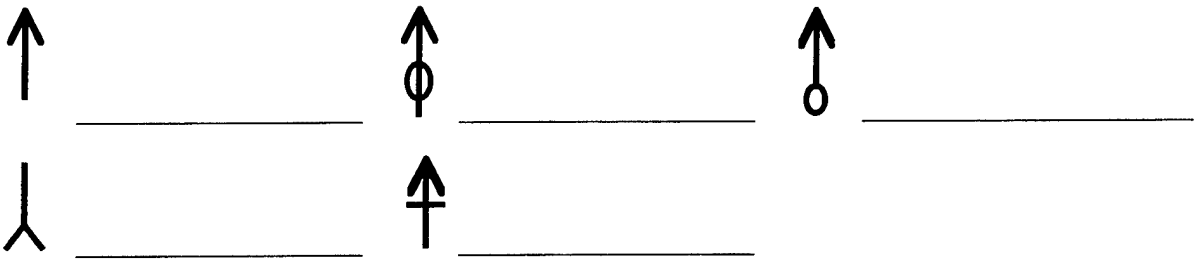


b) platoon



c) company

9. In the spaces provided, name the following weapon systems:



_____ _____ _____

_____ _____

10. Have you ever received training on the Army's battle roster system? Yes_____ No_____

11. Have you used the battle roster system in a duty position within a unit? Yes_____No_____

Practice Exercises for Land Warrior Map Exploration

The following practice exercises will help you familiarize yourself with the Land Warrior map functions. This is NOT a test, and you will not be scored on your responses.

In addition to completing the tasks listed below, continue practicing all available functions. Do not proceed to the Final Exam until you feel you are ready to perform a series of complex, timed exercises.

Practice Exercises:

1. Pan around the map display until you locate Gow Hill.
2. Zoom out until BM (Benchmark) 147 is visible on your map display.
3. Using the FindMe function, display your symbol.
4. Determine the range and azimuth FROM YOU to BM 147.
5. Zoom in on your symbol until Mount Paran is no longer visible on your map display.
6. Using FindX, find Company B. When you find the unit symbol on the map, click on it.
7. Using FindX, find the B Team Grenadier for Co. C, 1st Plt, 1st Sqd, and click on his symbol.
8. You are the commander, Company A. Display all of your platoon leaders.
9. Use pan to locate the second platoon leader. Click on his symbol.

Note on availability of individuals and units in the map area:

- Company D is not available.
- Only four **complete** squads are available for display:
  - Company A, 3rd Platoon, Weapons Squad
  - Company B, 2nd Platoon, 2nd Squad
  - Company C, 1st Platoon, 1st Squad
  - Company C, 2nd Platoon, Weapons Squad

Instructions for the Map Final Exam

At beginning of each task, there is a red banner that says:

Click NEXT to begin the exercise.

Once you click NEXT, the timer for the exercise starts. You must click NEXT to start each exercise. You will not progress unless you click NEXT, and none of your responses will be scored.

Tip. Take the time to figure out the answer or determine your approach to solving the question *before* clicking the NEXT button.

In the Range and Azimuth questions, you must physically move the cursor to each answer box by clicking on it. You cannot tab to the other box.

Be patient; don't rush when answering.

Appendix C
Soldier Background Results

Table C-1
Descriptive Statistics on Age of each Soldier Group

Soldier Group	*N*	*M*	*Mdn*	*SD*	Range
ANCOC	29	31.59	30	3.40	27-39
BNCOC	48	27.75	27	3.32	22-38
IOBC	42	23.14	23	1.92	21-29
OSUT	48	19.58	19	2.36	17-27

$F(3, 163) = 137.59$, $p = .0000$. Mean age for each soldier group differed from the mean of each other group.

Table C-2
Number of Soldiers by Rank in Each Soldier Group

Rank	Soldier Group			
	OSUT	BNCOC	ANCOC	IOBC
Private	All 48	NA	NA	NA
Sergeant		15		
Staff Sergeant		33	0	
Sergeant First Class			28	
2d Lieutenant				All 42

Note. No data on rank from 1 soldier in ANCOC.
Of the IOBC students, 17 (41%) received their commission through Reserve Officer Training Corps, 24 (57%) from the US Army Military Academy, and 1 (2%) from the US Air Force Academy.

Table C-3
Descriptive Statistics on Years in Active Service

Soldier Group	*N*	*M*	*Mdn*	*SD*	Range
ANCOC	29	11.51	11.9	2.21	9.00- 18.17
BNCOC	48	7.47	7.0	2.60	4.25-19.67
IOBC	42	1.93	0.8	2.29	0.00-7.17
OSUT	Not asked because not applicable				

Note. For the OSUT soldiers, 31 (65%) had a high school education, 3 (6%) had technical school training, 10 (21%) had less than 4 years of college, 3 (6%) had a college degree, and 1 (2%) had a GED.

Table C-4
Percentage of Soldiers Using a Computer in Different Phases of Their Formal Education

Soldier Group	% Use Computer					
	Grade School	Junior High	High School	Technical School	College	Not Use
OSUT	54%	71%	83%	2%	23%	4%
BNCOC	6%	15%	58%	2%	40%	19%
ANCOC	0%	10%	24%	0%	52%	24%
IOBC	29%	50%	76%	0%	95%	0%

Table C-5
Number of Educational Settings Where Soldiers Used a Computer

Soldier Group	# Educational Settings (% soldiers)				
	0	1	2	3	4-5
OSUT	4%	21%	27%	33%	15%
BNCOC	19%	52%	23%	4%	2%
ANCOC	24%	69%	3%	3%	0%
IOBC	0%	24%	29%	21%	26%

Note. Mean number of settings for each group was: OSUT – 2.33; BNCOC – 1.19;, ANCOC-0.86; IOBC - 2.52. $F(3, 163) = 26.90$, $p = .0000$. All courses differed from each other except OSUT and IOBC.

Table C-6
Percentage of Soldiers Indicating Computer Ownership and Current Use of a Computer

Soldier Group	% Own a Computer[a]	% Use Computer Now[b]	Where Currently Use Computer		
			Home	Work/Unit	Trng Facility
OSUT	58%	63%	56%	6%	21%
BNCOC	67%	98%	69%	63%	42%
ANCOC	90%	97%	90%	76%	38%
IOBC	93%	95%	95%	21%	24%

[a] Own: $\chi^2(3) = 19.63$, $p = .0002$.
[b] Use: $\chi^2(3) = 34.99$, $p = .0000$.

Table C-7
Descriptive Statistics on the Sum of Feature Use Ratings

Soldier Group	**Sum of Feature Use Ratings**					
	N	*M*	*Mdn*	*SD*	Range	Interquartile Range
OSUT	48	19.48	21.5	7.59	0-28	16-21.5
BNCOC	48	17.50	19.0	7.53	0-28	14-23
ANCOC	29	20.31	21.0	6.08	0-28	18-25
IOBC	42	20.57	21.5	5.13	2-28	17-21.5

Note. The 7 features were rated on a 0 to 4-point scale, ranging from "never used" to "daily use." Maximum score was 28 representing daily use of all 7 features; minimum score was 0 indicating a soldier never used any of the 7 features.
$F(3, 163) = 1.84, p = .1409$.

Table C-8
Percentage of Soldiers Indicating Different Levels of Typing Skill

Soldier Group	**Self Ratings of Typing Skill**			
	Hunt & Peck Slowly	Hunt & Peck Quickly	Type Slowly	Type Quickly
OSUT	6%	48%	25%	21%
BNCOC	19%	35%	38%	8%
ANCOC	17%	33%	30%	20%
IOBC	0%	36%	19%	45%

Note. $\chi^2(9) = 27.83$, p = .0010

Table C-9
Descriptive Statistics on Self-Ratings of Typing Skill

Soldier Group	**Self-Ratings of Typing Skill**				
	N	*M*	*Mdn*	*SD*	Interquartile Range
OSUT	48	2.60	2.00	0.89	2.0-3.0
BNCOC	48	2.35	2.00	0.89	2.0-3.0
ANCOC	30	2.53	2.50	1.01	2.0-3.0
IOBC	42	3.09	3.00	0.91	2.0-4.0

Note. $F(3, 164), = 5.18, p = .0018$. IOBC mean rating higher than BNCOC, ANCOC, and OSUT.

Table C-10
Percentage of Soldiers Indicating Different Levels of Computer Skill

Soldier Group	Self-Ratings of Computer Skill						
	N	Novice	Good w 1 softw program	Good w several Soft Progr	1 Progm Lang + Software	Several Progm Lang+Soft	Bill Gates hire me
OSUT	48	38%	25%	35%	0%	2%	0%
BNCOC	48	44%	25%	29%	2%	0%	0%
ANCOC	30	40%	20%	40%	0%	0%	0%
IOBC	42	12%	24%	45%	14%	5%	0%

Table C-11
Descriptive Statistics on Self-Ratings of Computer Skill

Soldier Group	Self-Ratings of Computer Skill					
	N	*M*	*Mdn*	*SD*	Range	Interquartile Range
OSUT	48	2.04	2.00	0.97	1-5	1-3
BNCOC	48	1.89	2.00	0.91	1-4	1-3
ANCOC	30	2.00	2.00	0.91	1-3	1-3
IOBC	42	2.76	3.00	1.01	1-5	2-3

Note. Scale: Novice = 1, One software program = 2; Several software program = 3, One program language + software = 4, Program languages + software = 5; Bill Gates hire me = 6. $F(3, 164) = 7.38, p = .0001$; IOBC mean rating higher than ANCOC, BNCOC and OSUT. Chi-square test was also significant, $\chi^2 (12) = 27.48, p = .0065$.

Table C-12
Descriptive Statistics on Icon Test Score

Soldier Group	Icon Test Scores					
	M	*Mdn*	*Range*	*SD*	Interquartile Range	Mean % Correct
OSUT	8.92	8.50	1-15	3.39	6.5-12	50%
BNCOC	7.97	7.75	1-15	3.48	5.5-10.75	44%
ANCOC	9.53	9.50	2-15	3.12	7.5-11	53%
IOBC	11.17	11.00	4-15.5	2.58	10-11	62%

Note. $F(3, 164) = 7.89, p = .0001$. IOBC mean score higher than ANCOC, BNCOC, and OSUT; ANCOC mean score higher than BNCOC.

Table C-13
Weapon Symbols: Percent who Answered Correctly and Percent who Made no Response

Weapon Symbol	OSUT	BNCOC	ANCOC	IOBC	All Groups
% Soldiers Answering Correctly					
M16 Rifle/M4	4%	17%	10%	45%	19%
M240B/M60	4%	15%	10%	24%	13%
Anti-tank-Javelin	2%	17%	20%	24%	15%
M203	0%	2%	3%	31%	9%
Mortar	0%	13%	33%	21%	15%
% Soldiers Not Responding					
M16Rifle/M4	96%	44%	10%	26%	48%
M240B/M60	96%	54%	30%	36%	57%
Anti-tank Javelin	98%	69%	73%	62%	76%
M203	98%	71%	70%	33%	69%
Mortar	100%	58%	57%	38%	65%

Note. For each soldier group, the percentage of soldiers answered but answered incorrectly is 100% minus % Correct and % No Response.

Table C-14
Weapon Symbols: Frequency Distribution

# Correct	OSUT	BNCOC	ANCOC	IOBC
% Soldiers Within Group				
0	96%	58%	53%	38%
1	0%	25%	27%	21%
2	2%	15%	13%	10%
3	2%	0%	3%	21%
4	0%	2%	3%	7%
5	0%	0%	0%	2%
Mean (5 symbols)	0.10	0.62	0.77	1.45
SD	0.51	0.89	1.04	1.48
N	48	48	30	42

Note. $F(3,164) = 13.13, p = .0000$; IOBC mean higher than OSUT, BNCOC, and ANCOC; ANCOC and BNCOC means higher than OSUT. Because of the nonnormal distribution of scores, a Chi-square analysis was also conducted. Scores were divided at 0 and greater than zero. $\chi^2(3) = 38.75, p = .0001$

Table C-15
Unit Symbols: Percent who Answered Correctly and Percent who Made no Response

Unit Symbol	OSUT	BNCOC	ANCOC	IOBC	All Groups
% Soldiers Answering Correctly					
Squad	2%	27%	79%	65%	39%
Platoon	0%	13%	67%	55%	29%
Company	2%	4%	73%	43%	26%
% Soldiers not Responding					
Squad	88%	42%	7%	12%	41%
Platoon	85%	38%	0%	12%	38%
Company	83%	44%	0%	24%	42%

Note. For each soldier group, the percentage who answered, but answered incorrectly is 100% minus the percentage correct plus the percentage of no responses.

Table C-16
Unit Symbols: Frequency Distribution

# Correct	OSUT	BNCOC	ANCOC	IOBC
% Soldiers Within Group				
0	97%	69%	13%	33%
1	0%	21%	10%	12%
2	2%	8%	20%	14%
3	0%	2%	57%	41%
Mean (3 symbols)	0.04	0.44	2.20	1.62
SD	0.29	0.74	1.09	1.32
N	48	48	30	42

Because of the nonnormal distribution of scores, a Chi-square analysis was also conducted. Scores were divided at 0 and greater than zero. $\chi^2(3) = 73.22, p = .0001$. It appeared that each group differed from each other group, based on the difference between the observed and expected frequencies.

Table C-17
Map Reading: Percent Soldiers who Answered Correctly

Item	OSUT	BNCOC	ANCOC	IOBC	All Groups
8-digit grid #1	33%	96%	93%	78%	73%
8-digit grid #2	29%	94%	97%	71%	70%
Terrain feature	40%	75%	87%	71%	66%
Hard-surface road	81%	81%	67%	66%	75%
Distance in meters	60%	77%	67%	90%	74%
Grid azimuth	79%	94%	97%	95%	91%

Table C-18
Map Reading: Frequency Distribution

# Correct	OSUT	BNCOC	ANCOC	IOBC
	% Soldiers Within Group			
0	8%	0%	0%	0%
1	8%	0%	0%	0%
2	17%	0%	0%	2%
3	23%	2%	3%	17%
4	17%	19%	20%	19%
5	17%	40%	43%	33%
6	10%	40%	33%	29%
Mean (6 items)	3.29	5.17	5.07	4.69
SD	1.74	0.81	0.83	1.14
N	48	48	30	42

$F(3,164) = 24.43$, $p = .0000$. IOBC, ANCOC, and BNCOC means each greater than OSUT mean.

Table C-19
Experience with the Battle Roster System: % Soldiers

	OSUT	BNCOC	ANCOC	IOBC	All Groups
Trained on Battle Roster System	0%	13%	21%	5%	9%
Used Battle Roster System	0%	31%	38%	7%	18%

Table C-20
Summary of Item Responses for Tendency to Solve Problems Independently

Item or Task	% Soldiers Responding to Each Alternative				
	Complete With No Instructions	Instructions Only If Needed	Read Instructions First	Find Someone Else To Do It	Not Applicable
Change a Tire on a New Vehicle	57%	30%	13%	---	---
Find Your Seat at a Ballgame or Concert	33%	41%	21%	1%	4%
Change Settings on a New Digital Watch	27%	48%	25%	---	---
Cook a Frozen Dinner	24%	15%	58%	1%	1%
Put Up a New Tent	19%	51%	30%	---	1%
Play a New Video or Computer Game	18%	48%	27%	1%	7%
Put Together a New Bicycle	15%	45%	40%	---	1%
Respond to a Survey	15%	23%	58%	4%	1%
Program a New VCR	11%	38%	48%	1%	1%
Put Together a Piece of Furniture that Requires Assembly	8%	33%	58%	1%	---
Drive Unfamiliar Route to a New Destination More Than 100 Miles From Home	8%	26%	65%	---	1%
Set-up a New Computer	7%	41%	39%	10%	4%
Take a New, Over-The-Counter Medication	4%	4%	**83%**	1%	8%
Learn a New Computer Software Application	4%	31%	55%	4%	6%
Fill Out Tax Forms	3%	11%	49%	**33%**	4%

Note. $N = 168$. Items ordered by percent responding to "complete with no instructions." The two items/tasks shaded in gray were eliminated from additional analyses (take a new over-the-counter medication, and fill out tax forms). Row percentages sum to 100%, within rounding error.

Table C-21
Mean Number of Tasks Checked in each Response Option to the Working Independently Items

	OSUT	**BNCOC**	**ANCOC**	**IOBC**	**All Soldiers**
Response Option	*M* *(SD)* *(Range)*	*M* *(SD)* *(Range)*	*M* *(SD)* *(Range)*	*M* *(SD)* *(Range)*	*M* *(SD)* *(Range)*
Tasks usually completed without instructions[a]	3.10 (3.32) (0-10)	2.35 (2.65) (0-10)	1.87 (2.27) (0-9)	2.24 (2.55) (0-10)	2.45 (2.79) (0-13)
Tasks usually attempted wo/ instructions until problem occurs[b]	4.71 (2.45) (0-10)	4.46 (2.74) (0-13)	4.63 (3.55) (0-13)	4.98 (2.68) (0-12)	4.69 (2.79) (0-13)
Tasks usually performed only after reading instructions (or given guidance)[c]	4.96 (3.06) (0-12)	5.50 (3.02) (0-12)	5.93 (3.30) (0-13)	5.24 (3.03) (0-11)	5.36 (3.08) (0-13)
Tasks usually given to someone else to do[d]	0.17 (0.48) (0-2)	0.29 (0.65) (0-3)	0.20 (0.48) (0-2)	0.24 (0.53) (0-2)	0.23 (0.54) (0-3)
Tasks where soldier could not respond (e.g., not done before) --- Not applicable[e]	0.06 (0.32) (0-2)	0.40 (0.89) (0-5)	0.37 (0.96) (0-4)	0.31 (0.64) (0-3)	0.27 (0.73) (0-5)

Note. Because soldiers were required to select one of the response options listed for each of the 13 tasks, means in each column sum to 13.

[a] Completed without instructions: $F(3, 160) = 1.55, p = .204$.

[b] Attempted without instructions until problem occurs: $F(3, 160) = .26, p = .853$.

[c] Performed only after reading instructions: $F(3, 160) = .80, p = .50$.

[d] Task usually given to someone else: $F(3, 160) = .45, p = .72$.

[e] Not applicable: $F(3, 160) = 2.10, p = .10$.

Table C-22
Analysis of Variance on Tendency to Work Independently: Task Approach Strategies by Soldier Group and Map Training Conditions

Factor	*df*	MS	*F*	*p*
Complete With No Instructions				
Map Conditions	2, 156	0.352	0.044	.957
Soldier Group	3, 156	11.83	1.48	.222
Interaction	6, 156	3.07	0.384	.888
Instructions Only If Needed				
Map Conditions	2, 156	0.951	0.116	0.890
Soldier Group	3, 156	3.64	0.444	0.722
Interaction	6, 156	2.36	0.287	0.942
Read Instructions First				
Map Conditions	2, 156	2.54	0.264	.768
Soldier Group	3, 156	10.66	1.11	.347
Interaction	6, 156	9.73	1.01	.419
Find Someone Else To Do It				
Map Conditions	2, 156	0.151	0.500	.607
Soldier Group	3, 156	0.078	0.259	.855
Interaction	6, 156	0.263	0.870	.519
Not Applicable				
Map Conditions	2, 156	0.311	0.570	.567
Soldier Group	3, 156	0.970	1.77	.154
Interaction	6, 156	0.066	0.120	.994

Table C-23
Mean Ratings on Facility with Computer Items

Item	**OSUT**	**BNCOC**	**ANCOC**	**IOBC**	**All Soldiers**
	M (SD) (Range)	*M (SD) (Range)*	*M (SD) (Range)*	*M (SD) (Range)*	*M (SD) (Range)*
Have a "knack" or "feel" for finding my way around a computer	5.58 (2.11) (1-10)	5.06 (2.86) (1-10)	5.23 (2.36) (1-10)	6.19 (2.33) (2-10)	5.52 (2.46) (1-10)
Even if know one way to perform a task, usually figure out a shortcut	5.48 (2.56) (1-10)	4.54 (2.88) (1-10)	4.77 (2.79) (1-10)	5.71 (2.78) (1-10)	5.14 (2.77) (1-10)

Note. No significant differences among soldier groups. Knack: $F(3, 164) = 1.77, p = .1559$. Shortcut: $F(3, 164) = 1.80, p = .1499$. Ratings on a 10-point scale, 1 = *does not describe me at all* to 10 = *describes me completely*.

Appendix D

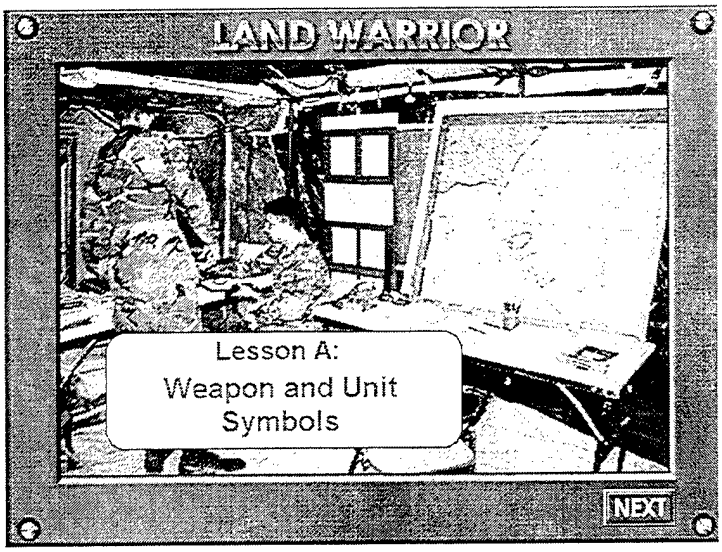
Examples of Lessons, Exercises, and Exams

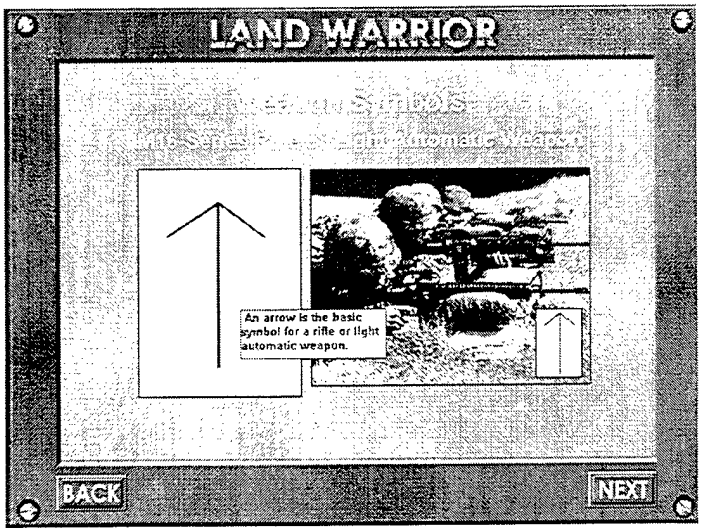
Disclaimer.

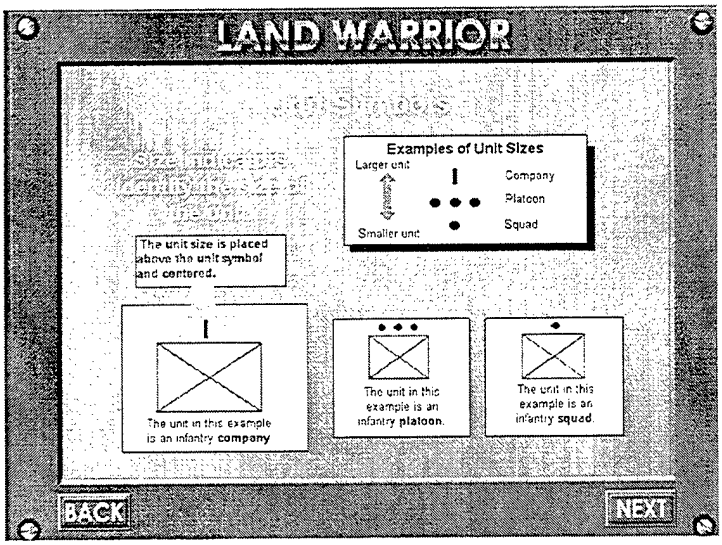
The border on the displays contains the words "Land Warrior."
The symbols and map interface ***DO NOT*** correspond to the current version of the Land Warrior system.
The experiment was based on a prototype version of the Land Warrior map.
For purposes of the experiment,
we generated our own detailed version of how the map might function and the symbols used to identify individuals and units.

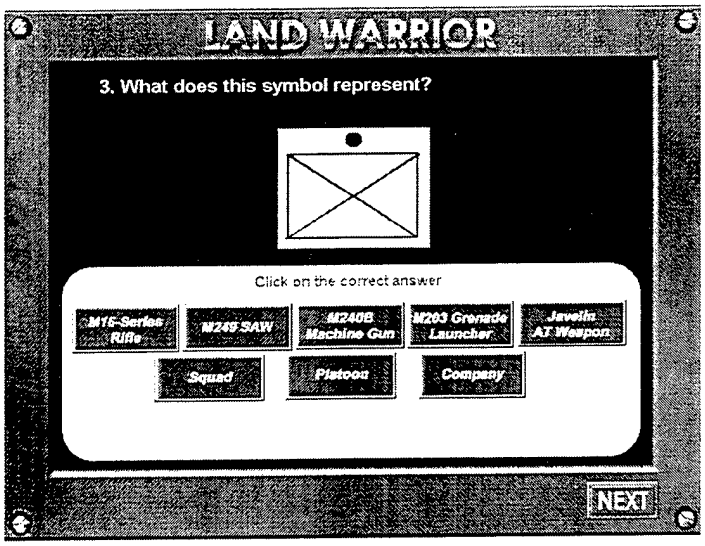
CODES

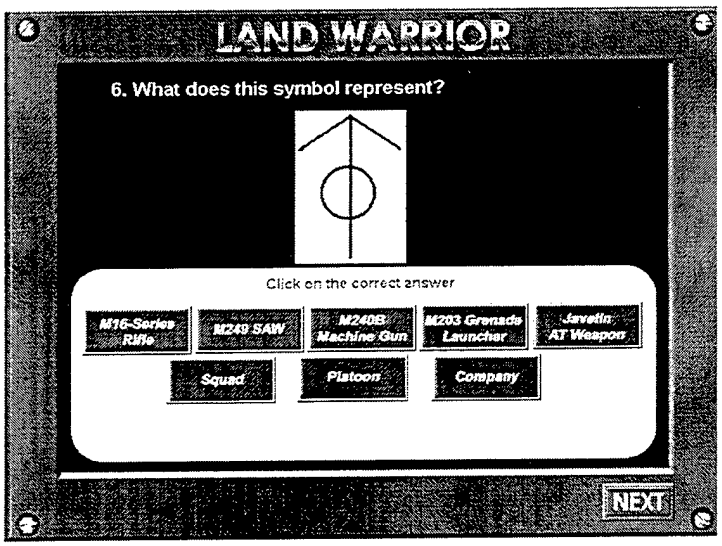
Examples of blocks of instruction for codes: Lesson and exercises.

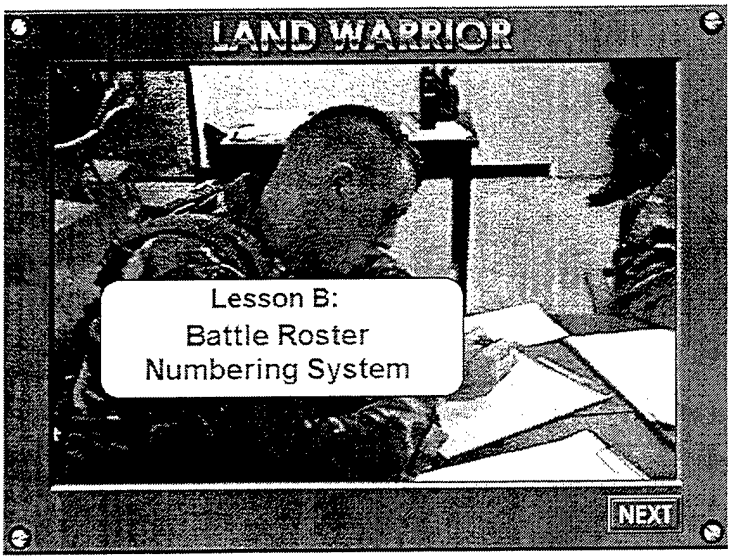


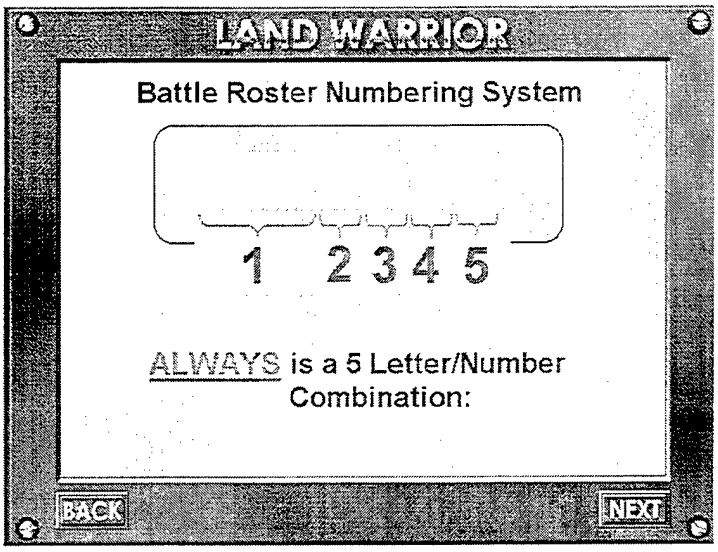


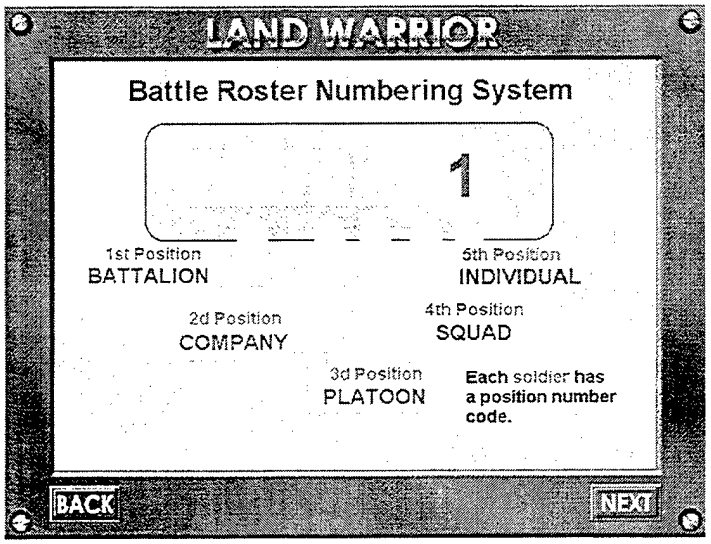


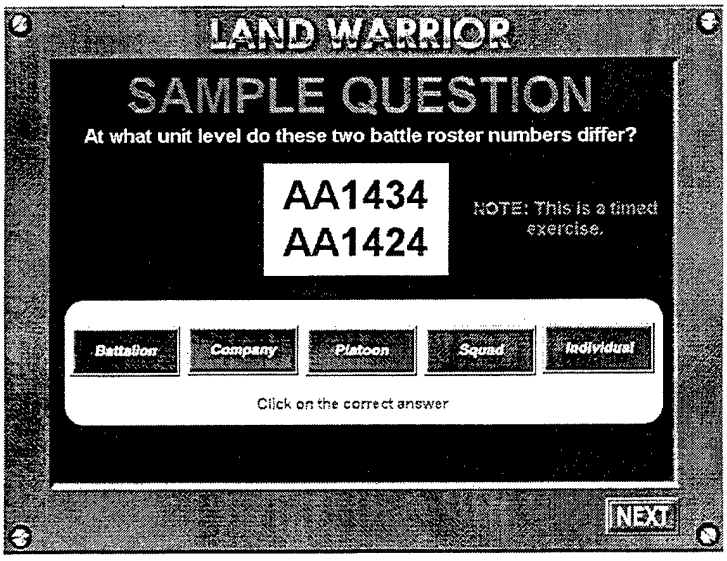

LAND WARRIOR
3. What does this symbol represent?
Click on the correct answer
M16-Series Rifle
M249 SAW
M240B Machine Gun
M203 Grenade Launcher
Javelin AT Weapon
Squad
Platoon
Company
NEXT

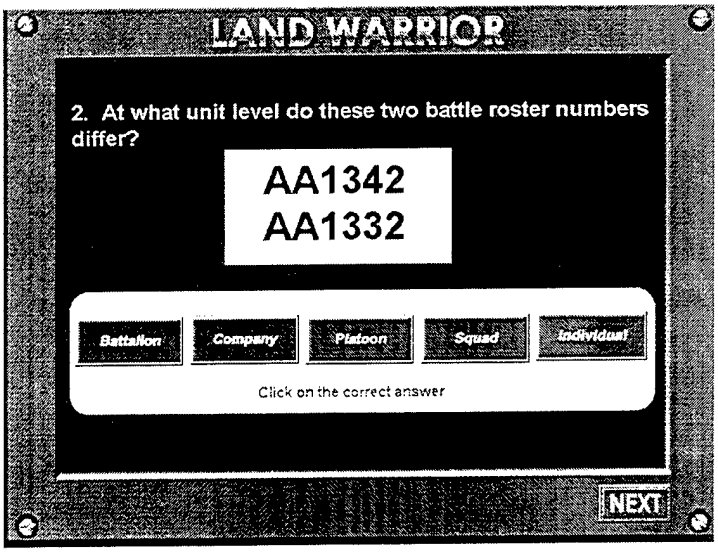

LAND WARRIOR
6. What does this symbol represent?
Click on the correct answer
M16-Series Rifle
M249 SAW
M240B Machine Gun
M203 Grenade Launcher
Javelin AT Weapon
Squad
Platoon
Company
NEXT


LAND WARRIOR
Lesson B:
Battle Roster
Numbering System
NEXT

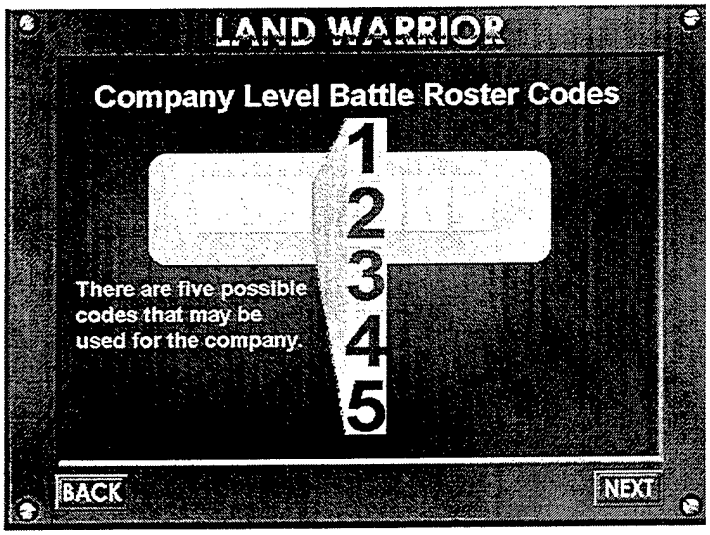

LAND WARRIOR
Battle Roster Numbering System
1 2 3 4 5
ALWAYS is a 5 Letter/Number Combination:
BACK
NEXT

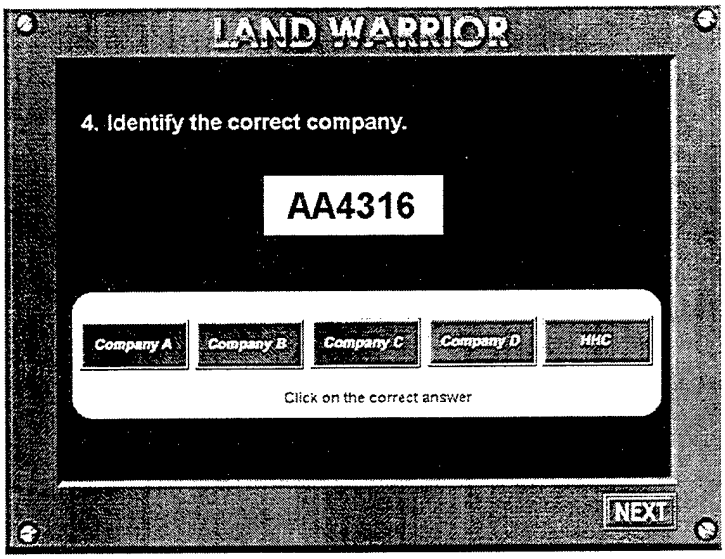

LAND WARRIOR
Battle Roster Numbering System
1
1st Position
BATTALION
2d Position
COMPANY
3d Position
PLATOON
4th Position
SQUAD
5th Position
INDIVIDUAL
Each soldier has a position number code.
BACK
NEXT


LAND WARRIOR
SAMPLE QUESTION
At what unit level do these two battle roster numbers differ?
AA1434
AA1424
NOTE: This is a timed exercise.
Battalion
Company
Platoon
Squad
Individual
Click on the correct answer
NEXT

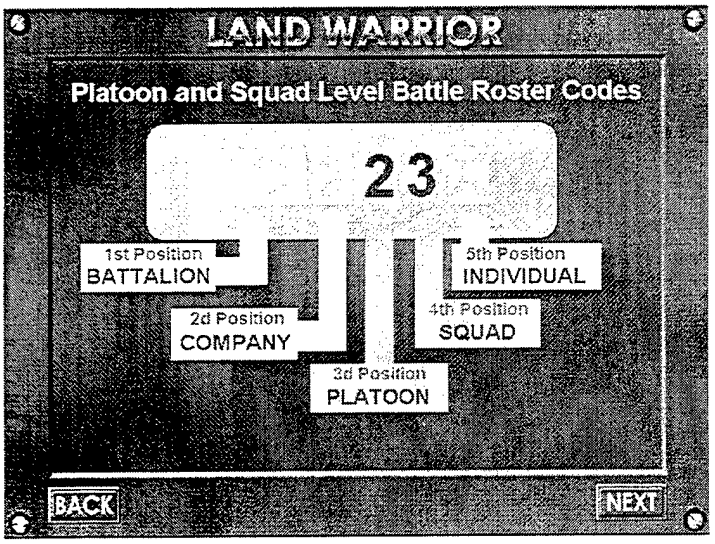

LAND WARRIOR
2. At what unit level do these two battle roster numbers differ?
AA1342
AA1332
Battalion
Company
Platoon
Squad
Individual
Click on the correct answer
NEXT

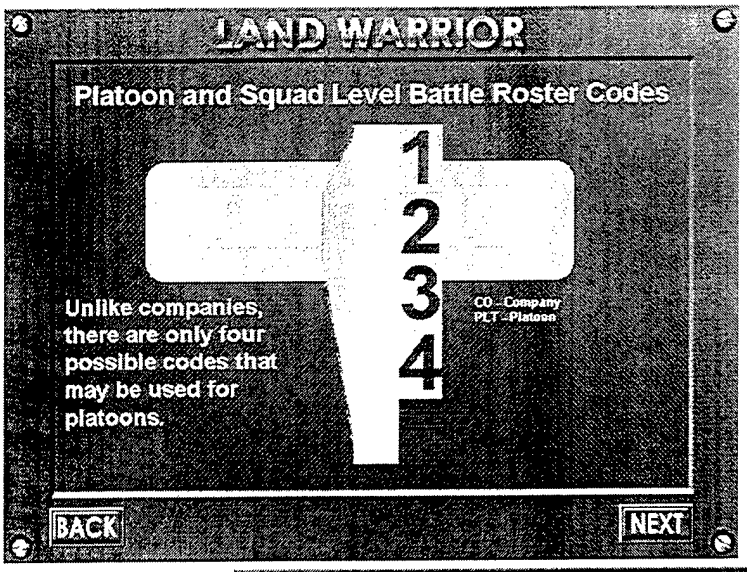
LAND WARRIOR
Lesson C:
Company Level
Battle Roster Codes
NEXT

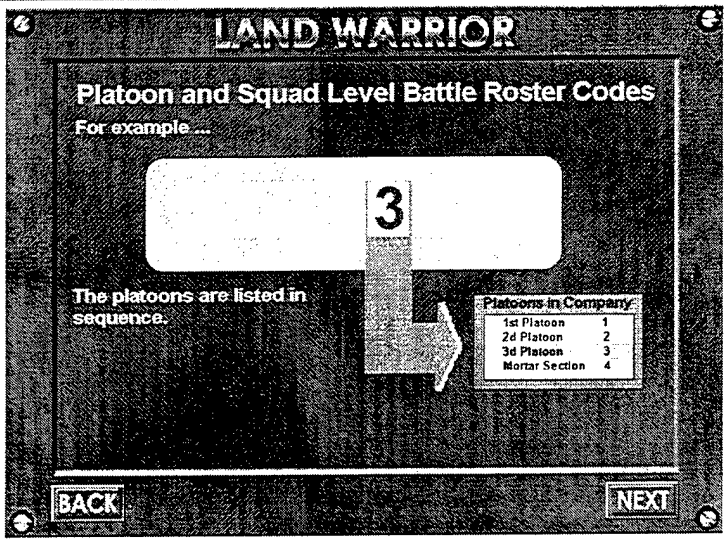

LAND WARRIOR
Company Level Battle Roster Codes
1
2
3
4
5
There are five possible codes that may be used for the company.
BACK
NEXT

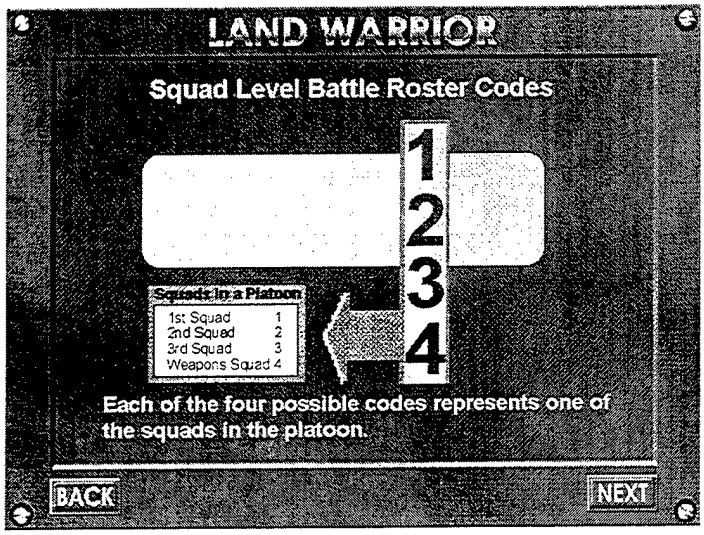

LAND WARRIOR
4. Identify the correct company.
AA4316
Company A
Company B
Company C
Company D
HHC
Click on the correct answer
NEXT

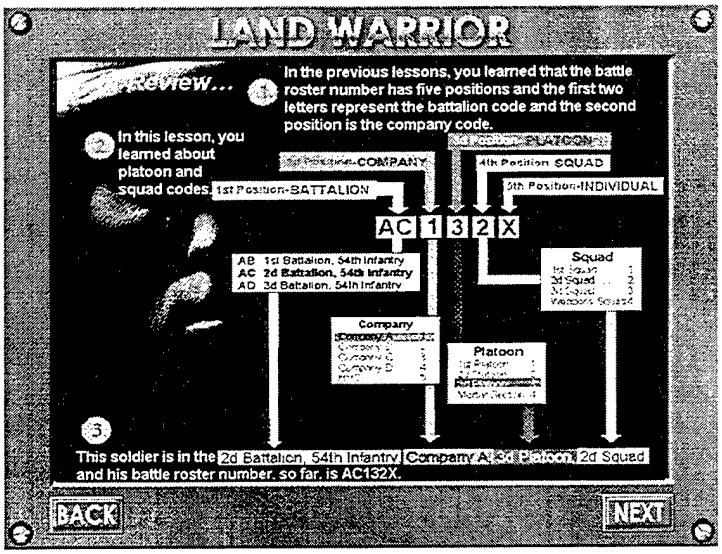
LAND WARRIOR
Lesson D:
Platoon and Squad
Level Battle Roster
Codes
NEXT

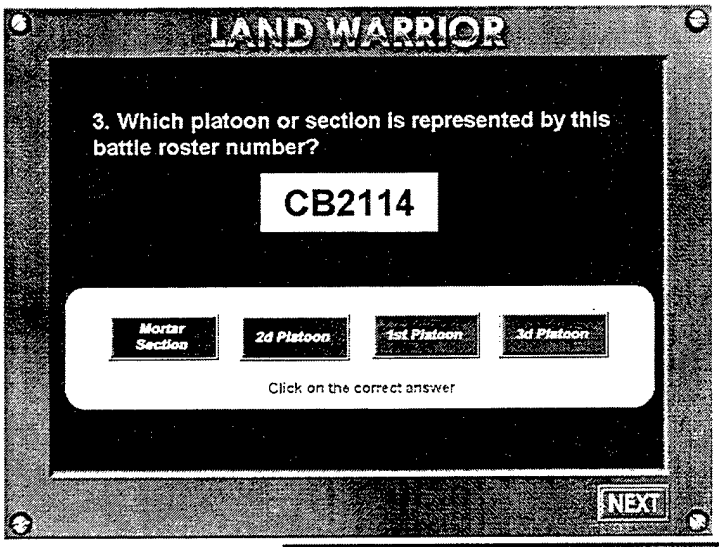

LAND WARRIOR
Platoon and Squad Level Battle Roster Codes
23
1st Position
BATTALION
2d Position
COMPANY
3d Position
PLATOON
4th Position
SQUAD
5th Position
INDIVIDUAL
BACK
NEXT

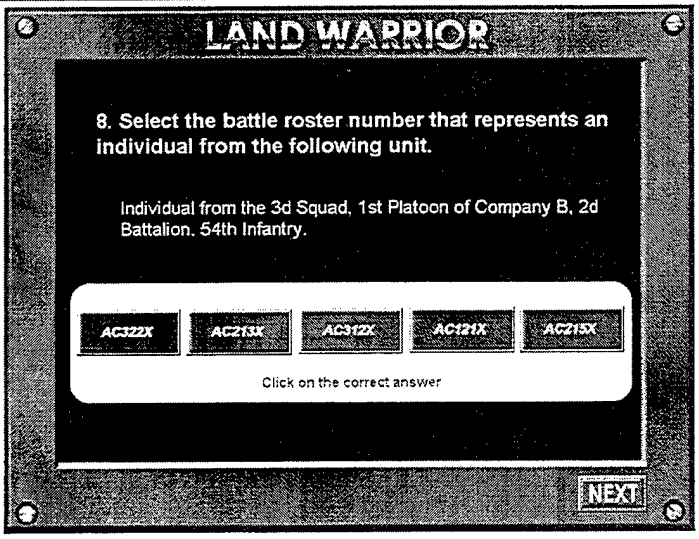

LAND WARRIOR
Platoon and Squad Level Battle Roster Codes
1
2
3
4
CO - Company
PLT - Platoon
Unlike companies, there are only four possible codes that may be used for platoons.
BACK
NEXT

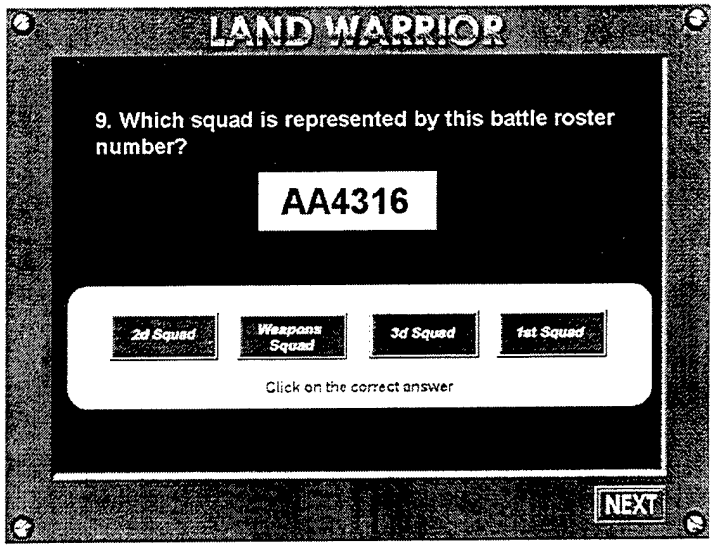

LAND WARRIOR
Platoon and Squad Level Battle Roster Codes
For example ...
3
The platoons are listed in sequence.
Platoons in Company
1st Platoon 1
2d Platoon 2
3d Platoon 3
Mortar Section 4
BACK
NEXT

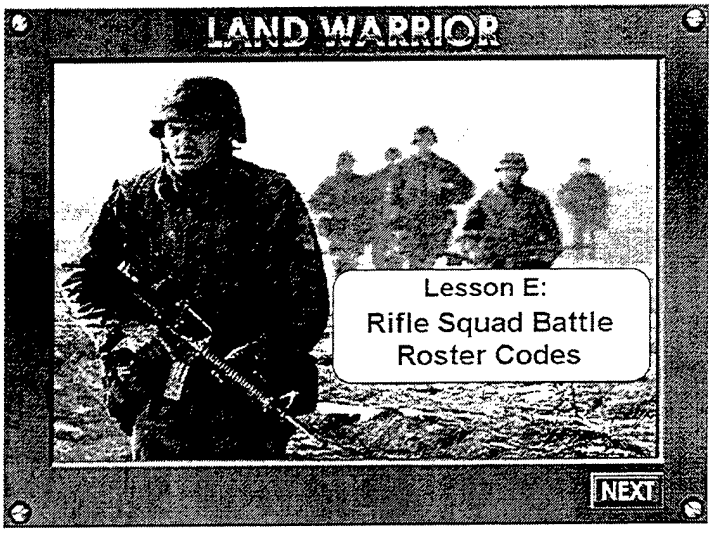

LAND WARRIOR
Squad Level Battle Roster Codes
1
2
3
4
Squads in a Platoon
1st Squad 1
2nd Squad 2
3rd Squad 3
Weapons Squad 4
Each of the four possible codes represents one of the squads in the platoon.
BACK
NEXT

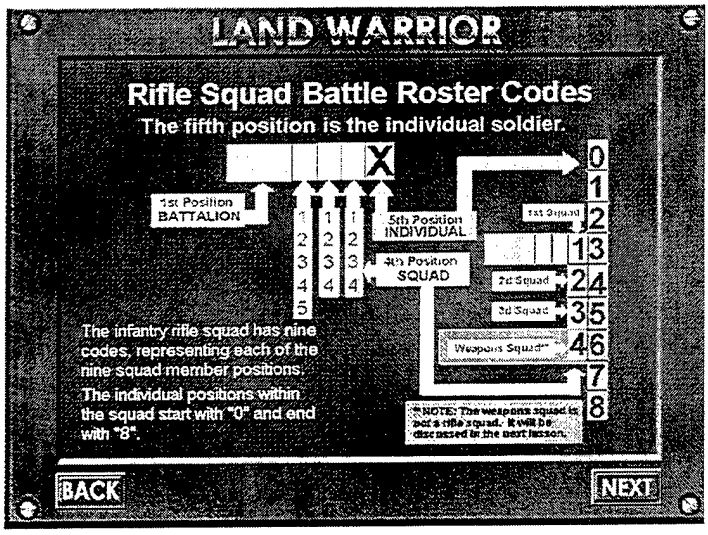

LAND WARRIOR
Review...
1 In the previous lessons, you learned that the battle roster number has five positions and the first two letters represent the battalion code and the second position is the company code.
2 In this lesson, you learned about platoon and squad codes.
3rd Position-COMPANY
4th Position-SQUAD
1st Position-BATTALION
5th Position-INDIVIDUAL
AC 1 3 2 X
AB 1st Battalion, 54th Infantry
AC 2d Battalion, 54th Infantry
AD 3d Battalion, 54th Infantry
Squad
Company
Platoon
3 This soldier is in the 2d Battalion, 54th Infantry Company A, 3d Platoon, 2d Squad and his battle roster number, so far, is AC132X.
BACK
NEXT

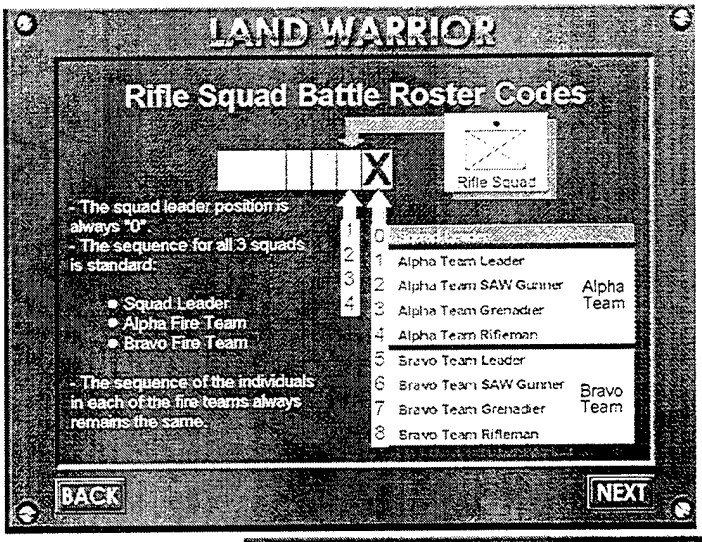

LAND WARRIOR
3. Which platoon or section is represented by this battle roster number?
CB2114
Mortar Section
2d Platoon
1st Platoon
3d Platoon
Click on the correct answer
NEXT

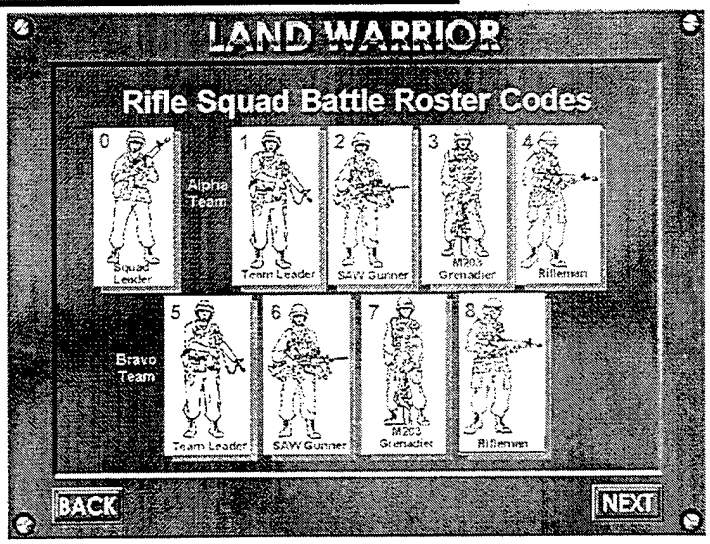

LAND WARRIOR
8. Select the battle roster number that represents an individual from the following unit.
Individual from the 3d Squad, 1st Platoon of Company B, 2d Battalion, 54th Infantry.
AC322X
AC213X
AC312X
AC121X
AC215X
Click on the correct answer
NEXT

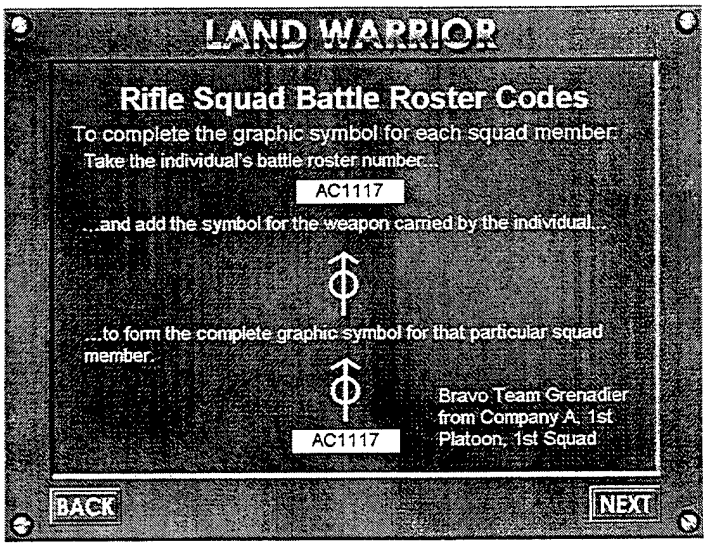

LAND WARRIOR
9. Which squad is represented by this battle roster number?
AA4316
2d Squad
Weapons Squad
3d Squad
1st Squad
Click on the correct answer
NEXT

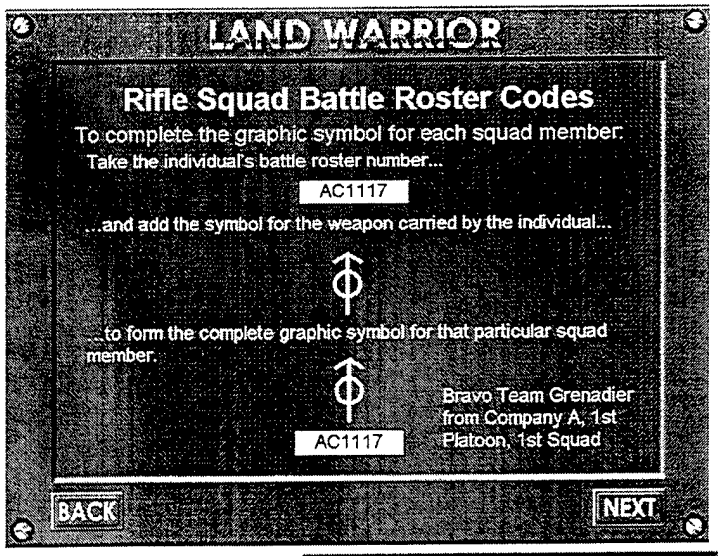

LAND WARRIOR
Lesson E:
Rifle Squad Battle Roster Codes
NEXT

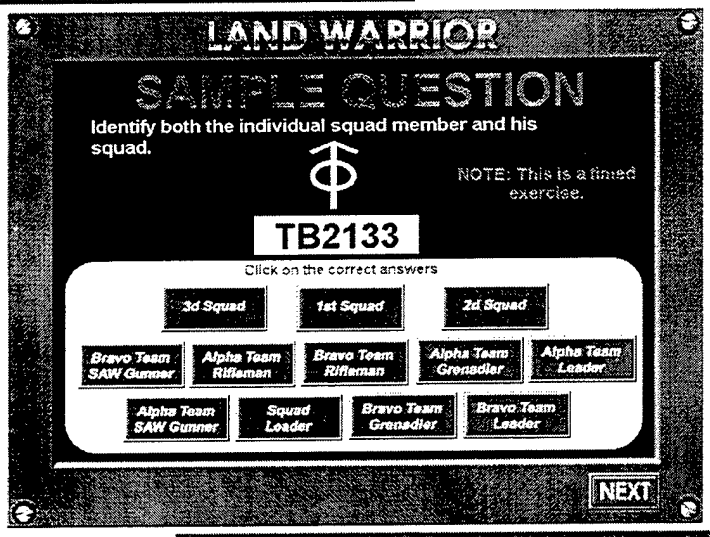

LAND WARRIOR
Rifle Squad Battle Roster Codes
The fifth position is the individual soldier.
1st Position BATTALION
5th Position INDIVIDUAL
4th Position SQUAD
The infantry rifle squad has nine codes, representing each of the nine squad member positions.
The individual positions within the squad start with "0" and end with "8".
BACK
NEXT

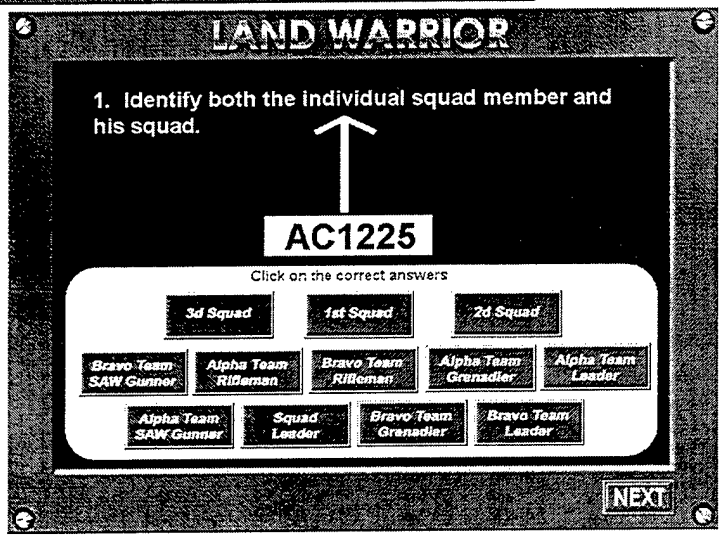

LAND WARRIOR
Rifle Squad Battle Roster Codes
Rifle Squad
- The squad leader position is always "0".
- The sequence for all 3 squads is standard:
• Squad Leader
• Alpha Fire Team
• Bravo Fire Team
- The sequence of the individuals in each of the fire teams always remains the same.
0 Alpha Team Leader
1 Alpha Team SAW Gunner
2 Alpha Team Grenadier
3 Alpha Team Rifleman
4 Alpha Team
5 Bravo Team Leader
6 Bravo Team SAW Gunner
7 Bravo Team Grenadier
8 Bravo Team Rifleman
Bravo Team
BACK
NEXT


LAND WARRIOR
Rifle Squad Battle Roster Codes
0
Squad Leader
Alpha Team
1
Team Leader
2
SAW Gunner
3
M203 Grenadier
4
Rifleman
5
Team Leader
6
SAW Gunner
7
M203 Grenadier
8
Rifleman
Bravo Team
BACK
NEXT


LAND WARRIOR
Rifle Squad Battle Roster Codes
To complete the graphic symbol for each squad member:
Take the individual's battle roster number...
AC1117
...and add the symbol for the weapon carried by the individual...
...to form the complete graphic symbol for that particular squad member.
AC1117
Bravo Team Grenadier from Company A, 1st Platoon, 1st Squad
BACK
NEXT

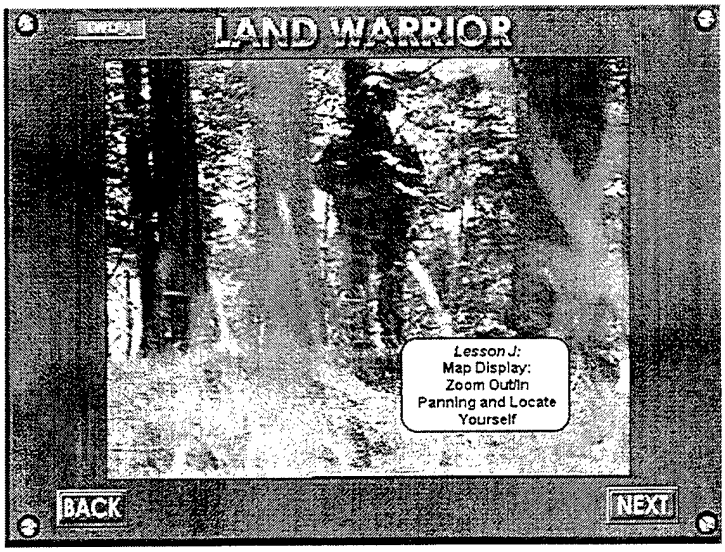

LAND WARRIOR
Rifle Squad Battle Roster Codes
To complete the graphic symbol for each squad member:
Take the individual's battle roster number...
AC1117
...and add the symbol for the weapon carried by the individual...
...to form the complete graphic symbol for that particular squad member.
AC1117
Bravo Team Grenadier from Company A, 1st Platoon, 1st Squad
BACK
NEXT

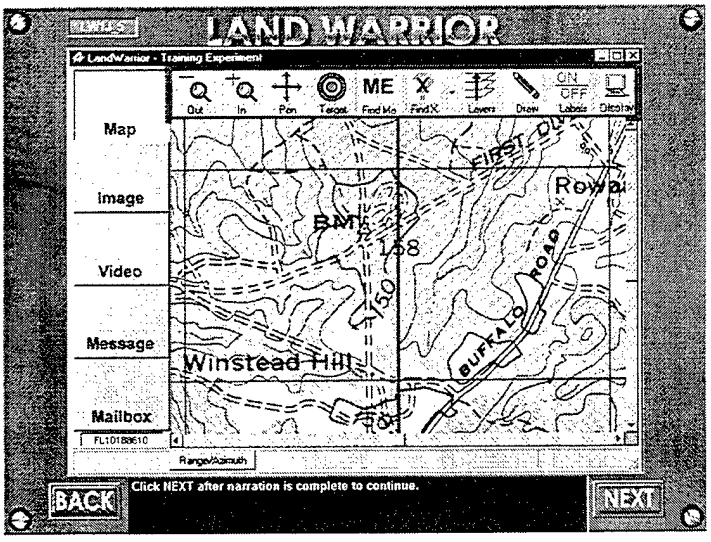

LAND WARRIOR
SAMPLE QUESTION
Identify both the individual squad member and his squad.
NOTE: This is a timed exercise.
TB2133
Click on the correct answers
3d Squad
1st Squad
2d Squad
Bravo Team SAW Gunner
Alpha Team Rifleman
Bravo Team Rifleman
Alpha Team Grenadier
Alpha Team Leader
Alpha Team SAW Gunner
Squad Leader
Bravo Team Grenadier
Bravo Team Leader
NEXT

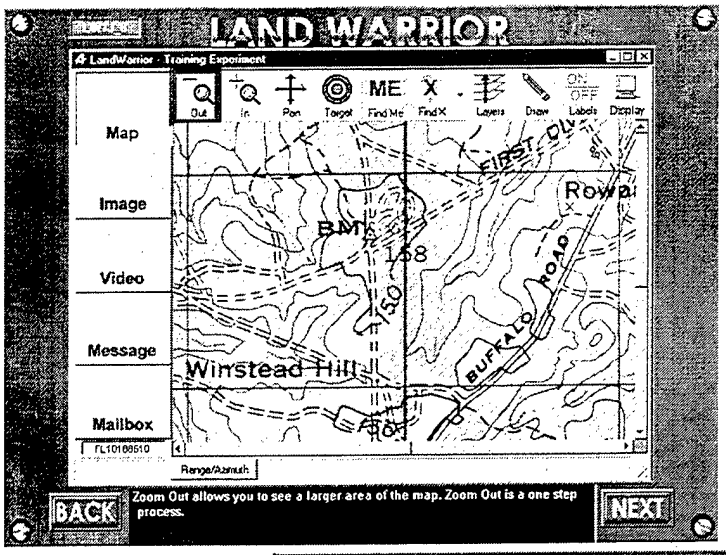

LAND WARRIOR
1. Identify both the individual squad member and his squad.
AC1225
Click on the correct answers
3d Squad
1st Squad
2d Squad
Bravo Team SAW Gunner
Alpha Team Rifleman
Bravo Team Rifleman
Alpha Team Grenadier
Alpha Team Leader
Alpha Team SAW Gunner
Squad Leader
Bravo Team Grenadier
Bravo Team Leader
NEXT

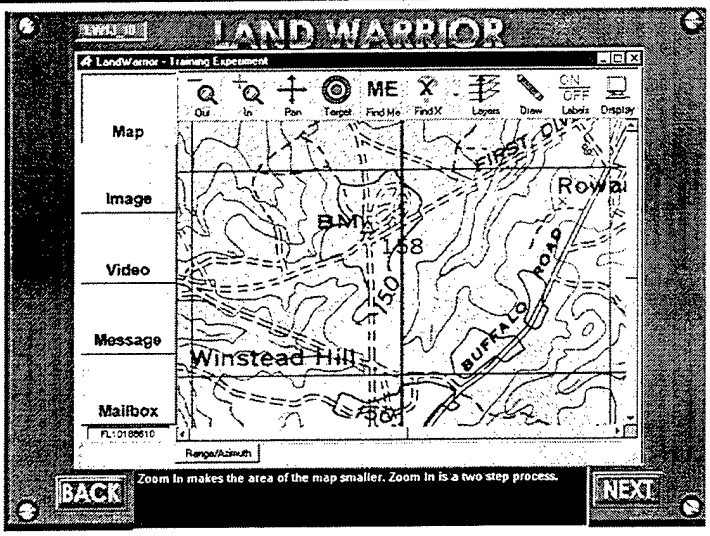
Examples of additional lessons and final exam questions are not provided. The exam questions followed the formats illustrated. However, there was no repetition of specific items given in the training exercises.

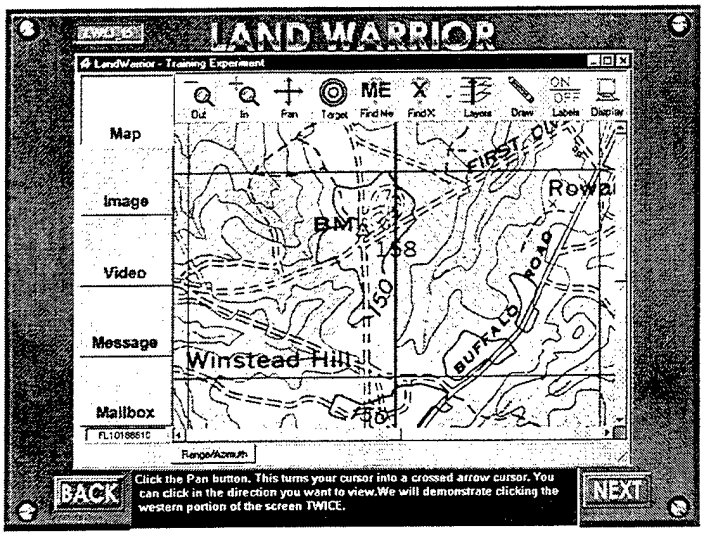
MAP LESSONS, EXERCISES, AND EXAM.

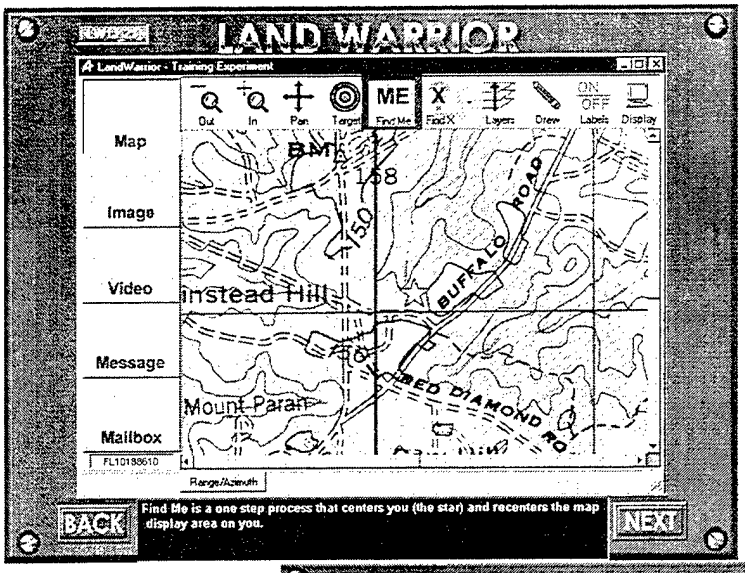


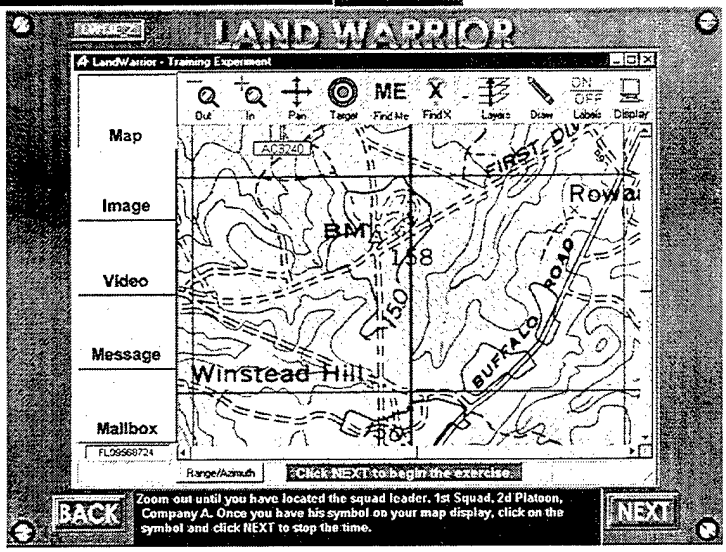


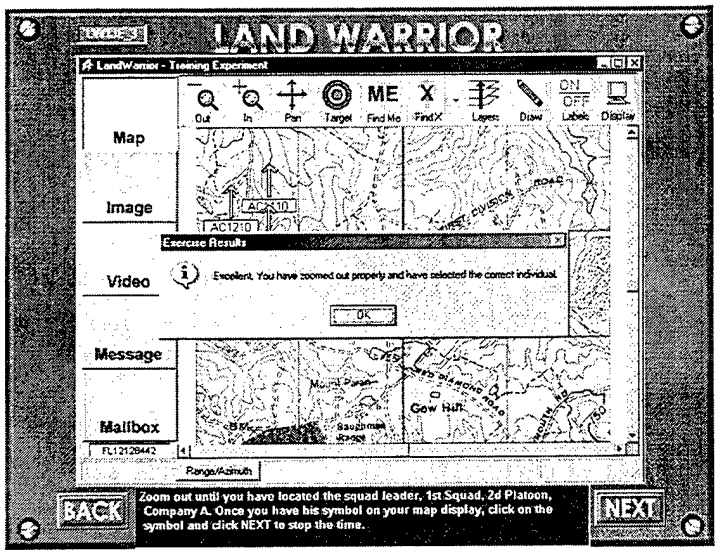

LAND WARRIOR
LandWarrior - Training Experiment
Out
In
Pan
Target
Find Me
Find X
Layers
Draw
Labels
Display
Map
Image
Video
Message
Mailbox
Range/Azimuth
BACK
Zoom Out allows you to see a larger area of the map. Zoom Out is a one step process.
NEXT

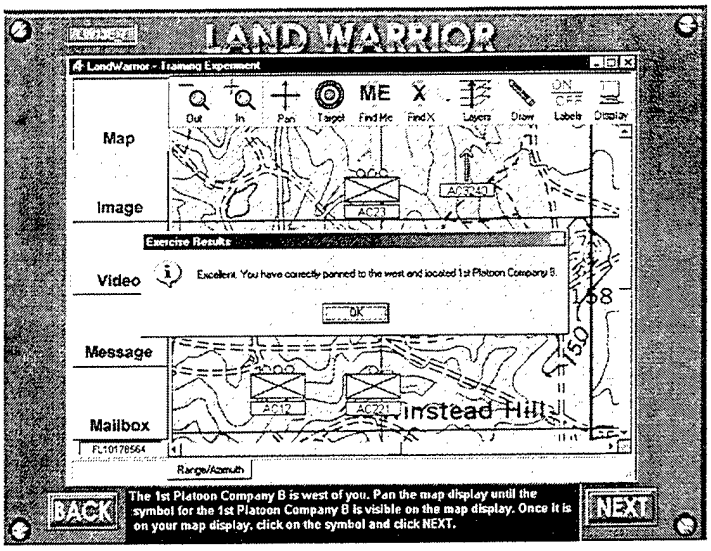

LAND WARRIOR
LandWarrior - Training Experiment
Out
In
Pan
Target
Find Me
Find X
Layers
Draw
Labels
Display
Map
Image
Video
Message
Mailbox
Range/Azimuth
BACK
Zoom In makes the area of the map smaller. Zoom In is a two step process.
NEXT

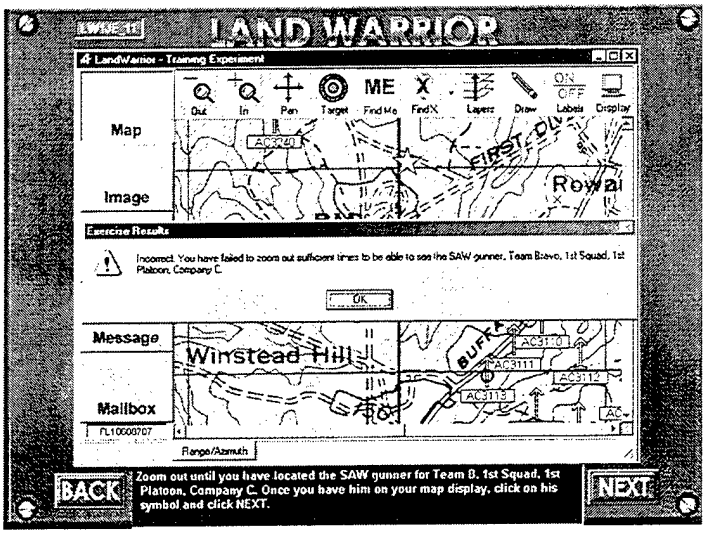

LAND WARRIOR
LandWarrior - Training Experiment
Out
In
Pan
Target
Find Me
Find X
Layers
Draw
Labels
Display
Map
Image
Video
Message
Mailbox
Range/Azimuth
BACK
Click the Pan button. This turns your cursor into a crossed arrow cursor. You can click in the direction you want to view.We will demonstrate clicking the western portion of the screen TWICE.
NEXT

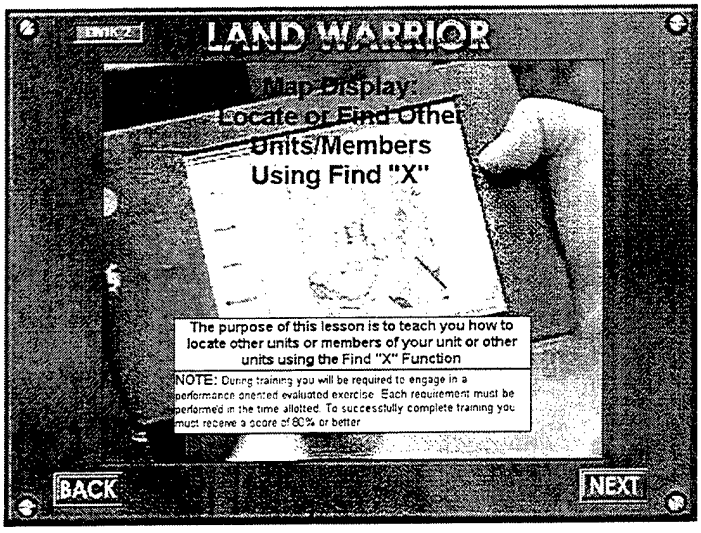

LAND WARRIOR
LandWarrior - Training Experiment
Out
In
Pan
Target
ME
Find Me
Find X
Layers
Draw
Labels
Display
Map
Image
Video
Message
Mailbox
BM
158
150
BUFFALO ROAD
Winstead Hill
Mount Paran
RED DIAMOND RO
Range/Azimuth
BACK
Find Me is a one step process that centers you (the star) and recenters the map display area on you.
NEXT

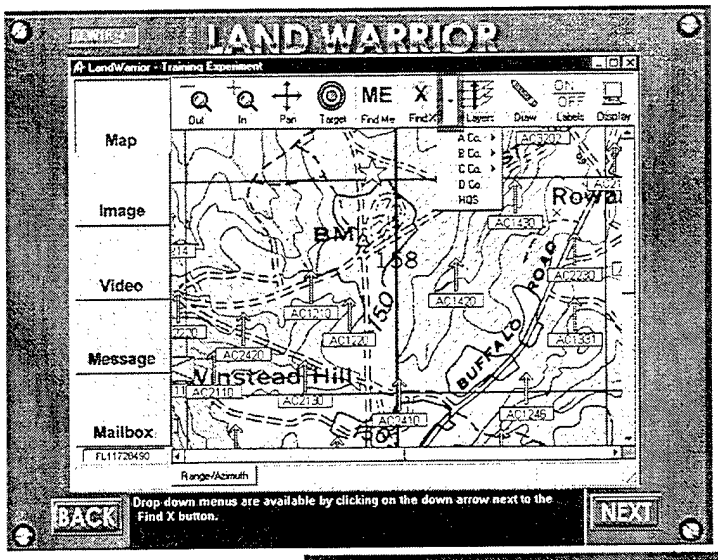

LAND WARRIOR
LandWarrior - Training Experiment
Out
In
Pan
Target
ME
Find Me
Find X
Layers
Draw
Labels
Display
Map
Image
Video
Message
Mailbox
AC3240
FIRST DIV
Rowa
BM
158
150
BUFFALO ROAD
Winstead Hill
Range/Azimuth
Click NEXT to begin the exercise.
BACK
Zoom out until you have located the squad leader, 1st Squad, 2d Platoon, Company A. Once you have his symbol on your map display, click on the symbol and click NEXT to stop the time.
NEXT

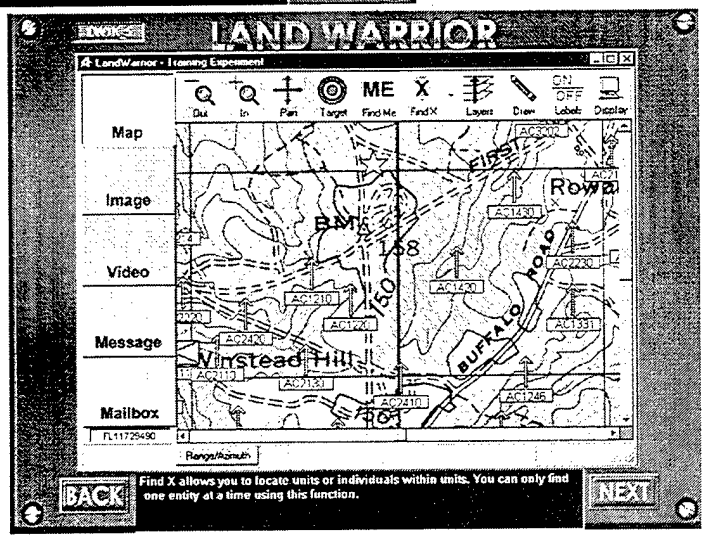

LAND WARRIOR
LandWarrior - Training Experiment
Out
In
Pan
Target
ME
Find Me
Find X
Layers
Draw
Labels
Display
Map
Image
Video
Message
Mailbox
AC1210
Exercise Results
Excellent. You have zoomed out properly and have selected the correct individual.
OK
Mount Paran
Gow Hill
Range/Azimuth
BACK
Zoom out until you have located the squad leader, 1st Squad, 2d Platoon, Company A. Once you have his symbol on your map display, click on the symbol and click NEXT to stop the time.
NEXT

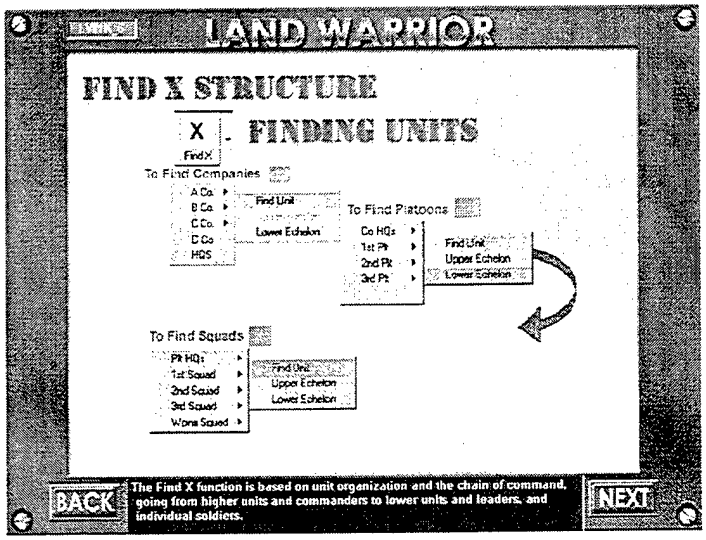

LAND WARRIOR
LandWarrior - Training Experiment
Map
Image
Video
Message
Mailbox
Exercise Results
Excellent. You have correctly panned to the west and located 1st Platoon Company B.
OK
Winstead Hill
Range/Azimuth
BACK
The 1st Platoon Company B is west of you. Pan the map display until the symbol for the 1st Platoon Company B is visible on the map display. Once it is on your map display, click on the symbol and click NEXT.
NEXT

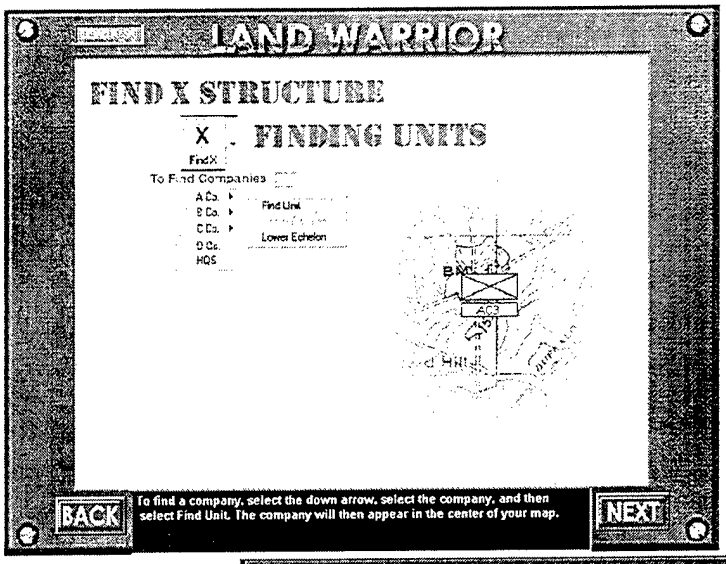

LAND WARRIOR
LandWarrior - Training Experiment
Map
Image
Message
Mailbox
Exercise Results
Incorrect. You have failed to zoom out sufficient times to be able to see the SAW gunner, Team Bravo, 1st Squad, 1st Platoon, Company C.
OK
Winstead Hill
Range/Azimuth
BACK
Zoom out until you have located the SAW gunner for Team B, 1st Squad, 1st Platoon, Company C. Once you have him on your map display, click on his symbol and click NEXT.
NEXT

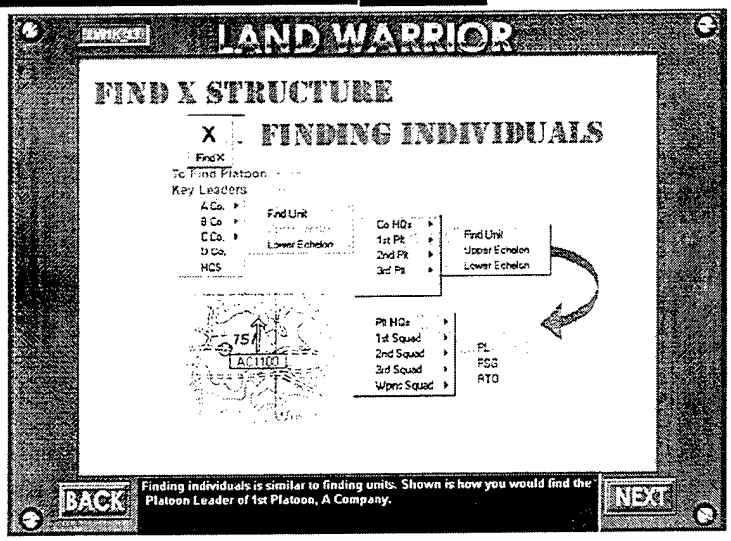

LAND WARRIOR
Map Display:
Locate or Find Other
Units/Members
Using Find "X"
The purpose of this lesson is to teach you how to locate other units or members of your unit or other units using the Find "X" Function
NOTE: During training you will be required to engage in a performance oriented evaluated exercise. Each requirement must be performed in the time allotted. To successfully complete training you must receive a score of 80% or better
BACK
NEXT

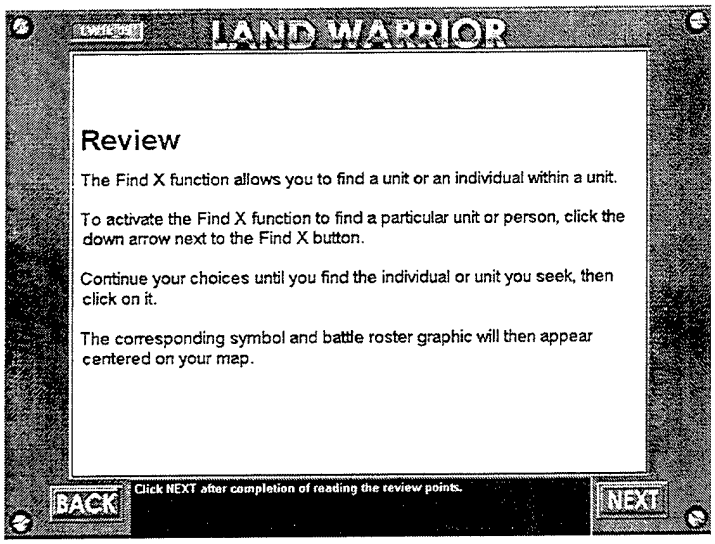

LAND WARRIOR
LandWarrior - Training Experiment
Map
Image
Video
Message
Mailbox
Out
In
Pan
Target
Find Me
Find X
Layers
Draw
Labels
Display
Range/Azimuth
Drop down menus are available by clicking on the down arrow next to the Find X button.
BACK
NEXT

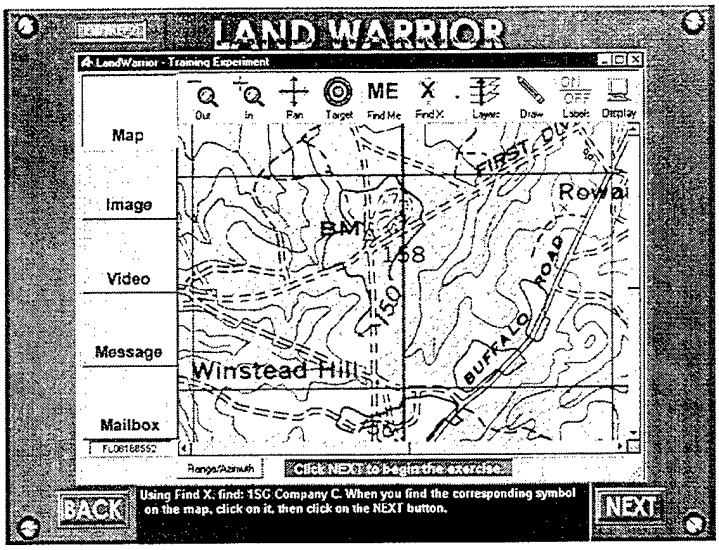

LAND WARRIOR
LandWarrior - Training Experiment
Map
Image
Video
Message
Mailbox
Out
In
Pan
Target
Find Me
Find X
Layers
Draw
Labels
Display
Range/Azimuth
Find X allows you to locate units or individuals within units. You can only find one entity at a time using this function.
BACK
NEXT

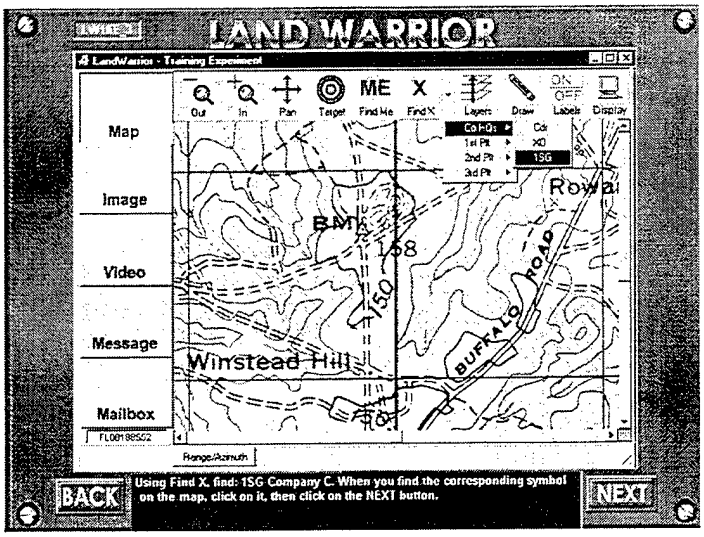

LAND WARRIOR
FIND X STRUCTURE
X
FindX
FINDING UNITS
To Find Companies
A Co
B Co
C Co
D Co
HQS
Find Unit
Lower Echelon
To Find Platoons
Co HQs
1st Pl
2nd Pl
3rd Pl
Find Unit
Upper Echelon
Lower Echelon
To Find Squads
Find Unit
Upper Echelon
Lower Echelon
The Find X function is based on unit organization and the chain of command, going from higher units and commanders to lower units and leaders, and individual soldiers.
BACK
NEXT

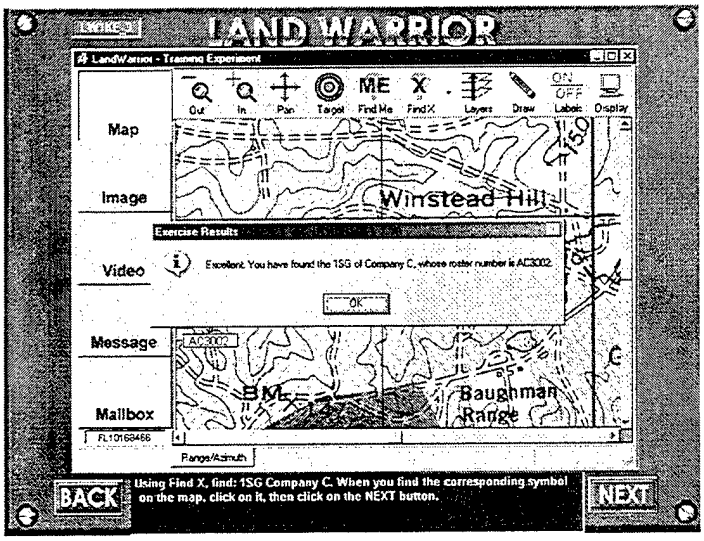

LAND WARRIOR
FIND X STRUCTURE
X . FINDING UNITS
FindX
To Find Companies
A Co.
B Co.
C Co.
D Co.
HQS
Find Unit
Lower Echelon
BACK
To find a company, select the down arrow, select the company, and then select Find Unit. The company will then appear in the center of your map.
NEXT

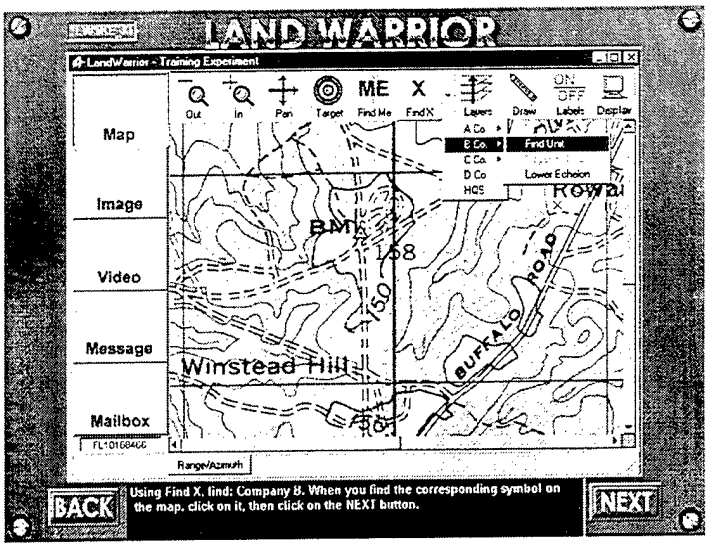

LAND WARRIOR
FIND X STRUCTURE
X . FINDING INDIVIDUALS
FindX
To Find Platoon
Key Leaders
A Co.
B Co.
C Co.
D Co.
HQS
Find Unit
Lower Echelon
Co HQs
1st Plt
2nd Plt
3rd Plt
Find Unit
Upper Echelon
Lower Echelon
Plt HQs
1st Squad
2nd Squad
3rd Squad
Wpns Squad
PL
PSG
RTO
BACK
Finding individuals is similar to finding units. Shown is how you would find the Platoon Leader of 1st Platoon, A Company.
NEXT

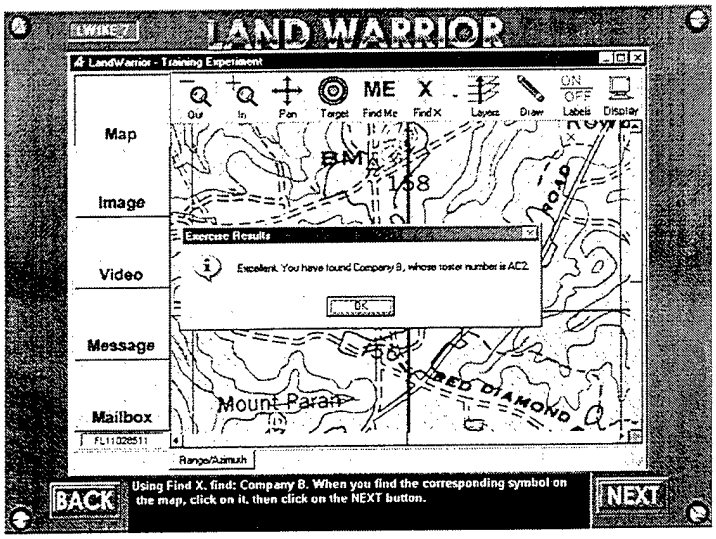

LAND WARRIOR
Review
The Find X function allows you to find a unit or an individual within a unit.
To activate the Find X function to find a particular unit or person, click the down arrow next to the Find X button.
Continue your choices until you find the individual or unit you seek, then click on it.
The corresponding symbol and battle roster graphic will then appear centered on your map.
BACK
Click NEXT after completion of reading the review points.
NEXT

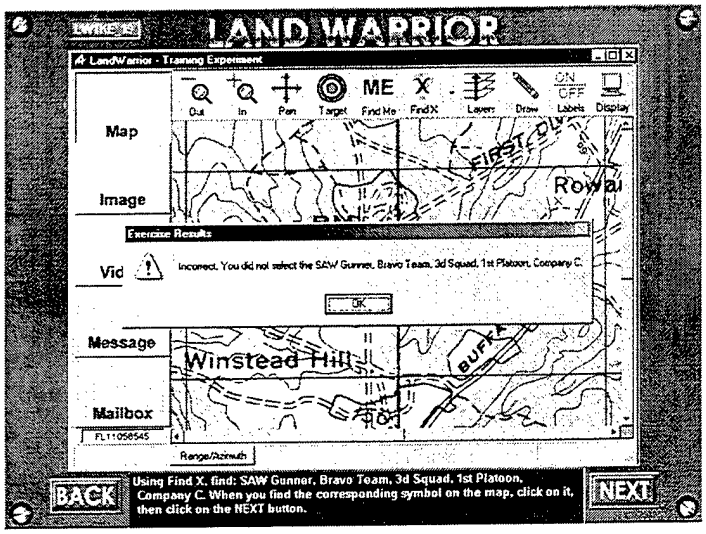

LAND WARRIOR
LandWarrior - Training Experiment
Out
In
Pan
Target
Find Me
Find X
Layers
Draw
Labels
Display
Map
Image
Video
Message
Mailbox
Winstead Hill
BUFFALO ROAD
Range/Azimuth
Click NEXT to begin the exercise.
BACK
Using Find X, find: 1SG Company C. When you find the corresponding symbol on the map, click on it, then click on the NEXT button.
NEXT

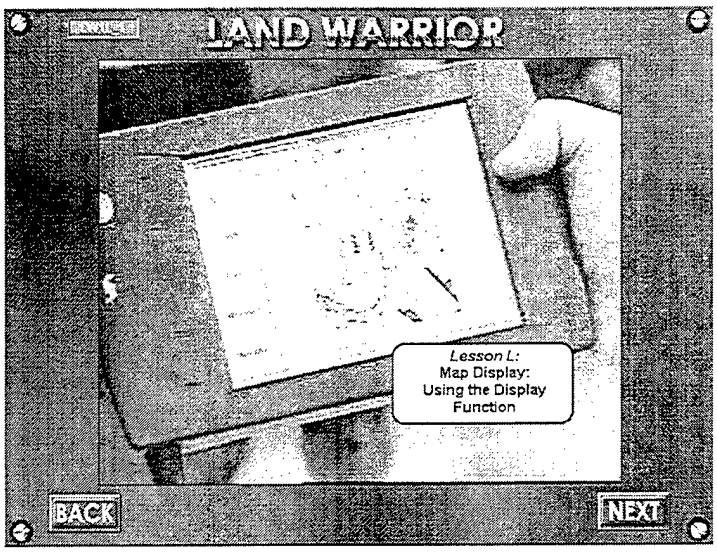

LAND WARRIOR
LandWarrior - Training Experiment
Out
In
Pan
Target
Find Me
Find X
Layers
Draw
Labels
Display
Map
Image
Video
Message
Mailbox
Winstead Hill
BUFFALO ROAD
Range/Azimuth
BACK
Using Find X, find: 1SG Company C. When you find the corresponding symbol on the map, click on it, then click on the NEXT button.
NEXT

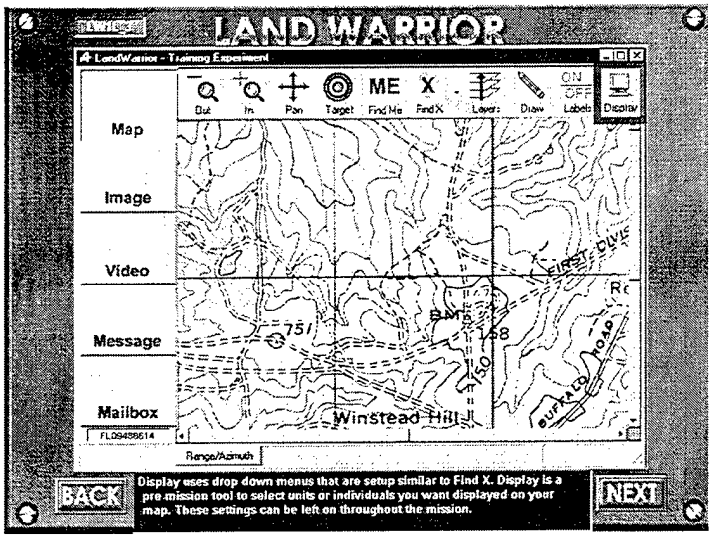

LAND WARRIOR
LandWarrior - Training Experiment
Out
In
Pan
Target
Find Me
Find X
Layers
Draw
Labels
Display
Map
Image
Video
Message
Mailbox
Winstead Hill
Exercise Results
Excellent. You have found the 1SG of Company C, whose roster number is AC3002.
OK
Baughman Range
Range/Azimuth
BACK
Using Find X, find: 1SG Company C. When you find the corresponding symbol on the map, click on it, then click on the NEXT button.
NEXT

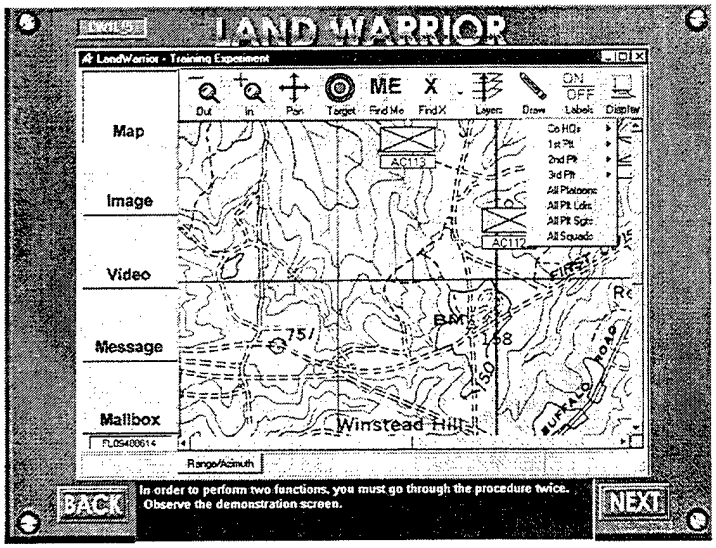

LAND WARRIOR
LandWarrior - Training Experiment
Out
In
Pan
Target
Find Me
Find X
Layers
Draw
Labels
Display
Map
Image
Video
Message
Mailbox
Winstead Hill
BUFFALO ROAD
Range/Azimuth
BACK
Using Find X, find: Company B. When you find the corresponding symbol on the map, click on it, then click on the NEXT button.
NEXT

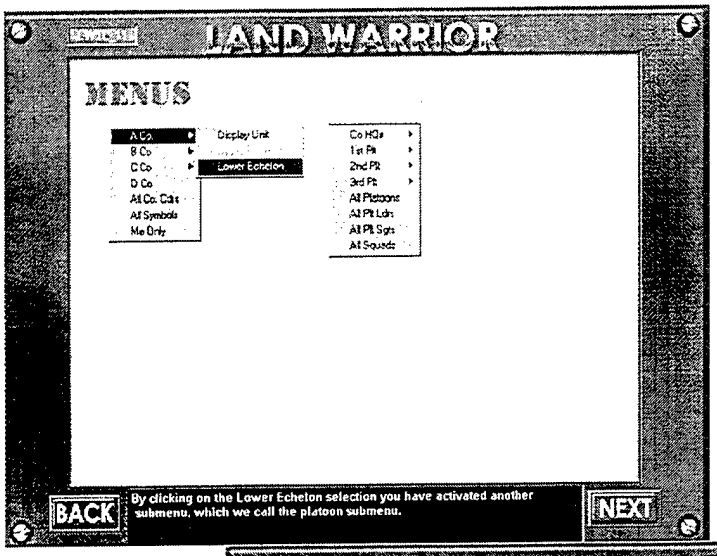

LAND WARRIOR
LandWarrior - Training Experiment
Map
Image
Video
Message
Mailbox
Exercise Results
Excellent. You have found Company B, whose roster number is AC2.
OK
Mount Parah
RED DIAMOND
Range/Azimuth
BACK
Using Find X, find: Company B. When you find the corresponding symbol on the map, click on it, then click on the NEXT button.
NEXT

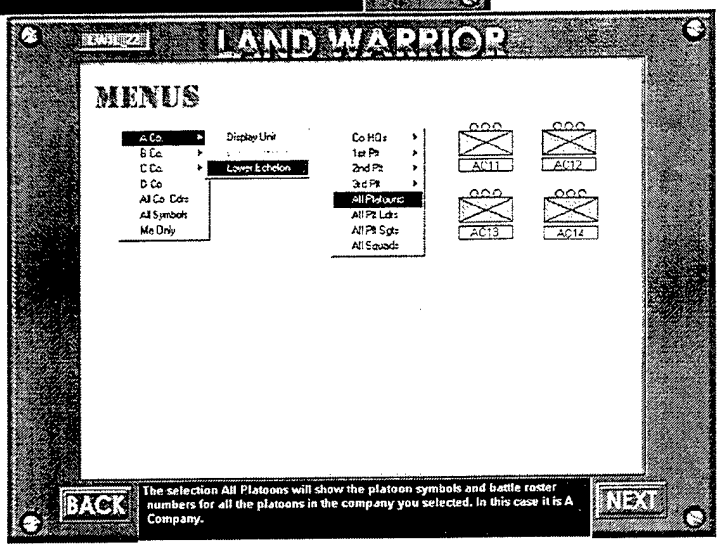

LAND WARRIOR
LandWarrior - Training Experiment
Map
Image
Vid
Message
Mailbox
Exercise Results
Incorrect. You did not select the SAW Gunner, Bravo Team, 3d Squad, 1st Platoon, Company C.
OK
Winstead Hill
Range/Azimuth
BACK
Using Find X, find: SAW Gunner, Bravo Team, 3d Squad, 1st Platoon, Company C. When you find the corresponding symbol on the map, click on it, then click on the NEXT button.
NEXT

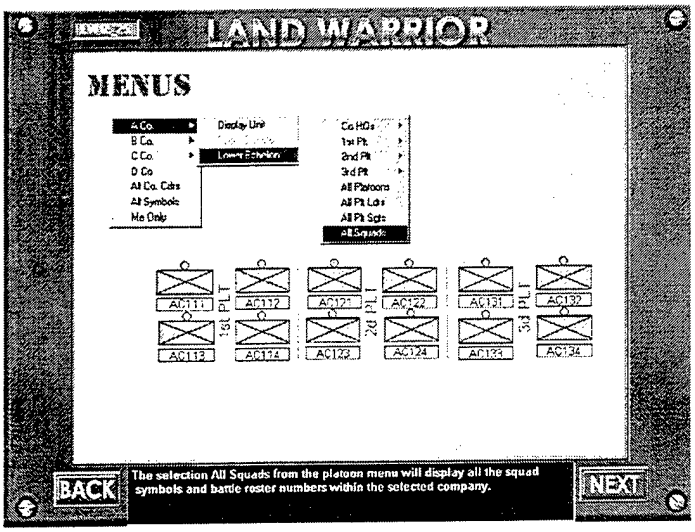

LAND WARRIOR
Lesson L:
Map Display:
Using the Display
Function
BACK
NEXT

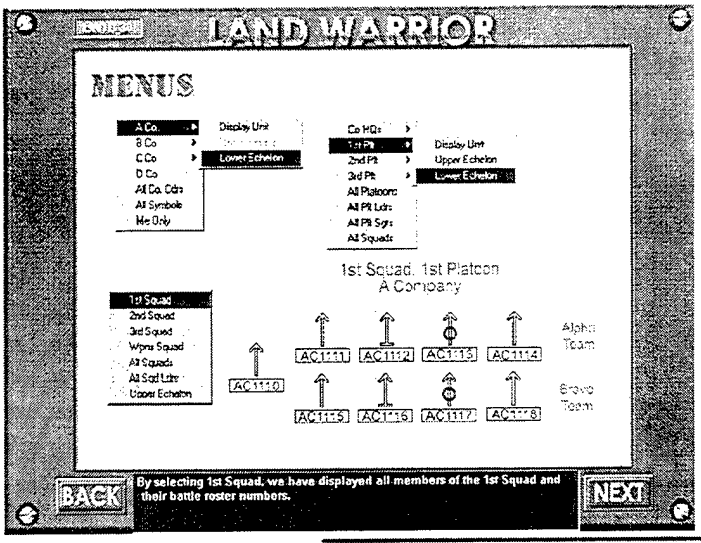

LAND WARRIOR
LandWarrior - Training Experiment
Map
Image
Video
Message
Mailbox
Winstead Hill
Range/Azimuth
BACK
Display uses drop down menus that are setup similar to Find X. Display is a pre-mission tool to select units or individuals you want displayed on your map. These settings can be left on throughout the mission.
NEXT

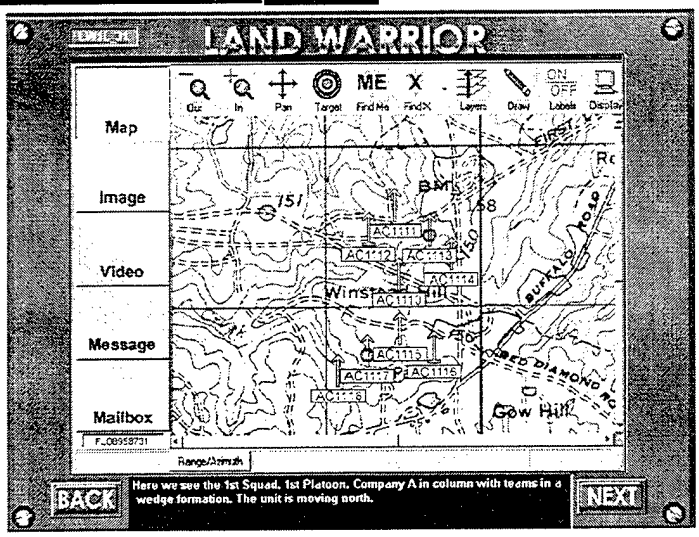

LAND WARRIOR
LandWarrior - Training Experiment
Map
Image
Video
Message
Mailbox
Winstead Hill
Range/Azimuth
BACK
In order to perform two functions, you must go through the procedure twice. Observe the demonstration screen.
NEXT

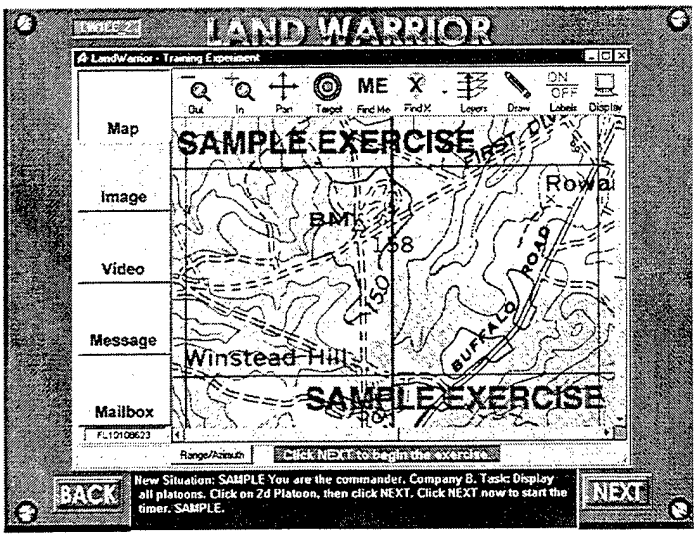

LAND WARRIOR
MENUS
A Co
B Co
C Co
D Co
All Co. Cdrs
All Symbols
Me Only
Display Unit
Lower Echelon
Co HQs
1st Plt
2nd Plt
3rd Plt
All Platoons
All Plt Ldrs
All Plt Sgts
All Squads
BACK
By clicking on the Lower Echelon selection you have activated another submenu, which we call the platoon submenu.
NEXT

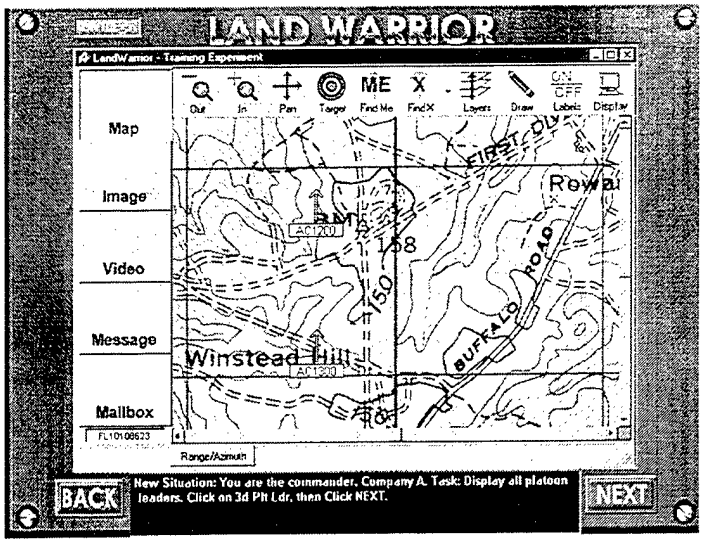

LAND WARRIOR
MENUS
A Co.
B Co.
C Co.
D Co
All Co. Cdrs
All Symbols
Me Only
Display Unit
Lower Echelon
Co HQs
1st Plt
2nd Plt
3rd Plt
All Platoons
All Plt Ldrs
All Plt Sgts
All Squads
AC11
AC12
AC13
AC14
BACK
The selection All Platoons will show the platoon symbols and battle roster numbers for all the platoons in the company you selected. In this case it is A Company.
NEXT

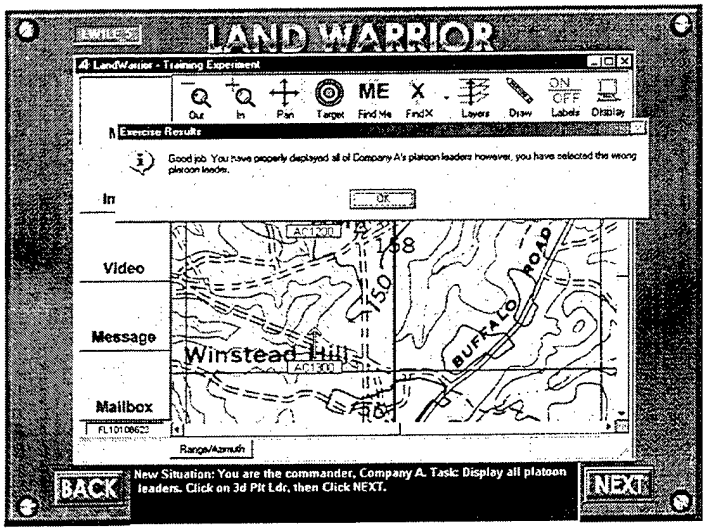

LAND WARRIOR
MENUS
A Co.
B Co.
C Co.
D Co
All Co. Cdrs
All Symbols
Me Only
Display Unit
Lower Echelon
Co HQs
1st Plt
2nd Plt
3rd Plt
All Platoons
All Plt Ldrs
All Plt Sgts
All Squads
AC111
AC112
AC113
AC114
AC121
AC122
AC123
AC124
AC131
AC132
AC133
AC134
1st PLT
2d PLT
3d PLT
BACK
The selection All Squads from the platoon menu will display all the squad symbols and battle roster numbers within the selected company.
NEXT

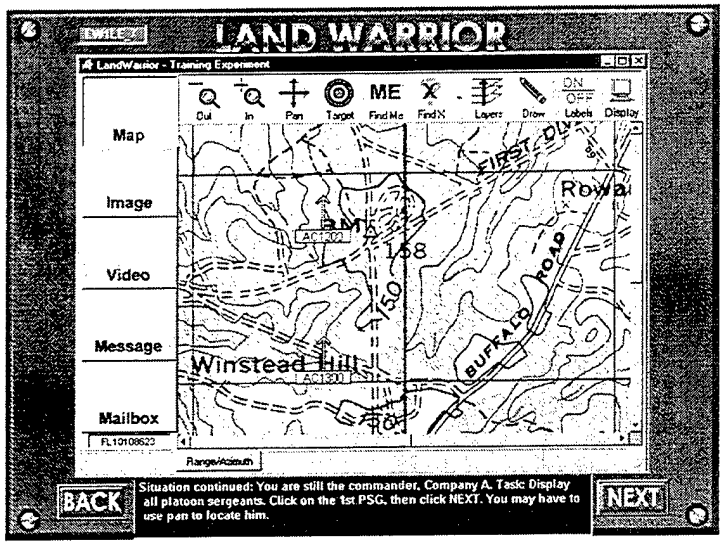

LAND WARRIOR
MENUS
A Co
B Co
C Co
D Co
All Co. Cdrs
All Symbols
Me Only
Display Unit
Lower Echelon
Co HQs
1st Plt
2nd Plt
3rd Plt
All Platoons
All Plt Ldrs
All Plt Sgts
All Squads
Display Unit
Upper Echelon
Lower Echelon
1st Squad, 1st Platoon
A Company
1st Squad
2nd Squad
3rd Squad
Wpns Squad
All Squads
All Sqd Ldrs
Upper Echelon
AC1110
AC1111
AC1112
AC1113
AC1114
AC1115
AC1116
AC1117
AC1118
Alpha Team
Bravo Team
BACK
By selecting 1st Squad, we have displayed all members of the 1st Squad and their battle roster numbers.
NEXT

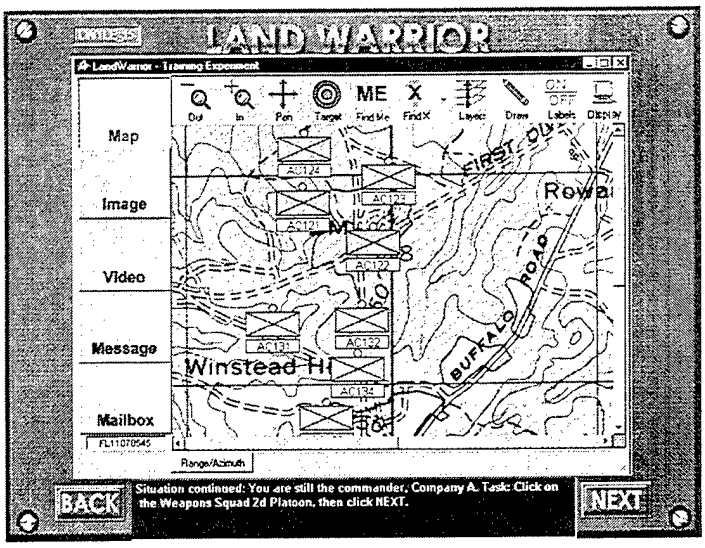

LAND WARRIOR
Map
Image
Video
Message
Mailbox
Out
In
Pan
Target
Find Me
Find X
Layers
Draw
Labels
Display
BM
158
150
AC1111
AC1112
AC1113
AC1114
AC1115
AC1116
AC1117
AC1118
BUFFALO ROAD
RED DIAMOND RD
Gow Hill
Range/Azimuth
BACK
Here we see the 1st Squad, 1st Platoon, Company A in column with teams in a wedge formation. The unit is moving north.
NEXT

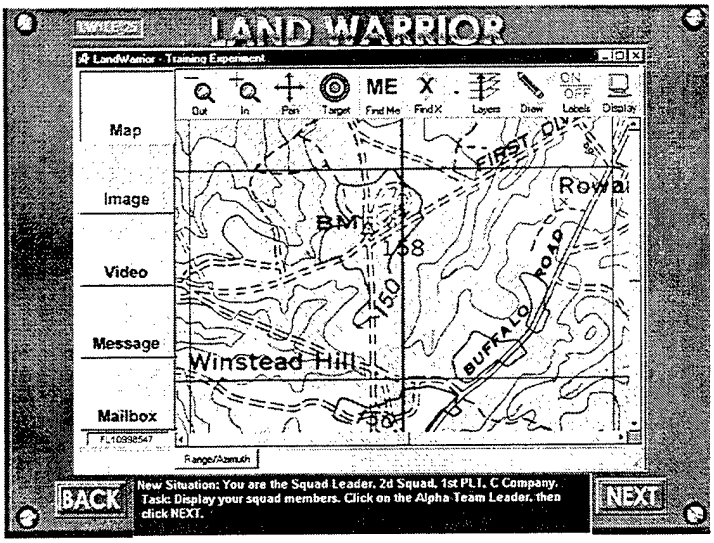

LAND WARRIOR
LandWarrior - Training Exercise
Map
Image
Video
Message
Mailbox
SAMPLE EXERCISE
BM
158
150
BUFFALO ROAD
Winstead Hill
Range/Azimuth
Click NEXT to begin the exercise.
BACK
New Situation: SAMPLE You are the commander, Company B. Task: Display all platoons. Click on 2d Platoon, then click NEXT. Click NEXT now to start the timer. SAMPLE.
NEXT

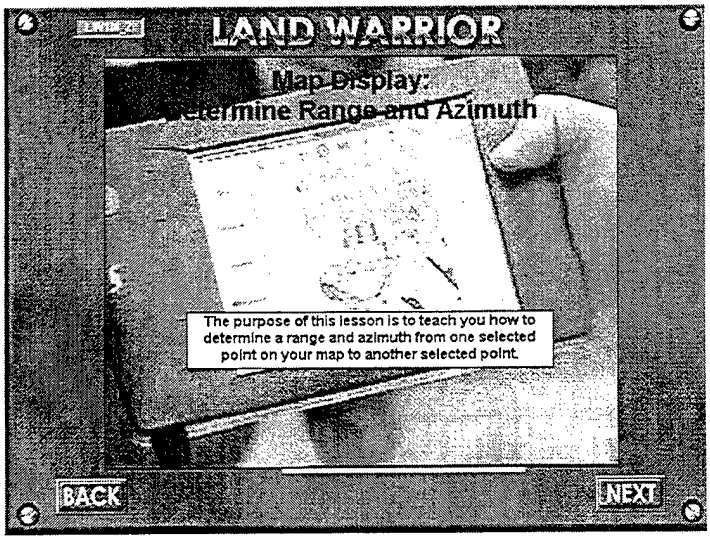

LAND WARRIOR
LandWarrior - Training Experiment
Out
In
Pan
Target
Find Me
Find X
Layers
Draw
Labels
Display
Map
Image
Video
Message
Mailbox
FL10108623
Range/Azimuth
Winstead Hill
BUFFALO ROAD
158
150
New Situation: You are the commander, Company A. Task: Display all platoon leaders. Click on 3d Plt Ldr, then Click NEXT.
BACK
NEXT

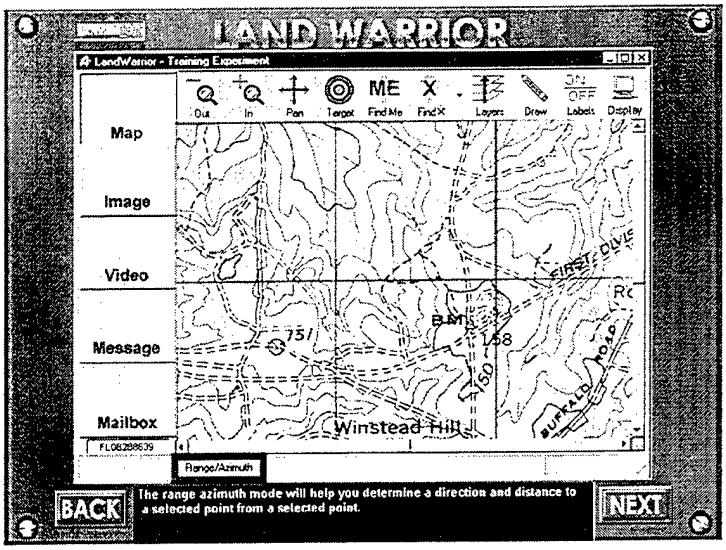

LAND WARRIOR
LandWarrior - Training Experiment
Exercise Results
Good job. You have properly displayed all of Company A's platoon leaders however, you have selected the wrong platoon leader.
OK
Video
Message
Mailbox
Winstead Hill
BUFFALO ROAD
158
150
New Situation: You are the commander, Company A. Task: Display all platoon leaders. Click on 3d Plt Ldr, then Click NEXT.
BACK
NEXT

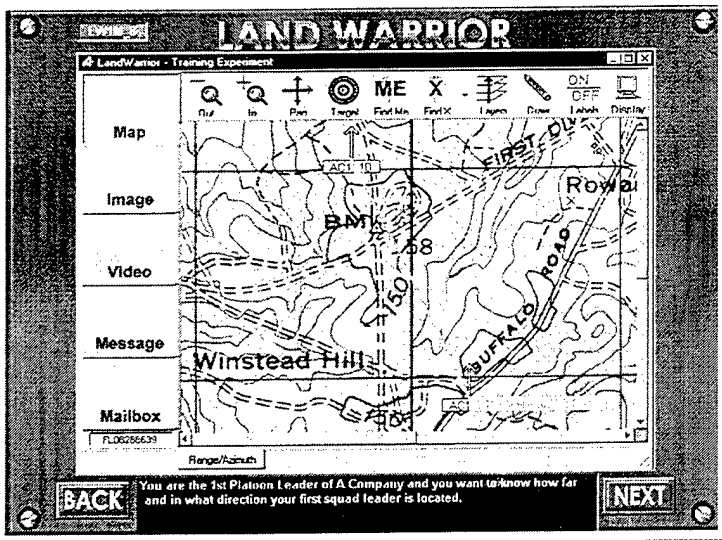

LAND WARRIOR
LandWarrior - Training Experiment
Map
Image
Video
Message
Mailbox
Winstead Hill
BUFFALO ROAD
158
150
Situation continued: You are still the commander, Company A. Task: Display all platoon sergeants. Click on the 1st PSG, then click NEXT. You may have to use pan to locate him.
BACK
NEXT

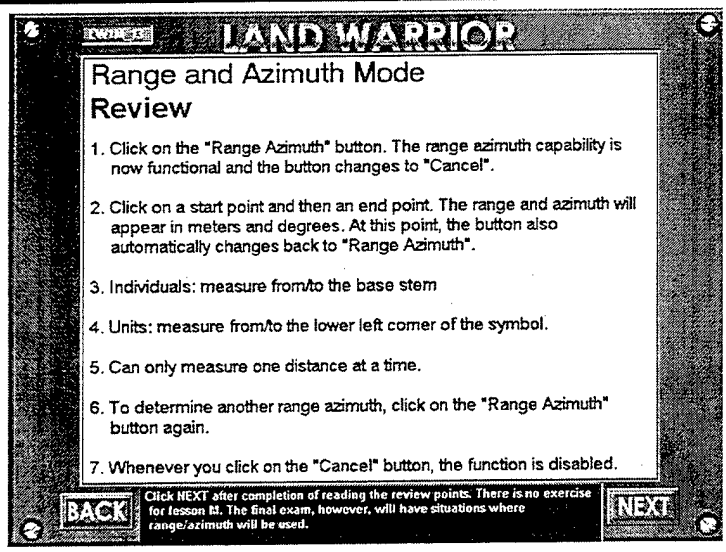

LAND WARRIOR
LandWarrior - Training Experiment
Out
In
Pan
Target
ME
Find Me
Find X
Layers
Draw
Labels
Display
Map
Image
Video
Message
Mailbox
FIRST DIV
Rowa
BUFKALO ROAD
Winstead Hi
Range/Azimuth
BACK
Situation continued: You are still the commander, Company A. Task: Click on the Weapons Squad 2d Platoon, then click NEXT.
NEXT

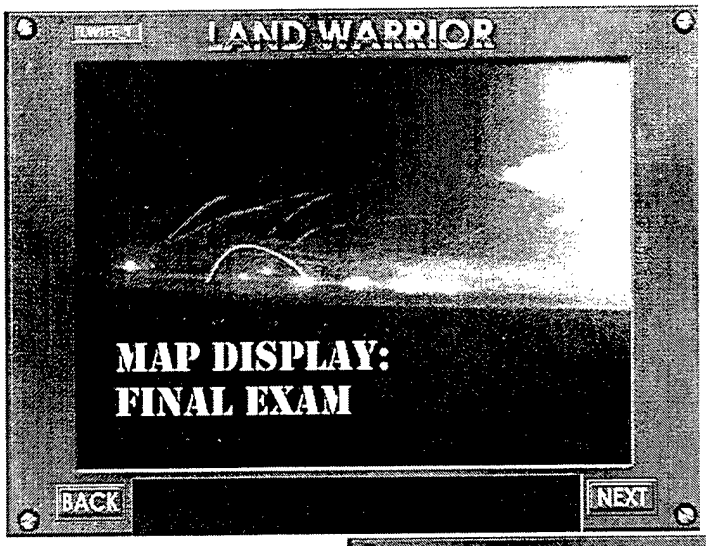

LAND WARRIOR
LandWarrior - Training Experiment
Out
In
Pan
Target
ME
Find Me
Find X
Layers
Draw
Labels
Display
Map
Image
Video
Message
Mailbox
FIRST DIV
Rowa
BUFKALO ROAD
Winstead Hill
Range/Azimuth
BACK
New Situation: You are the Squad Leader. 2d Squad, 1st PLT, C Company. Task: Display your squad members. Click on the Alpha Team Leader, then click NEXT.
NEXT

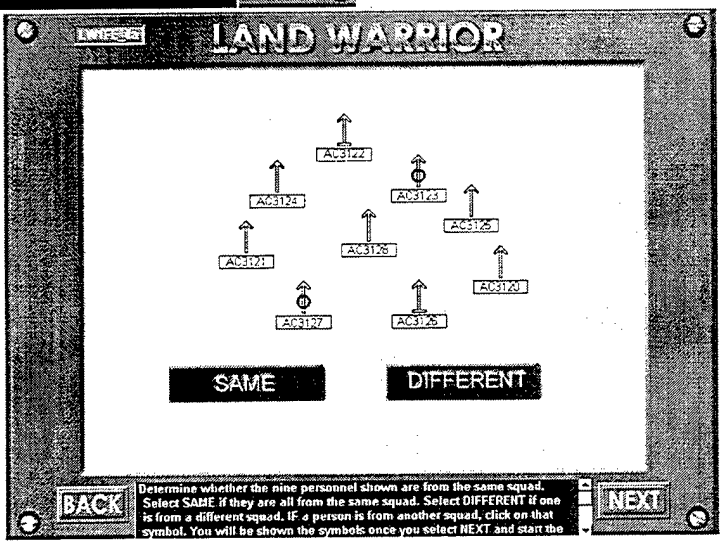

LAND WARRIOR
Map Display:
Determine Range and Azimuth
The purpose of this lesson is to teach you how to determine a range and azimuth from one selected point on your map to another selected point.
BACK
NEXT

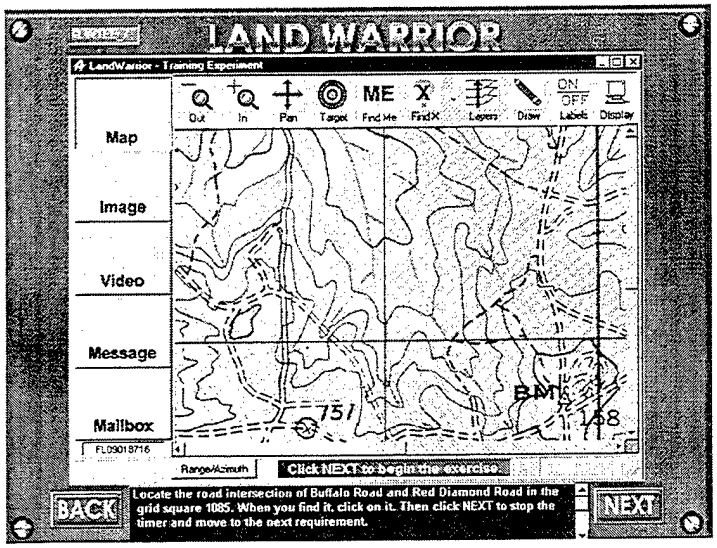

LAND WARRIOR
LandWarrior - Training Experiment
Out
In
Pan
Target
Find Me
Find X
Layers
Draw
Labels
Display
Map
Image
Video
Message
Mailbox
Winstead Hill
Range/Azimuth
BACK
The range azimuth mode will help you determine a direction and distance to a selected point from a selected point.
NEXT

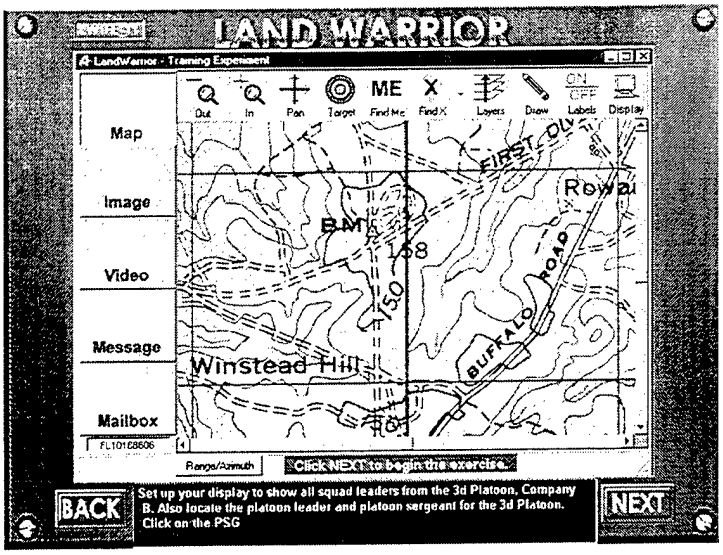

LAND WARRIOR
LandWarrior - Training Experiment
Map
Image
Video
Message
Mailbox
Winstead Hill
Range/Azimuth
BACK
You are the 1st Platoon Leader of A Company and you want to know how far and in what direction your first squad leader is located.
NEXT

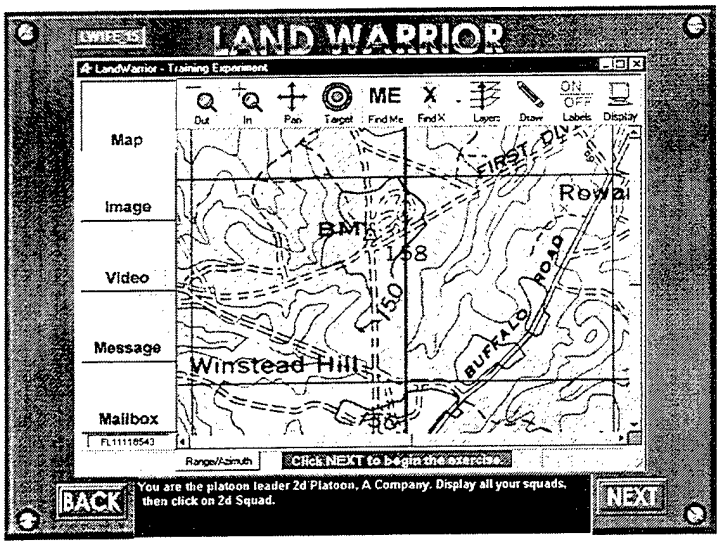

LAND WARRIOR
Range and Azimuth Mode Review
1. Click on the "Range Azimuth" button. The range azimuth capability is now functional and the button changes to "Cancel".
2. Click on a start point and then an end point. The range and azimuth will appear in meters and degrees. At this point, the button also automatically changes back to "Range Azimuth".
3. Individuals: measure from/to the base stem
4. Units: measure from/to the lower left corner of the symbol.
5. Can only measure one distance at a time.
6. To determine another range azimuth, click on the "Range Azimuth" button again.
7. Whenever you click on the "Cancel" button, the function is disabled.
BACK
Click NEXT after completion of reading the review points. There is no exercise for lesson 8. The final exam, however, will have situations where range/azimuth will be used.
NEXT

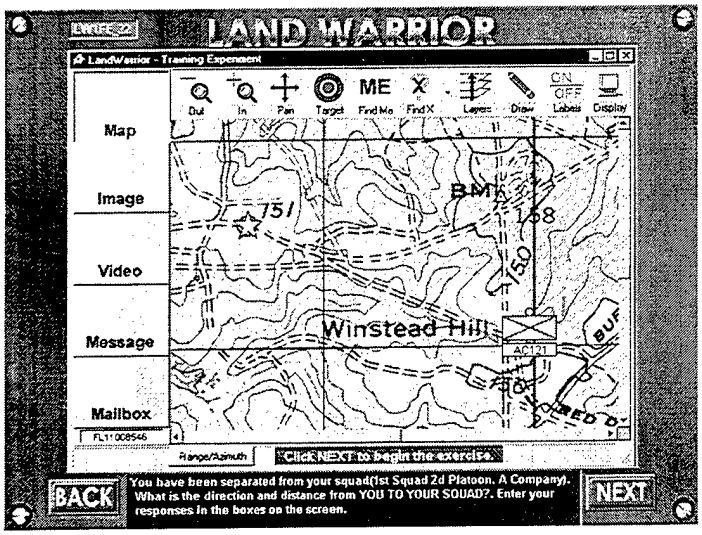

LAND WARRIOR
MAP DISPLAY:
FINAL EXAM
BACK
NEXT

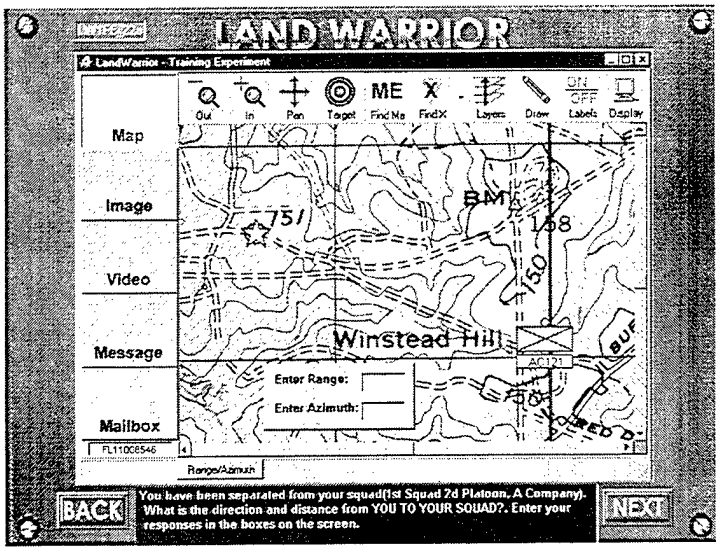

LAND WARRIOR
AC3122
AC3124
AC3123
AC3125
AC3121
AC3126
AC3120
AC3127
AC3128
SAME
DIFFERENT
BACK
Determine whether the nine personnel shown are from the same squad. Select SAME if they are all from the same squad. Select DIFFERENT if one is from a different squad. IF a person is from another squad, click on that symbol. You will be shown the symbols once you select NEXT and start the
NEXT


LAND WARRIOR
LandWarrior - Training Experiment
Out
In
Pan
Target
Find Me
FindX
Layers
Draw
Labels
Display
Map
Image
Video
Message
Mailbox
751
BM
168
Range/Azimuth
Click NEXT to begin the exercise
BACK
Locate the road intersection of Buffalo Road and Red Diamond Road in the grid square 1085. When you find it, click on it. Then click NEXT to stop the timer and move to the next requirement.
NEXT


LAND WARRIOR
LandWarrior - Training Experiment
Map
Image
Video
Message
Mailbox
Winstead Hill
BUFFALO ROAD
Click NEXT to begin the exercise.
BACK
Set up your display to show all squad leaders from the 3d Platoon, Company B. Also locate the platoon leader and platoon sergeant for the 3d Platoon. Click on the PSG
NEXT

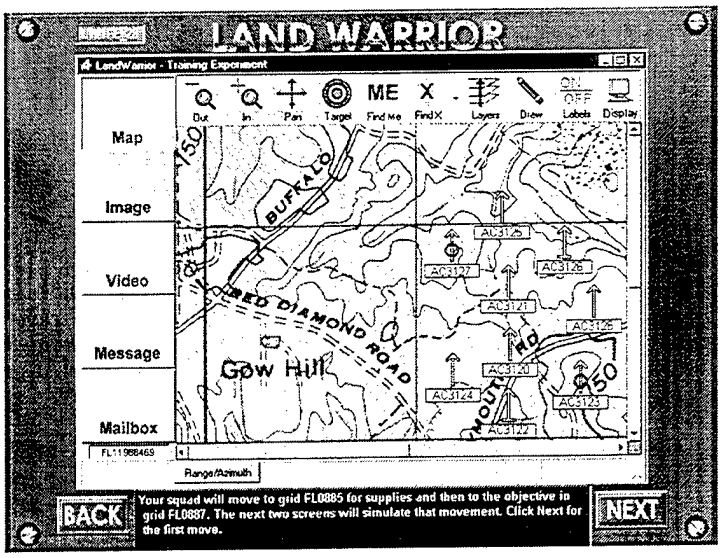

LAND WARRIOR
LandWarrior - Training Experiment
Map
Image
Video
Message
Mailbox
Winstead Hill
BUFFALO ROAD
Click NEXT to begin the exercise.
BACK
You are the platoon leader 2d Platoon, A Company. Display all your squads, then click on 2d Squad.
NEXT


LAND WARRIOR
LandWarrior - Training Experiment
Map
Image
Video
Message
Mailbox
Winstead Hill
Click NEXT to begin the exercise.
BACK
You have been separated from your squad(1st Squad 2d Platoon, A Company). What is the direction and distance from YOU TO YOUR SQUAD?. Enter your responses in the boxes on the screen.
NEXT


LAND WARRIOR
LandWarrior - Training Experiment
Out
In
Pan
Target
Find Me
Find X
Layers
Draw
Labels
Display
Map
Image
Video
Message
Mailbox
Winstead Hill
Enter Range:
Enter Azimuth:
Range/Azimuth
BACK
You have been separated from your squad(1st Squad 7d Platoon, A Company). What is the direction and distance from YOU TO YOUR SQUAD?. Enter your responses in the boxes on the screen.
NEXT

LAND WARRIOR
LandWarrior - Training Experiment
Map
Image
Video
Message
Mailbox
BUFFALO
MOUTH RD
Gow Hill
Range/Azimuth
BACK
Your squad will move to grid FL0885 for supplies and then to the objective in grid FL0887. The next two screens will simulate that movement. Click Next for the first move.
NEXT

LAND WARRIOR
LandWarrior - Training Experiment
Map
Image
Video
Message
Mailbox
BUFFALO
MOUTH RD
Gow Hill
Range/Azimuth
BACK
Your squad will move to grid FL0885 for supplies and then to the objective in grid FL0887. The next two screens will simulate that movement. Click Next for the first move.
NEXT


LAND WARRIOR
LandWarrior - Training Experiment
Out
In
Pan
Target
Find Me
Find X
Layers
Draw
Labels
Display
Map
Image
Video
Message
Mailbox
BUFFALO
RED DIAMOND ROAD
Gow Hill
MOUNT RD
AC3125
AC3127
AC3126
AC3121
AC3122
AC3120
AC3124
AC3123
AC3127
Range/Azimuth
BACK
Your squad will move to grid FL0885 for supplies and then to the objective in grid FL0887. The next two screens will simulate that movement. Click Next for the first move.
NEXT

Appendix E
Results on Code and Map Training

Codes: Exercise and Final Exam Scores

Table E-1
ANOVA on Code Exercises and Code Final Exam Scores: High-Low Demand Conditions by Soldier Group

Factor	*df*	MS	*F*	*p*
Weapon and Unit Symbols				
High-Low Demand	1, 160	43.08	1.59	.2091
Soldier Group	3, 160	1.97	0.07	.9745
Interaction	3, 160	3.10	0.11	.9516
BR Numbering System				
High-Low Demand	1, 159	75.47	0.76	.3847
Soldier Group	3, 159	121.05	1.22	.3049
Interaction	3, 159	179.82	1.81	.1475
Company through Squad BR				
High-Low Demand	1, 159	141.85	2.46	.1186
Soldier Group	3, 159	75.18	1.30	.2748
Interaction	3, 159	4.17	0.07	.9746
Rifle and Weapons Squads Codes				
High-Low Demand	1, 159	3,843.57	23.53	.0000
Soldier Group	3, 159	1,023.15	6.26	.0004
Interaction	3, 159	177.31	1.09	.3570
Key Leader and Unit Codes				
High-Low Demand	1, 159	0.39	0.004	.9482
Soldier Group	3, 159	501.69	5.51	.0012
Interaction	3, 159	12.58	0.14	.9371
Final Exam on Codes				
High-Low Demand	1, 159	186.86	1.48	.2240
Soldier Group	3, 159	814.49	6.49	.0003
Interaction	3, 159	23.28	0.18	.9061

Table E-2

Descriptive Statistics for High and Low Demand Conditions on the Code Exercises and Code Final Exam Scores (% Correct)

Condition	*M*	*SD*	*Mdn*	Min-Max	*N*
Weapon and Unit Symbols					
Low Demand	97.70	4.87	100	63-100	85
High Demand	96.69	5.36	100	71-100	83
BR Numbering System					
Low Demand	94.64	11.24	100	20-100	84
High Demand	95.78	8.71	100	60-100	83
Company through Squad BR					
Low Demand	97.65	3.38	100	87-100	84
High Demand	95.74	10.15	100	30-100	83
Rifle and Weapons Squads Codes[a]					
Low Demand	93.09	7.07	94	60-100	84
High Demand	82.89	17.60	88	31-100	83
Key Leader and Unit Codes					
Low Demand	89.73	9.09	92	54-100	84
High Demand	89.71	10.58	92	38-100	83
Final Exam on Codes					
Low Demand	87.19	12.00	92	48-100	84
High Demand	89.30	11.31	92	40-100	83

[a] Rifle/Weapons Squads. $F(1, 159) = 23.53, p = .0000$; Low scores greater than High.

Table E-3

Descriptive Statistics for Soldier Group on the Code Exercises and Code Final Exam Scores (% Correct)

Soldier Group	*M*	*SD*	*Mdn*	Min-Max	*N*
Weapon and Unit Symbols					
IOBC	97.32	3.99	100	83-100	42
ANCOC	97.08	4.66	100	79-100	30
BNCOC	97.39	6.35	100	63-100	48
OSUT	96.96	5.07	100	71-100	48
BR Numbering System					
IOBC	97.56	5.38	100	80-100	41
ANCOC	93.00	16.43	100	20-100	30
BNCOC	95.00	8.25	100	70-100	48
OSUT	94.79	9.45	100	60-100	48
Company through Squad BR					
IOBC	98.69	2.22	100	93-100	41
ANCOC	96.44	6.37	97	67-100	30
BNCOC	95.97	11.11	100	30-100	48
OSUT	95.90	6.78	98	63-100	48
Rifle and Weapons Squads Codes [a]					
IOBC	92.33	12.09	97	31-100	41
ANCOC	91.52	10.44	94	57-100	30
BNCOC	88.51	11.65	91	40-100	48
OSUT	81.67	18.13	88	34-100	48
Key Leader and Unit Codes [b]					
IOBC	92.77	8.54	96	71-100	41
ANCOC	91.53	7.70	92	71-100	30
BNCOC	90.54	9.44	92	67-100	48
OSUT	85.16	12.18	88	38-100	48
Final Exam on Codes [c]					
IOBC	92.68	9.33	96	48-100	41
ANCOC	91.20	10.10	96	60-100	30
BNCOC	87.92	12.25	92	44-100	48
OSUT	82.92	11.95	84	56-100	48

[a] Rifle/Weapons Squads. $F(3, 159) = 6.26$. $p = .0004$; ANCOC, BNCOC, and IOBC greater than OSUT.

[b] Key Leaders/Unit. $F(3, 159) = 5.51$, $p = .0012$; ANCOC, BNCOC, and IOBC greater than OSUT.

[c] Final Exam. $F(3, 159) = 6.49$, $p = .0003$; ANCOC, BNCOC, and IOBC greater than OSUT; IOBC greater than BNCOC.

Codes: Exercise and Exam Times

Table E-4
ANOVA on Time to Complete Code Instruction and Code Final Exam: High-Low Demand Conditions by Soldier Group (all soldiers)

Factor	df	MS	F	*p*
Weapon and Unit Symbols				
High-Low Demand	1, 160	0.89	0.43	.5140
Soldier Group	3, 160	36.46	17.41	.0000
Interaction	3, 160	2.19	1.05	.3725
BR Numbering System				
High-Low Demand	1, 159	1.06	0.43	.5123
Soldier Group	3, 159	3.47	1.41	.2420
Interaction	3, 159	3.76	1.53	.2098
Company through Squad BR				
High-Low Demand	1, 159	0.19	0.04	.8431
Soldier Group	3, 159	47.74	10.02	.0000
Interaction	3, 159	3.14	0.66	.5787
Rifle and Weapons Squads Codes				
High-Low Demand	1, 159	764.15	16.32	.0001
Soldier Group	3, 159	606.17	12.95	.0000
Interaction	3, 159	117.64	2.51	.0605
Key Leader and Unit Codes				
High-Low Demand	1, 159	0.37	0.01	.9055
Soldier Group	3, 159	235.27	8.87	.0000
Interaction	3, 159	4.25	0.16	.9228
Final Exam on Codes				
High-Low Demand	1, 159	9.59	0.99	.3200
Soldier Group	3, 159	19.03	1.97	.1198
Interaction	3, 159	15.69	1.63	.1849

Table E-5

Descriptive Statistics for High and Low Demand Conditions on Time to Complete Code Instruction and Code Final Exam (in minutes and fraction of a minute, for all soldiers)

Condition	*M*	*SD*	*Mdn*	Min-Max	*N*
Weapon and Unit Symbols					
Low Demand	6.02	1.49	5.90	2.02-10.38	85
High Demand	6.15	1.80	5.82	2.72-12.58	83
BR Numbering System					
Low Demand	4.96	1.86	4.69	2.22-16.42	84
High Demand	4.78	1.24	4.85	1.57-7.25	83
Company through Squad BR					
Low Demand	9.39	1.83	9.27	5.97-13.70	84
High Demand	9.27	2.78	8.88	3.50-20.18	83
Rifle and Weapons Squads Codes[a]					
Low Demand	17.37	4.30	16.92	10.28-28.47	84
High Demand	21.94	9.93	19.68	5.82-67.40	83
Key Leader and Unit Codes					
Low Demand	16.55	4.76	16.29	8.57-29.27	84
High Demand	16.38	6.10	14.95	5.13-48.03	83
Final Exam on Codes					
Low Demand	10.03	3.00	9.11	5.57-23.72	84
High Demand	9.41	3.30	8.58	4.60-26.17	83

Note. Includes time for soldiers who repeated exercises. No repetition of the final exam was allowed.

[a] Rifle/Weapons Squads. $F(1, 159) = 16.32, p = 0001$; Low faster than High.

Table E-6

Descriptive Statistics for Soldier Groups on Time to Complete Code Instruction and Code Final Exam (in minutes and fraction of a minute, for all soldiers)

Soldier Group	*M*	*SD*	*Mdn*	Min-Max	*N*
Weapon and Unit Symbols [a]					
IOBC	5.03	1.28	4.87	2.02- 8.59	42
ANCOC	5.68	1.69	5.27	3.78 -12.58	30
BNCOC	6.18	1.19	5.94	4.28 -11.77	48
OSUT	7.18	1.63	7.31	2.52 -11.18	48
BR Numbering System					
IOBC	4.45	2.28	4.05	2.22-16.42	41
ANCOC	5.10	1.46	4.81	2.93-9.37	30
BNCOC	4.92	1.17	4.98	2.33-7.32	48
OSUT	5.06	1.22	4.90	1.56 -8.57	48
Company through Squad BR [b]					
IOBC	7.89	1.56	7.73	5.97-13.70	41
ANCOC	9.03	1.98	8.92	6.10-13.63	30
BNCOC	9.71	2.57	9.25	6.17-20.18	48
OSUT	10.36	2.28	10.16	3.50-17.37	48
Rifle and Weapons Squads Codes [c]					
IOBC	16.01	3.44	15.35	10.67-27.32	41
ANCOC	17.17	6.07	15.82	10.28-37.60	30
BNCOC	19.47	6.05	18.53	11.07-42.77	48
OSUT	24.46	10.72	22.33	5.82-67.40	48
Key Leader and Unit Codes [d]					
IOBC	13.74	4.63	12.38	8.07-25.23	41
ANCOC	15.79	5.14	16.21	8.57-24.68	30
BNCOC	16.36	3.72	16.54	10.17-28.22	48
OSUT	19.32	6.45	18.30	5.13-48.03	48
Final Exam on Codes					
IOBC	9.56	4.04	8.28	5.52-26.17	41
ANCOC	8.60	1.58	8.15	6.23-12.80	30
BNCOC	9.97	3.05	9.44	5.56-23.72	48
OSUT	10.30	3.04	9.83	4.60-17.53	48

[a] Weapon/Unit Symbols. $F(3, 160) = 17.41, p = .0000$; IOBC, ANCOC, and BNCOC each faster than OSUT. IOBC faster than BNCOC.

[b] Company-Squad. $F(3, 159), = 10.02, p = .0000$; IOBC and ANCOC faster than OSUT. IOBC faster than ANCOC and BNCOC.

[c] Rifle/Weapons Squads. $F(3, 159), = 12.95, p = .0000$; IOBC, ANCOC, and BNCOC faster than OSUT; IOBC faster than BNCOC.

[d] Key Leader/Unit. $F(3, 159), = 8.87, p = .0000$; IOBC, ANCOC, and BNCOC faster than OSUT; IOBC faster than BNCOC.

Table E-7

ANOVA on Time to Complete Code Instruction and Code Final Exam: High-Low Demand Conditions by Soldier Group for Soldiers who did not Repeat an Exercise

Factor	df	MS	F	*P*
Weapon and Unit Symbols				
High-Low Demand	1, 156	0.09	0.06	.8084
Soldier Group	3, 156	34.95	23.47	.0000
Interaction	3, 156	1.06	0.71	.5449
BR Numbering System				
High-Low Demand	1, 152	0.71	0.31	.5791
Soldier Group	3, 152	2.31	1.00	.3929
Interaction	3, 152	4.03	1.75	.1599
Company through Squad BR				
High-Low Demand	1, 154	6.19	1.60	.2075
Soldier Group	3, 154	37.79	9.77	.0000
Interaction	3, 154	1.94	0.50	.6816
Rifle and Weapons Squads Codes				
High-Low Demand	1, 140	214.18	8.71	.0037
Soldier Group	3, 140	212.38	8.64	.0000
Interaction	3, 140	25.83	1.05	.3722
Key Leader and Unit Codes				
High-Low Demand	1, 122	0.03	0.00	.9627
Soldier Group	3, 122	126.41	7.91	.0000
Interaction	3, 122	21.17	1.32	.2694
Final Exam on Codes				
High-Low Demand	1, 106	8.99	0.84	.3601
Soldier Group	3, 106	7.83	0.73	.5331
Interaction	3, 106	13.14	1.23	.3001

Note. Final exam times included only those soldiers who did not repeat any exercises.

Table E-8

Descriptive Statistics for High and Low Demand Conditions on Time to Complete Code Instruction and Code Final Exam for Soldiers who did not Repeat an Exercise (in minutes and fraction of a minute)

Condition	*M*	*SD*	*Mdn*	*N*
Weapon and Unit Symbols				
Low Demand	5.98	1.46	5.89	84
High Demand	5.94	1.44	5.76	80
Battle Roster Numbering System				
Low Demand	4.85	1.80	4.68	81
High Demand	4.72	1.18	4.68	79
Company through Squad BR				
Low Demand	9.29	1.83	9.27	84
High Demand	8.89	2.39	8.68	78
Rifle and Weapons Squads Codes[a]				
Low Demand	16.98	4.00	16.66	78
High Demand	19.34	6.51	18.61	70
Key Leader and Unit Codes				
Low Demand	15.06	4.25	14.34	58
High Demand	15.09	4.34	14.59	72
Final Exam on Codes				
Low Demand	9.71	2.90	8.61	54
High Demand	9.26	3.55	8.18	60

Note. Final exam times included only those soldiers who did not repeat any exercises.

[a] Rifle/Weapons Squads. $F(1, 140) = 8.71$, $p = 0037$; Low condition faster than High.

Table E-9

Descriptive Statistics for Soldier Groups on Time to Complete Code Instructions and Final Exam for Soldiers who did not Repeat an Exercise (in minutes and fraction of a minute)

Soldier Group	*M*	*SD*	*Mdn*	*N*
Weapon and Unit Symbols [a]				
IOBC	5.03	1.29	4.88	42
ANCOC	5.44	1.09	5.23	29
BNCOC	5.99	0.76	5.92	46
OSUT	7.09	1.54	7.22	47
Battle Roster Numbering System				
IOBC	4.45	2.28	4.05	41
ANCOC	4.91	1.25	4.76	28
BNCOC	4.78	1.06	4.85	45
OSUT	4.99	1.20	4.83	46
Company through Squad BR [b]				
IOBC	7.90	1.56	7.73	41
ANCOC	8.88	1.81	8.87	29
BNCOC	9.44	2.26	9.24	46
OSUT	10.13	2.07	10.07	46
Rifle and Weapons Squads Codes [c]				
IOBC	16.03	3.48	15.37	40
ANCOC	16.66	4.85	15.58	28
BNCOC	18.38	4.33	17.93	43
OSUT	21.43	7.14	20.97	37
Key Leader and Unit Codes [d]				
IOBC	12.83	3.66	12.35	37
ANCOC	14.52	5.09	12.43	23
BNCOC	15.39	2.88	15.13	39
OSUT	17.57	4.64	16.63	31
Final Exam on Codes				
IOBC	9.62	4.28	8.28	36
ANCOC	8.52	1.62	8.15	20
BNCOC	9.73	2.47	9.35	33
OSUT	9.69	3.45	8.63	25

Note. Final exam times included only those soldiers who did not repeat any exercises.

[a] Weapon & Unit symbols. $F(3, 156) = 23.47$, $p = .0000$; IOBC, ANCOC, and BNCOC each faster than OSUT, and IOBC faster than BNCOC.

[b] Company-Squad BR. $F(3, 154), = 9.77, p = .0000$; IOBC faster than OSUT and BNCOC.

[c] Rifle/Weapons Squads. $F(3, 140), = 8.64, p = .0000$; IOBC, ANCOC, and BNCOC faster than OSUT.

[d] Key Leader and Unit. $F(3, 122), = 7.91, p = .0000$; IOBC and ANCOC faster than OSUT; IOBC faster than BNCOC.

Map: Exercise and Final Exam Scores

Table E-10
ANOVA on Map Exercises and Map Final Exam Scores: High-Low-Exploratory Conditions by Soldier Group

Factor	*df*	MS	*F*	*p*
Zoom, Pan, Find Me				
High-Low Demand	1, 74	305.29	2.66	.1071
Soldier Group	3, 74	227.95	1.99	.1233
Interaction	3, 74	33.26	0.29	.8326
Find X				
High-Low Demand	1, 71	362.46	1.32	.2540
Soldier Group	3, 71	782.61	2.86	.0431
Interaction	3, 71	224.42	0.82	.4878
Display				
High-Low Demand	1, 70	2992.16	4.07	.0474
Soldier Group	3, 70	1846.66	2.51	.0655
Interaction	3, 70	573.97	0.78	.5086
Final Exam on Map				
High-Low-Exploratory Conditions	2, 142	1704.01	6.84	.0014
Soldier Group	3, 142	819.17	3.29	.0226
Interaction	6. 142	92.18	0.37	.8971

Table E-11

Descriptive Statistics for High and Low Demand Conditions on the Map Exercises, and for High, Low and Exploratory Conditions on the Map Final Exam (% correct)

Condition	*M*	*SD*	*Mdn*	Min-Max	*N*
Zoom, Pan, Find Me					
Low Demand	94.96	6.59	100	75-100	43
High Demand	91.45	13.98	100	33-100	39
Find X					
Low Demand	87.70	15.96	92	33-100	43
High Demand	84.91	18.20	92	8-100	37
Display [a]					
Low Demand	84.23	20.30	87	13-100	42
High Demand	71.18	34.44	87	0-100	36
Final Exam on Map [b]					
Low Demand	78.27	13.02	82	40-100	40
High Demand	75.27	15.22	80	23-71	34
Exploratory	66.62	17.70	73	17-80	80

[a] Display. $F(1, 70) = 4.07$, $p = .0474$; Low scores greater than High scores.

[b] Final Exam. $F(2, 142) = 6.84$, $p = .0014$; Low scores greater than both High and Exploratory scores, High scores greater than Exploratory scores.

Table E-12
Descriptive Statistics for Soldier Group on the Map Exercises and Final Exam (% correct)

Soldier Group	*M*	*SD*	*Mdn*	Min-Max	*N*
Zoom, Pan, Find Me					
IOBC	97.22	6.63	100	75-100	21
ANCOC	88.89	17.72	92	33-100	15
BNCOC	93.84	6.75	92	83-100	23
OSUT	92.03	10.80	100	67-100	23
Find X [a]					
IOBC	88.89	9.98	92	67-100	21
ANCOC	81.94	24.32	87	8-100	12
BNCOC	92.75	11.32	100	58-100	23
OSUT	80.07	20.11	92	13-100	23
Display					
IOBC	90.00	20.11	87	13-100	20
ANCOC	84.37	19.31	87	38-100	12
BNCOC	69.57	33.25	87	0-100	23
OSUT	73.37	30.22	87	0-100	23
Final Exam on Map [b]					
IOBC	78.70	15.04	70	40-100	41
ANCOC	72.00	10.67	73	33-90	25
BNCOC	68.11	17.98	72	17-90	44
OSUT	68.11	18.30	70	23-97	44

[a] Find X. $F(3, 71) = 2.86, p = .0431$; BNCOC scores greater than ANCOC and OSUT.
[b] Final Exam. $F(3, 142) = 3.29, p = .0226$; IOBC scores greater than BNCOC and OSUT.

Map: Times on Lessons-Exercises and Final Exam

Table E-13
ANOVA on Time to Complete Map Training: High-Low-Exploratory Conditions by Soldier Group

Factor	df	MS	F	p
Zoom, Pan, Find Me				
High-Low Demand	1, 74	29.61	5.34	.0235
Soldier Group	3, 74	31.72	5.72	.0014
Interaction	3, 74	3.14	0.57	.6385
Find X				
High-Low Demand	1, 71	5.85	0.91	.3432
Soldier Group	3, 71	28.96	4.50	.0059
Interaction	3, 71	1.78	0.28	.8415
Display				
High-Low Demand	1, 70	11.54	0.94	.3355
Soldier Group	3, 70	113.85	9.28	.0000
Interaction	3, 70	2.06	0.17	.9177
Range and Azimuth (lesson only, no exercises)				
High-Low Demand	1, 75	29.87	20.14	.0000
Soldier Group	3, 75	1.22	0.82	.4862
Interaction	3, 75	1.05	0.71	.5500
Final Exam on Map				
High-Low-Exploratory	2, 138	395.46	46.34	.0000
Soldier Group	3, 138	16.86	1.97	.1205
Interaction	6. 138	3.47	0.41	.8738
Map Training (All lessons and exercises for Low and High Demand; Working with map for Exploratory)				
High-Low Exploratory	2, 143	31,051.71	622.65	.0000
Soldier Group	3, 143	476.51	5.55	.0000
Interaction	6, 143	63.06	1.26	.2774
Total Time in Map Phase				
High-Low Exploratory	2, 138	22,359.18	296.45	.0000
Soldier Group	3, 138	577.50	7.66	.0000
Interaction	6, 138	43.07	0.57	.7528

Table E-14

Descriptive Statistics on Time on Map Lesson/Exercises and Map Final Exam (times in minutes and fractions of minute)

Condition	*M*	*SD*	*Mdn*	Min-Max	*N*
Zoom, Pan, Find Me [a]					
Low Demand	15.17	2.64	14.78	11.03-26.00	43
High Demand	13.92	2.40	13.77	8.40-20.53	39
Find X					
Low Demand	14.03	2.86	13.55	9.08–22.98	42
High Demand	13.37	2.43	13.43	7.88–20.52	37
Display					
Low Demand	22.29	3.88	22.27	14.88–29.42	42
High Demand	21.66	4.09	21.64	12.75–29.72	36
Range Azimuth [b]					
Low Demand	2.98	0.97	3.03	0.82-6.62	43
High Demand	4.23	1.41	4.32	1.63-9.23	40
Final Exam on Map [c]					
Low Demand	15.07	2.12	15.40	11.28-19.35	39
High Demand	15.33	2.63	15.16	10.00-20.72	32
Exploratory	22.02	5.37	20.75	12.23-42.38	79
Map Training [d]					
Low Demand	54.54	8.68	55.30	38.20-74.82	42
High Demand	53.65	8.43	54.40	33.02-72.62	36
Exploratory	12.63	6.32	11.08	2.10-34.88	79
Total Time [e]					
Low Demand	69.28	9.21	69.40	50.27-83.90	39
High Demand	70.81	10.26	70.65	45.90-96.53	32
Exploratory	34.65	8.57	33.58	19.65-59.00	79

Note. Range-Azimuth times are based only on the lesson as there were no practice exercises.

[a] Zoom and Pan. $F(1, 74) = 5.34, p = .0235$; Low faster than High.

[b] Range and Azimuth. $F(1, 75) = 20.14, p = .0000$; Low faster than High.

[c] Final Exam. $F(2, 138) = 46.34, p = .0000$; Low and High faster than Exploratory.

[d] Map training. $F(2, 143) = 622.65, p = .0000$; Exploratory faster than High and Low.

[e] Total time. $F(2, 138) = 296.45, p = .0000$; Exploratory faster than High and Low

Table E-15

Descriptive Statistics on Time in Map Lessons/Exercises and Map Final Exam by Soldier Group (times in minutes and fraction of minutes)

Condition	*M*	*SD*	*Mdn*	Min-Max	*N*
Zoom, Pan, Find Me [a]					
IOBC	12.84	2.06	12.72	8.40-17.28	21
ANCOC	14.64	2.01	12.82	9.75–16.48	15
BNCOC	15.25	2.02	14.72	11.83–19.18	23
OSUT	15.47	3.03	14.92	11.37–26.00	23
Find X [b]					
IOBC	12.29	1.94	12.77	7.88–15.10	21
ANCOC	13.16	2.01	12.82	9.75–16.48	12
BNCOC	14.02	2.97	13.75	9.08–22.98	23
OSUT	15.02	2.67	14.57	10.77–20.52	23
Display [c]					
IOBC	19.00	3.05	19.53	12.75–23.80	20
ANCOC	20.63	4.22	21.42	12.95–26.23	12
BNCOC	23.23	3.06	23.92	16.00–29.42	23
OSUT	24.09	3.68	24.65	15.38–29.72	23
Range and Azimuth					
IOBC	3.43	1.41	3.03	1.97-6.62	21
ANCOC	3.26	1.25	3.52	0.82-5.57	15
BNCOC	3.68	1.52	3.38	1.38-9.23	24
OSUT	3.84	1.19	3.75	1.52-5.58	23
Final Exam on Map					
IOBC	17.50	4.58	16.67	10.00-32.13	41
ANCOC	18.71	6.32	17.62	11.65-42.38	25
BNCOC	20.23	5.75	19.41	11.77-37.57	44
OSUT	18.54	5.06	17.65	10.37-32.28	41
Map Training [d]					
IOBC	29.69	19.51	26.69	2.1-59.33	40
ANCOC	30.88	21.95	22.68	4.82-68.48	25
BNCOC	34.06	22.75	28.13	6.53-72.62	45
OSUT	35.94	23.73	34.88	3.1-74.82	45
Total Time [e]					
IOBC	47.60	17.56	46.21	20.30-74.25	40
ANCOC	50.24	20.71	50.27	20.95-93.12	25
BNCOC	54.73	20.49	49.87	26.00-96.53	44
OSUT	52.14	20.86	55.15	19.65-82.50	41

[a] Zoom and Pan. $F(3, 74) = 5.72$, $p = .0014$; IOBC faster than ANCOC, BNCOC, and OSUT.

[b] Find X. $F(3, 71) = 4.50$, $p = .0059$; IOBC faster than BNCOC and OSUT; ANCOC faster than OSUT.

[c] Display. $F(3, 70) = 9.28$, $p = .0000$; ANCOC and IOBC faster than OSUT; IOBC faster than BNCOC.

[d] Map Training. $F(3, 143) = 5.55$, $p = .0000$, IOBC faster than BNCOC and OSUT.

[e] Total Time. $F(3, 138) = 7.66$, $p = .0000$; IOBC faster than BNCOC and OSUT.

Correlations

Table E-16
Correlations Among Code Scores (Low and High Demand)

	Code Scores					
	Sym	BR	Co/Sqd	Rifle/Wpn	Ldr/Unit	Exam
Sym	1.00	.07	-.01	.00	-.06	.08
BR		1.00	.13	.21**	.15*	.17*
Co/Sqd			1.00	.24**	.23**	.24**
Rifle/Wpn				1.00	.43***	.37***
Ldr/Unit					1.00	.43***
Exam						1.00

Note. $N = 167$.
*$p < .05$. ** $p < .01$. *** $p < .001$.

Table E-17
Correlations Among Code Times (Low and High Demand)

	Code Times						
	Sym	BR	Co/Sqd	Rifle/Wpn	Ldr/Unit	Exam	Total
Sym	1.00	.50***	.59***	.48***	.53***	.19*	.63***
BR		1.00	.50***	.40***	.42***	.15*	.50***
Co/Sqd			1.00	.55***	.60***	.23**	.74***
Rifle/Wpn				1.00	.62***	.20**	.86***
Ldr/Unit					1.00	.27***	.82***
Exam						1.00	.44***
Total							1.00

Note. $N = 167$. Times represent total of lesson and exercise times, as separate times on code lessons and exercises were not available.
*$p < .05$. ** $p < .01$. *** $p < .001$.

Table E-18
Correlations Between Code Scores and Code Times

Code Scores	**Code Times**						
	Sym	BR	Co/Sqd	Rifle/Wpn	Ldr/Unit	Exam	Total
Sym	**-.32*****	-.11	-.15*	-.05	-.11	.04	-.10
BR	-.03	**-.33*****	-.17*	-.12	-.14	-.08	-.19*
Co/Sqd	-.05	-.09	**-.46*****	-.16*	-.12	.03	-.18*
Rifle/Wpn	-.19*	-.15	-.27***	**-.34*****	-.49***	-.09	-.42***
Ldr/Unit	-.17*	-.10	-.23**	-.56***	**-.17***	-.05	-.39***
Exam	-.29***	-.18*	-.37***	-.37***	-.34***	**-.15***	-.42***

Note. $N = 167$. Correlations between time and scores on same topic are in bold (diagonal)
*$p < .05$. ** $p < .01$. *** $p < .001$.

Table E-19
Correlations Among Map Scores (Low and High Demand)

Map Scores				
	Zoom/Pan	Find X	Display	Exam
Zoom/Pan	1.00	.33**	.36***	.45***
Find X		1.00	.33**	.31**
Display				.61***
Exam				1.00

Note. $N = 71$-82. (some missing data on some variables).
*$p < .05$. ** $p < .01$. *** $p < .001$.

Table E-20
Correlations Among Map Times (Low and High Demand)

Map Lesson Times					
	Zoom/Pan	Find X	Display	Range/Azm	Exam
Zoom/Pan	1.00	.61***	.58***	.22*	.61***
Find X		1.00	.71***	.42***	.75***
Display			1.00	.53***	.73***
Range/Azm				1.00	.55***
Exam					1.00
Map Exercise Times					
Zoom/Pan	1.00	.39***	.57***	NA	.47***
Find X		1.00	.54***	NA	.56***
Display			1.00	NA	.66***
Range/Azm				NA	NA
Exam					1.00

Note. $N = 71$-82 (some missing data on some variables). There were no range/azimuth exercises. Correlations between lesson and exercise times for the map functions were as follows:
Zoom/Pan/Find Me = .30*; Find Others = .31*; Display = .18
*$p < .05$. ** $p < .01$. *** $p < .001$.

Table E-21
Correlations Between Map Scores and Map Times (Low and High Demand)

Map Scores	**Map Times**	
	Map Lesson	Map Exercise/Exam
Zoom/Pan	.15 w/ zoom/pan lesson time	-.35*** w/ zoom/pan exercise time
Find X	-.04	-.46***
Display	.12	-.43***
Exam	-.14 w/ total time in map training	.06 w/ time to take exam

Note. $N = 71$-82 (some missing data on some variables).
*$p < .05$. ** $p < .01$. *** $p < .001$.

Table E-22
Correlations Between Map Scores and Map Times (Exploratory condition only)

	Time Exploring	Time taking Exam
Final Exam Score	.26*	-.13

Note. $N = .79$. Correlation between time exploring and time taking exam was .07.
* $p < .05$

Table E-23
Correlations Among Background Variables

	Computer Survey				**Military Knowledge**							**Work Independently**			
	Own	Freq	Self Rate	Icon	Wpns	Unit	Sym	Map Read	BR Use	BR Trn	BR	Knack	Short	K&S	Work Ind
Own	1.00	.66	.42	.33	.23	.29	.31	.12	.16	.16	.19	.33	.36	.37	.00
Freq		1.00	.45	.49	.12	.20	.19	-.09	.06	.06	.06	.55	.52	.57	-.05
Rate			1.00	.52	.30	.27	.33	.00	-.04	.03	-.01	.57	.55	.60	-.12
Icon				1.00	.22	.32	.32	.03	-.02	-.04	-.03	.53	.51	.55	-.05
Wpns					1.00	.42	.86	.13	-.13	-.09	-.13	.09	.08	.09	.09
Unit						1.00	.83	.22	.07	.16	.12	.20	.16	.19	-.03
Sym							1.00	.21	.04	.04	.00	.17	.14	.17	.03
Map								1.00	.18	.11	.17	-.06	-.08	-.08	.12
BR Use									1.00	.49	.81	.03	.09	.06	-.05
BR Trn										1.00	.91	.07	.09	.09	.04
BR											1.00	.05	.10	.09	-.07
Knack												1.00	.76	.93	-.17
Short													1.00	.94	-.18
K&S														1.00	-.19
Work Ind															1.00

Note. $N = 168$. Shaded variables were not included in multiple regression. Shaded variables were replaced by the variable immediately following them in the table.
Correlations greater than .16 were significant at .05 levels; those greater than .31 were significant at the .01 level.

Table E-24
Correlations Between Tendency to Work Independently and Map Measures (Exploratory condition only)

	Map Final Exam Score	Time Taking Map Final Exam	Exploratory Time
Tendency to Work Independently	.04	.15	-.12

Note. N = 79.

Table E-25
Correlations between Background Measures and Final Exam Scores

Background Measures	Criterion Measures and Training Conditions				
	Code Exam		Map Exam		
	Low (n = 84)	High (n = 83)	Low (n = 40)	High (n = 34)	Exp (n = 80)
Computer background					
-Own computer	.10	.21	.06	.14	.18
-Use computer features	.11	.17	.25	.20	.23*
-Self-rating of expertise	.18	.28**	.29*	.32*	.28**
-Icon score	.26*	.29**	.35*	.29*	.42***
-Short cut/Knack	.17	.13	.38**	.03	.24*
BR	.17	.01	-.10	-.12	-.04
Military knowledge					
-Symbols	.28**	.21*	.23	.28	.33**
-Map Reading	.24*	.29**	.01	.36*	.20
Tendency to work independently	-.01	.01	-.09	-.05	-.07
Multiple R – all predictors	.42	.46	.51	.52	.52
F	1.77	1.95	1.20	.95	2.83
df	9, 73	9, 71	9, 30	9, 23	9, 69
p	.088	.059	.333	.504	.007
Multiple R – stepwise	.33	.41	.38	.46	.47
F	4.99	7.49	6.52	4.08	10.94
df	2, 80	1, 49	1, 38	2, 30	2, 76
p	.009	.001	.015	.027	.000

* $p < .05$. ** $p < .01$. *** $p < .001$.