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# Digital Warrior

## Task B Report and Recommendations

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## Context and Problem Space

> *Task B Statement of Work*: Produce a report that evaluates tasks related to training digital skills, identifies digital skills that can be taught using instructional technologies, and recommends technological training solutions appropriate to a Distance Learning environment. IAT and BCTC will assist in the evaluation of digital skills.

Sand tables, maps, acetate overlays and scraps of paper have been the common tools of commanders and battle staffs to track events, solve problems, build shared perspective, plan, rehearse and execute battles (Neal et al. 1998). This long history of using physical artifacts and manual, tactile procedures is currently in transition as the U.S. Army is now converting to the use of digital battle command systems, also known as command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR) systems.

The combination of Army Battle Command Systems (ABCS) and the Defense Collaboration Tool Suite (DCTS), along with other current and future digital C4ISR systems, enable battle command and control supported by information including digital topographic maps with embedded data, application and staff function specific overlays, two-way voice communication, two-way video communication, email, chat, and remote desktop collaboration.

The U.S. Army seeks to attain the full benefits of force digitization. Digital systems "will allow the Army forces to see first, understand first, decide first, act first, and finish decisively" (Army Digital Training Strategy, 2003).

Utilization of advanced information technologies profoundly impacts the tasks of planning, rehearsal and execution. Just as the change from analog to digital systems "changes the way the Army does business," it also changes "what gets trained and how" (Schaab et al. 2004).

In *Training for Future Operations: Digital Leaders' Transformation Insights* (2002) the Army Research Institute (ARI) notes "digital systems enable staffs to operate more efficiently and effectively. To do so requires repetitive training of staff fundamentals (e.g., analyze a situation and maintain a running estimate) using the digital systems. Staffs have to be more than tactically proficient; they have to be experts with digital systems"(p. 14).

The mass and rapid adoption of new technologies brings both new opportunities and new challenges. The ARI identified the following training challenges associated with digital systems:

- Frequent upgrades in digital system hardware and software limit learning of skills to mastery levels and place great demands on refresher training.

- The volume of ambiguous data, along with smaller operational units and novel situations, require methods for training junior and mid-level soldiers to be flexible and adaptive.

- Training time and resource limitations demand that training of digital procedures and skills, including back-up and work-around skills, be integrated into training of tactics, techniques, and procedures.

- Future operations call for widely dispersed soldiers linked through electronic networks to perform as digital teams with new training demands (Moses, 2000).

A review of the Army research literature on digital transformation revealed other training challenges:

- Classroom training tends to focus on single aspects of digital systems and "do not incorporate the complexity or variety of situations that Soldiers would encounter when returning to their unit." (Sanders, 2001, p. 18)

- "Trainers are proficient in operating the system but do not instruct soldiers about how to integrate it into unit operations. Therefore, they are quite good at producing system operators, but not operators who know how to fit that system into the overall job functions. Unit leaders complain that soldiers come to them from training with limited understanding of the purposeful use of systems" (Schaab et al. 2004, p. 9)

- "The digital transformation clearly indicates a need for a low-overhead driver (LOD) with training packages that set conditions to train the staff. Units need to focus on being trained, not on developing the exercise in which they will be trained." (Johnston et al., 2002, p. 10)

Combined with issues of skills perishability, personnel turbulence in units, and shortened train-alert-deploy cycles (Johnston, et al., 2002), it is imperative that the Army be able to accelerate learning and compress training time.

Like the C4ISR systems, digital Distance Learning systems (also called "Distributed Learning" in the U.S. Army literature) promise similar improvements of agility, adaptability, scalability, effectiveness and efficiencies to Army training.

Distance Learning technologies provide new training opportunities that combine the science of human cognition with computer-based instructional advantages of interactive multimedia, automated assessment, on-demand access to remediation and enrichment materials, and anytime-anywhere availability.

To realize the full benefit of its investment in battle command systems, the Army must leverage the immense potential capabilities of digital distance training environments.

This report provides an analysis of the digital skills needed to use the Army Battle Command Systems (ABCS) and provides recommendations on the utilization of Distance Learning techniques and technologies to improve training of digital skills.

## *Research Process*

Along with an extensive review of the U.S. Army research literature on digital skills and digital transformation, information interviews were conducted with key personnel at the Battle Command Training Center (BCTC) at Fort Hood, Texas, including:

John Diem, Acting G-3, III Corps
Georgie McAteer, Director, Battle Command Training Center, Fort Hood
Northrup Grumman and Lockheed Martin training staff:
- Lin Grasso
- John Leese
- Danny McCoy
- Ed Pax
- Kevin Pillsbury

Battle Staff Integration Course – instructors and students
MCS-L Course – instructors and students
Tactical Operation Center live field exercise – battle captains, staff sections, and operators.

The methodology of research for this report followed eight steps:

1. Needs Analysis – included interviews with stakeholders at BCTC plus review of U.S. Army research and academic research on learning theories and strategies for training digital skills via distance learning.
2. Target Learner Analysis – from interviews and the literature, examined the common characteristics of battle staff utilizing digital systems (the leaders, staff sections and operators typically making up the Tactical Operations Center).
3. Army Training Modalities Matrix – constructed a framework of the military training cycle that outlined the typical training domains of digital skills.
4. Adaptive Learning Ecology – developed a pedagogical construct for analyzing digital skills across training domains and digital C4ISR applications.
5. Digital Skills Matrix and Task Analysis– from primary sources, processed ABCS digital skills through the Adaptive Learning Ecology to sort skills into common domains or "knowledge categories" and to then match skill cognitive requirements to instructional strategies.
6. Evaluate Best Practices and Technologies Matrix for Distance Learning – from the research work of Task A of this subcontract, associated best practices and technologies identified for effective DL training of digital skills.
7. Research Conclusions – implications/results from the analysis of Army digital skills training.
8. Recommendations and Scenarios – correlating the previous research steps, recommend appropriate applications of DL to Army digital skills training.

In total, this research informs the Army's analysis of key criteria for effective C4ISR digital distance training.

## *Needs Analysis*

The administrators, instructional developers, trainers and learners of digital skills uniformly seek more efficient and effective means to accomplish training. Ease of implementation and usability was noted as an important factor to adoption. Supplementing instruction versus replacing instructors was a common concern about Distance Learning. Training personnel sought near-, intermediate- and long-term solutions to improve training performance in the institutional, operational, and self-development domains.

The expressed goal is not merely the training of buttonlogy of digital systems, but to impart the critical role and functions of digital systems to support operations and to impart and exercise the knowledge, application and integration of these systems to optimize mission success. This involves high-order cognitive skills for situational understanding, sense-making, decision-making and battlefield visualizations.

From the needs identified by focus groups, interviews and observations at the BCTC combined with the U.S. Army research literature review, essential requirements for Distance Learning training of digital skills were gathered.

Distance Learning environments for digital skills training must:

- Enable foundational and collective battlefield automation training;

- Incorporate learner-, trainer- and commander-centric learning strategies for flexible, self-directed, customizable instruction that can be accomplished in short bursts of learning activity (20 minutes or less);

- Provide content creation tools that can produce customizable instruction by trainers to accommodate unique missions, challenges, lessons learned, Tactics, Techniques and Procedures (TTP), and the Common Operating Environment (COE);

- Extend training reach to where the unit needs to conduct instruction, including deployments (capabilities-based, not facility-centric);

- Operate with low overhead for personnel and equipment; and

- Support Joint and Future Combat Systems (FCS) concepts.

The digitized training courses must eventually cover all digital training requirements stipulated in the Army Digital Training Strategy, ranging from individual digital training at the soldier and leader level to collective training exercises.

## *Target Learner Characteristics*

The battle staff (battle captains, staff sections, and digital operators) of a typical Army Tactical Operations Center (TOC) – brigade and below – were the primary learners identified by the BCTC for this report.

The role of the battle staff is to help the commander recognize and anticipate battlefield activities in order to make decisions and act faster than the enemy. The battle staff has a vital role in organizing, analyzing, managing, and presenting vast amounts of information to support the commander's decision making. Once a decision is made, the commander depends on the staff to communicate the decision to subordinates in a manner that quickly focuses the necessary capabilities to achieve the commander's intent (Felton, Schaab, Dressel, 2003).

Current forces are adapting to digital systems. Over the past four years, the Army Research Institute (ARI) has tracked soldiers through the process of fielding new digital systems. In *Training the Troops: What today's soldiers tell us about training for information-age competency*, soldiers reported on their experiences learning and using digital systems:

- Hands-on training, preferably during field exercises, is the best way to learn digital systems;
- Soldiers prefer learning digital skills as they perform their jobs as cooperative members of a team;
- Working with more knowledgeable peers is helpful;
- Soldiers seek more opportunities to advance their knowledge and expertise but say training support material is limited;
- Technology helps soldiers do their job; and
- To be effective in their jobs, soldiers must understand how to integrate digital information from the other digital systems and combat operations (Schaab, 2004).

Also, soldiers want to assume greater responsibility for their own training.

Regarding digital skills training:

- 92% of soldiers in Army digital units report that systems are available for training during work hours; and
- 58% report that they have the time to train during their workday (Schaab, 2004).

## *Army Training Modalities Matrix*

A model of the Army training ecology was developed to understand the constructs and context of digital skills training. The research team needed to know "How does the Army conduct training?" in order to make recommendations for appropriate inclusion of Distance Learning technologies and techniques. The Army Training System follows a systematic approach that develops skills along novice-to-expert pathways.

The basic steps followed in all training are:

- Establish skills;
- Sustain skills;
- Improve skills; and
- Delta skills.

Training progresses through a series of courses that build digital skills sequentially:

- Introduction (training overall awareness of system capabilities);
- Operator (training use of single systems – "buttonology");
- Integrator (training use of multiple systems in coordinated teamwork); and
- Leader (training use of digital systems for decision-making).

Two key types of training are offered:

- Individual; and
- Collective.

And training occurs in three major domains or settings:

- Institutional (schools and training Centers);
- Operational (unit training, at home station, Combat Training Centers, or when deployed); and
- Self-Development (self-study).

This framework, generated from the Army Digital Training Strategy, 2003, was utilized in constructing an Adaptive Learning Ecology. It was also utilized in a matrix of current Army course offerings on digital skills. Appendix A contains the digital training course audit that includes Army-wide and CTC courses.

## *Adaptive Learning Ecology*

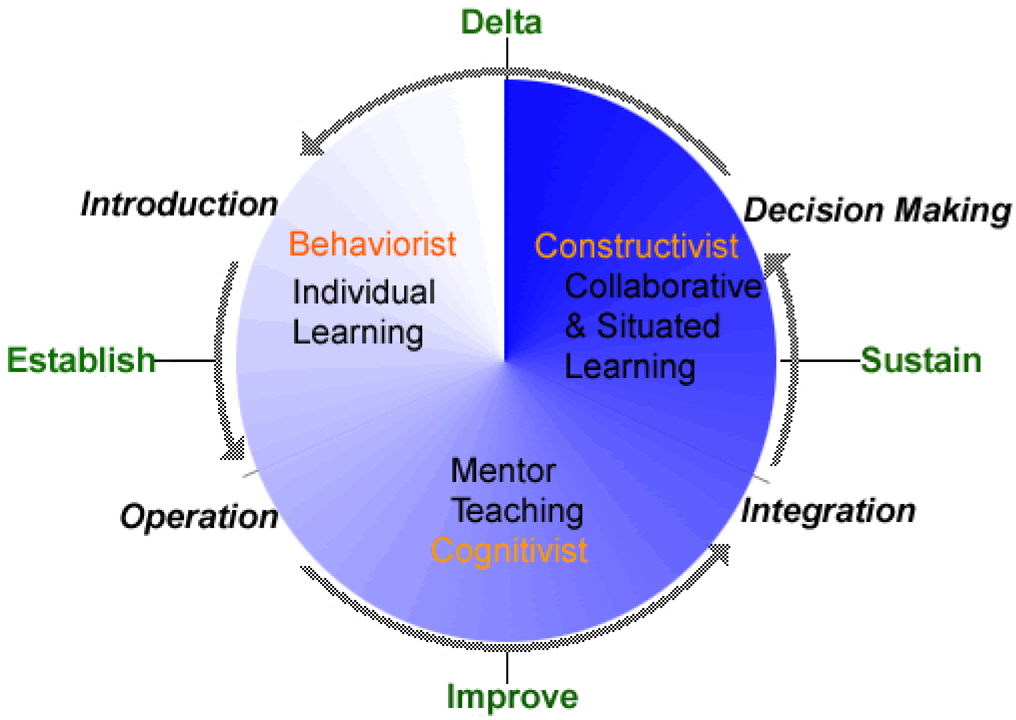


**Figure 1 The Adaptive Learning Ecology (ALE) for Army Digital Skills Training**

Key concepts illustrated in Figure 1, include:

| **Phases of Training** | **Types of Training** | **Learning Structure** | **Instructional Strategy** |
|---|---|---|---|
| 1. Establish | 1. Introduction | 1. Behaviorist | 1. Individual Learning |
| 2. Improve | 2. Operation | 2. Cognitivist | 2. Mentor Teaching |
| 3. Sustain | 3. Integration | 3. Constructivist | 3. Collaborative and Situated Learning |
| 4. Delta | 4. Decision Making (Leader) | | |

In order to systematically analyze and consistently organize digital skills, to select appropriate instructional strategies, and to provide suitable and adaptive training scenarios, a learning process flow was created that we call an Adaptive Learning Ecology (Figure 1). The process flow represents the phases of skills training in the U.S. Army: *establish, improve, sustain, delta*. Like the training cycle of the U.S. Army, the process flow maps to the progressive and synchronous development of skill levels from novice to expert usage pathways through four types of courses, *introduction*, *operation*, *integration*, and *decision making (leader)*.

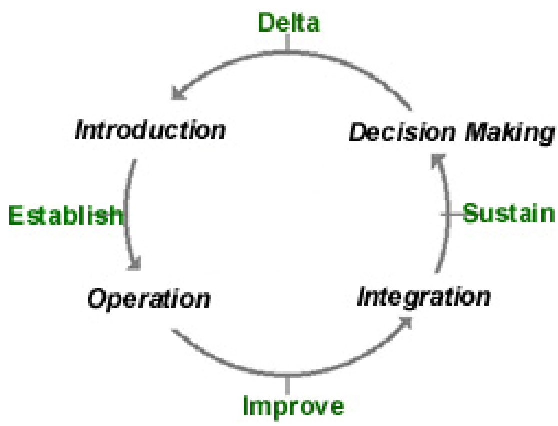


**Figure 2 Phases and Types of Training**

When a change in digital systems or in Tactics, Techniques and Procedures (TTPs) occurs, this delta resets the cycle to the established skill phase, or introductory training. Learning theories of behaviorism, cognitivism, and constructivism create the structure of the learning system, and the instructional theories of distributed cognition, situated learning and cognitive apprenticeship underpin the pedagogy. In terms of feedback and computer-mediated communication, human-to-agent, human-to-human, and agent-to-agent interactions are present in the learning ecology.

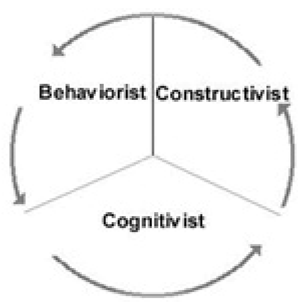


**Figure 3 Learning Structure**

This process flow, or what the authors shall call a "learning ecology," represents a system view. At the component level, learning theories and instructional strategies are correlated to the type of learning objectives associated within each stage of the training cycle. For example, skill establishment involves acquiring new terminology and concepts.

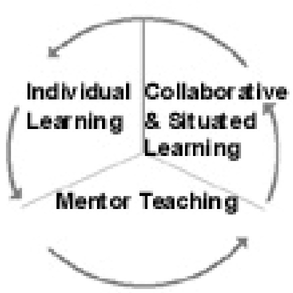


**Figure 4 Instructional Strategy**

Pedagogically, this type of learning is best accomplished via behaviorism (automatic recall) and cognitivism (information processing). In this way, instruction mainly follows a structured approach that can be used for all digital skills training. Represented at a macro level, the learning ecology works as an instructional framework for general training purposes.

The system also can be broken into its component parts to address specific learning needs of individual soldiers. In the micro-level view, the instruction can adapt to meet individual needs. The component parts can be turned to diagnose and remedy specific learning requirements of a single soldier. For example, in operation training the soldier experiences problems discerning the standard of application for several graphical overlay options; at the micro level, the system responds with schema theory based instruction (a strategy of cognitivism) that helps the learner to differentiate the overlays.

The Adaptive Learning Ecology  provides guidance for sequences and strategies for instruction. The system can work from a macro or micro level; indeed, it works best when the components work together to reach instructional goals.

## Framework in Macro and Micro perspectives

Macro perspective: The macro-adaptive instructional system consists of three major theories of learning (behaviorism, cognitivism, and constructivism) as the learning structure and presents instruction in three types of training formats: 1) independent learning, 2) trainer/mentor teaching, and 3) collaborative and situated learning. The instructional theories of distributed cognition, situated learning, and cognitive apprenticeship underpin the pedagogy The modes of learning consist of individual learning, community-of-interest learning, and community-of-practice learning.

First, basic knowledge and skills are established through the Introduction and Operation courses. Learning is facilitated through behaviorism and cognitivism. Much of the instruction can be independent learning, whereby individuals learn knowledge and gain comprehension.

The Operation and Integration courses rely on extensive hands-on experience with the digital system. A trainer/mentor instructional model works well to establish a master-apprentice relationship whereby demonstration and scaffolding strategies improve comprehension and information processing, and the trainer/mentor demonstrates the process of analysis and application. This type of learning is best achieved in classrooms or via live virtual classrooms. The soldiers are together but learn individually within a common community of interest.

More advanced levels of Integration and Decision Making courses that include decision making, critical thinking, and staff integration training occur best through collaboration and social interaction in the culture of the authentic learning environments. By doing collaborative work and by engaging in situated learning to do problem-solving, the soldiers interact within a broader community of practice.

With regard to feedback and computer-mediated communication, human-to- human interaction occurs when the soldiers receive feedback from their instructor or when their colleagues provide feedback for their problem solutions. Human-to-agent interaction occurs when the soldiers receive feedback from the programmed instruction or when the soldiers conduct collaborative and situated learning, receiving feedback from the learning program. Finally, agent-to-agent interaction occurs whenever the learning ecology functions as an intelligent learning management system and directs the soldiers to the appropriate instruction package.

It should be noted that in all of the training phases the presence of a live or virtual trainer/mentor is extremely important for providing feedback and learning support. Help should be hierarchically structured, from general to specific.

Micro-perspective: The micro-adaptive instructional system acts much like an intelligent tutoring system to remedy the soldiers' weakness. When does the micro-adaptive instructional system start? When a soldier needs to develop specific types of abilities (i.e., having automatic responses to some situations, doing effective information processing, employing critical thinking ability, or problem-solving ability), at that time the macro system turns static and the micro system becomes active.

Depending on the situation, the micro-adaptive instructional system will retrieve different instructional strategies through intelligent systems (to be developed) or through instructor intervention to improve the soldiers' specific weaknesses. For example, to develop automatic responses and learn new knowledge, independent learning is a starting instructional strategy. To further improve comprehension, to do effective information processing, and to yield optimal retention, mentor-teaching is an appropriate instructional strategy. To verify conceptual understanding, to improve problem-solving and to strengthen critical thinking, collaborative and situated learning should be used. The instructional strategies are not contradictory with one another; they can co-exist to meet the instructional goals, when necessary.

The Adaptive Learning Ecology is designed to form a "mechanistic" process for enabling a routinized yet dynamic learning environment. The system also acts as an instructional design tool to match cognitive skills and tasks to appropriate learning strategies.

## How Tasks Are Processed

Within the Adaptive Learning Ecology, tasks are analyzed according to Bloom's taxonomy and are sorted into three categories that capture Bloom's six domains of competency, organized to correspond to this learning system: Knowledge and Comprehension (sorted together for our model), Application and Analysis (sorted together for our model), and Synthesis and Evaluation (sorted together for our model). These three groupings match to the skill progression of the adaptive learning ecology and to the continuum of the U.S. Army's standard course pathway of *introduction*, *operation*, *integration,* and *decision making*.

Therefore, Bloom's taxonomy functions as a task processor. Accordingly, it is essential to explain the legitimacy of use of Bloom's taxonomy by presenting the details on how Bloom's taxonomy relates to the Adaptive Learning Ecology.

First, the stages of the learning ecology are tuned to the categories of Bloom's taxonomy. According to the characteristics of Bloom's categories, knowledge and comprehension development tend to be achieved by independent learning that provides introduction and awareness to the skill.

Second, the skills of analysis and application can be developed through mentor/teacher instruction that provides context and support of skills and showcases analysis and application of skills. Incidentally, skill comprehension also can be further improved through mentor/teacher instruction.

Finally, the abilities of synthesis and evaluation can be developed through collaborative and situated learning scenarios whereby the soldiers are given ill-defined tasks and real-world problems representing authentic activities in which they practice and strengthen their decision-making ability.

The hierarchical relationships of Bloom's taxonomy categories and the instructional strategies of the learning ecology are demonstrated Figure 5

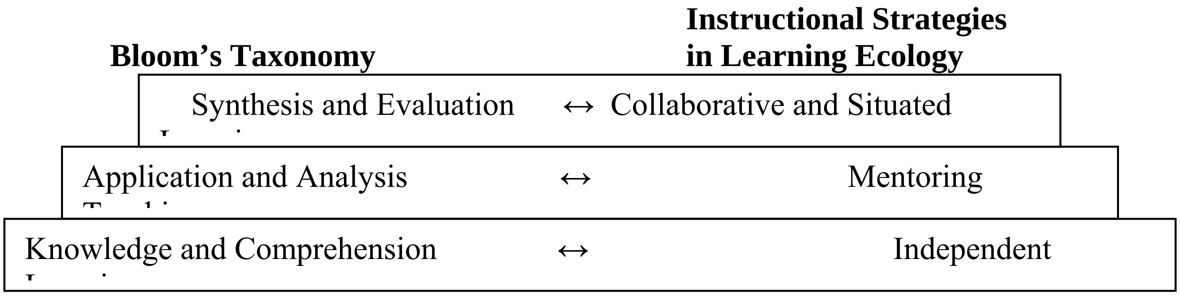


**Figure 5 Bloom Taxonomy Categories Aligned to Instructional Strategies**

With known instructional strategies, teaching techniques can be applied. Table 1 below recommends teaching techniques for each instructional strategy.

**Table 1 Teaching Techniques for each instructional strategy**

| Instructional Strategy | Teaching Technique |
|---|---|
| **Independent learning** | 1. State objectives and break them down into steps. 2. Provide hints or cues that guide learners to desired behavior. 3. Use consequences to reinforce the desired behavior. 4. Use programmed instruction and tutorials |
| Direct instruction | Stimulus and response, use of prompts |
| Automated performance and feedback | Computer generates questions and answers |
| Highly structured instruction | Sequencing of instructional presentation |
| Observable and measurable learning outcomes. | Use behavioral objectives, task analysis, criterion referenced assessment |
| Pre-assessment of learners to determine where instruction should begin. | Learner analysis |
| Mastery learning | Simple to complex sequencing of practice |
| Use of reinforcement to improve performance | Tangible rewards, informative feedback |

| Instructional Strategy | Teaching Technique |
| --- | --- |
| **Mentor teaching** | 1. Organize new information.<br>2. Link new information to existing knowledge.<br>3. Use techniques to guide and support learners' attention, encoding, and retrieval process.<br>4. Use:<br><u>1). Cognitive strategies</u>:<br>Advance organizer<br>Summary<br>Questioning<br>Graphic organizers like tables, sitemaps and flowcharts<br><u>2). Metacognitive strategies:</u><br>Learners develop a plan of action<br>Learners maintain/monitor the plan<br>Learners evaluate the plans |
| Direct instruction | Make knowledge meaningful, relate new information to prior knowledge |
| Automated performance and feedback | Computer generates questions and answers |
| Highly structured instruction with learner support | Sequencing of instructional presentation, scaffolding (learner support) |
| Emphasis on the active involvement of the learner in the learning process, to include learner control of training delivery method | Intrinsic motivation: Give "learner control" by providing variety of training modes. Learner selected training delivery modes:<br>1. Demonstration mode: Use multimedia technologies (i.e., videos) to demonstrate correct steps of task completion to learners.<br>2. Teacher/Mentor mode: an instructor or expert peer models behavior, and guides learners through required task steps.<br>3. Concurrent mode: Student engages in task performance within a virtual software environment with access to "Help" functions/features. |
| Use of hierarchical analyses to identify and illustrate prerequisite relationships | Use Bloom's cognitive task analysis procedures. |
| Ease learner's cognitive load by chunking, organizing, and sequencing learning materials to facilitate information processing for learners | Use of cognitive learning strategies that include chunking, summaries, advance organizers, visual aids (i.e. concept maps, images), metaphor, rehearsal, mnemonics. |

| Instructional Strategy | Teaching Technique |
|---|---|
| **Collaborative and Situated learning** | 1. Create group-learning activities.<br>2. Model and guide the learners' knowledge construction process.<br>3. Use asynchronous conferencing, synchronous conferencing, structured controversy, team investigation, team debate, team projects, team competition.<br>4. Pose (Simulate) ill-defined tasks/cases/situations and real-world problems representing an authentic activity.<br>5. Learners work together to solve the problems. |
| Constructivist instruction | Learners construct new ideas or concepts based upon their prior knowledge. |
| Non-automated performance assessment and feedback | Assessment of individual contributions to collective performance. |
| Provide multiple representations of information and perspectives | Provide different representations of the unfolding task; enables "pattern" generation and recognition |
| Collaborative learning | Social negotiation of meaning through collaborative work. |
| Situated learning: authentic learning environment, ill-defined and ill-structured problems | 1. Provide situations that push learners into meaningful contexts.<br>2. Provide related situations/cases or worked examples to increase learner cognitive flexibility. |
| Provide learner support | Adaptive learner support should fade scaffolding |

(Table constructed by Yungwei Hao, 2004, IC$^2$ Institute)

## Assessment-enabled Help

To match with the adaptive nature of the learning ecology, functional assessment will be adopted for soldier evaluation. Functional assessment means measurement is used to detect whether the goals (the purpose of the instructional strategies) are reached and then to address the soldiers' weaknesses through remedial instruction. The procedures are as follows.

First, assess soldiers through appropriate assessment activities, which are listed in Table 2. The assessment questions or items need to be categorized into one of the learning domains of Bloom's taxonomy.

Secondly, based on the learner's assessment results, identify each soldier's problem within the domain and match instructional strategy for remedy. Notice: If a soldier has an analysis problem, then remedial instruction will operate from "application and analysis" instruction first, which would be trainer/mentor learning. If learner assessment passes the rubrics of application and analysis, the instruction will move forward to the next stage, the "synthesis and evaluation" instruction, which would be "collaborative and situated learning." If he fails, the remedial instruction would move back to "knowledge and comprehension" instruction for assessment, which would be independent learning. If he passes, the instruction will move forward to the stage, application, and analysis instruction. If he fails again, the remedial instruction would move back further to "knowledge and comprehension" instruction for testing, etc. These rules apply across the learning ecology.

Table 2 summarizes basic assessment techniques that can be used within the learning ecology. Whereas there are literally hundreds of assessment techniques, the chart represents the most commonly applied.

**Table 2 Assessment Strategies**

| **Assessment design and implementation for Web-based courses (Liang and Creasy, 2004)** | | |
|---|---|---|
| **Assessment type** | **Assessment Name** | **Assessment method** |
| Test and exam<br>(Introduction) | Module quiz<br>Exam | Numeric score |
| Written Assignment<br>(Operation) | Reaction paper<br>Evaluate cases/ situations<br>Personal reflections<br>Description of an effect<br>Journal writing | Evaluation rubrics<br>Work guideline |
| Participation<br>(Integration) | Questions posted<br>Answers posted | Response quality and quantity |
| Collaboration<br>(Integration and Decision Making) | Group research project,<br>Peer reflection<br>Peer facilitation | The amount of time and contribution to learning<br>Rubrics |
| Proficiency demonstration<br>(Integration and Decision Making) | Electronic portfolio<br>Create slide show<br>Create an evaluation product<br>Online case analysis<br>Electronic project presentation | Evaluation rubrics |

In total, the Adaptive Learning Ecology is both a toolset for instructional design of current and future C4ISR systems training and the basis for an heuristics engine to enable adaptive learning within sophisticated digital distance learning environments.

## *Digital Skills Matrix and Task Analysis*

The Training Needs Analysis for Digital Training Facility (DTF) report produced by TRW under Subcontract Number GSTC-01-006 in 2002 was the baseline document for analyzing digital skills. The TRW report identified the learning requirements for the Army Battle Command Systems for both individual and collective training.

The TRW analysis included:

- Recommend tasks to be trained;
- Recommend training method;
- Recommend course length;
- Recommend student throughput;
- Review the Centralized Technical Support Facility, mission support training facility, WARRIOR-T, DD2-N, instructional programs and training management systems and recommend program procedures for transition to the DTF;
- Identify training support systems and tools needed to support the training; and
- Determine availability and cost of drivers, databases, and resources necessary to modify them to meet the III Corps training requirements.

The TRW document did not provide detailed skills analysis, but rather a listing of tasks associated to each digital course. The research team looked at the Battle Command Training and Integration Division (BCTID, formerly known as Warrior-T) dataset of digital task maps and digital TTPs for more information on digital skill requirements.

However, the TRW document was authorized as the primary source for digital skills analysis in the Statement of Work for this subcontract. Therefore, the TRW task outlines for ABCS operator, integrator and leader courses were sorted using the Adaptive Learning Ecology. Each task was assigned to a Bloom's taxonomy category based on its cognitive requirements. With the Adaptive Learning Ecology as an instructional analysis tool, appropriate instructional strategies were correlated to the tasks.

Table 3 below is an example of the results gained through this analysis:

**Table 3 Analysis of AMDWS – Leader Training Tasks**

| Tasks | Bloom Taxonomy | Scenario/Instructional Strategies |
|---|---|---|
| 1. Present an overview of AMDWS and ABCS | Knowledge | Independent learning |
| 2. Establish the air defense artillery (ADA) section<br>a. Prepare common hardware systems equipment for operation<br>b. Initiate AMDWS | Application | Independent learning<br>Mentor Teaching<br>Collaborative and Situated learning |

| | | |
|---|---|---|
| c. Link the air defense system integrator | | |
| 3. Establish the Warfighter Information Network.<br>a. Install a Tactical Local Area Network (LAN)<br>b. Prepare SINCGARS ASIP (RT-1523E) for Operation<br>c. Troubleshoot the SINCGARS ASIP (RT-1523E) Radio Set<br>d. Supervise the Establishment of the Common Tactical Picture (CTP)<br>e. Supervise the Establishment of Data Dissemination Editor (DDE) Settings | Application | Collaborative and Situated learning |
| 4. Perform Troubleshooting and Fault Isolation of Equipment and Software<br>a. Troubleshoot the Local Area Network (LAN)<br>b. Troubleshoot Software Faults<br>c. Implement the Built in Test (BIT)<br>d. Verify Faults on CHS Equipment<br>e. Recover System Data<br>f. Troubleshoot the radio sets | Application | Collaborative and Situated learning |
| 5. Establish the Common Operational Picture<br>a. Supervise the Update Common Tactical Picture (CTP) Elements<br>b. Perform ABCS Data Distribution<br>c. Process a Message Using Common Operating Environment Message Processor (CMP).<br>d. Operate Collaborative Planning Tools.<br>e. Assess Verbal and Digital Reports.<br>f. Supervise File Management. | Application | Collaborative and Situated learning |

| | | |
|---|---|---|
| 6. Receive the mission.<br>a. Supervise the processing of reports.<br>b. Determine status of early warning systems.<br>c. Determine status of weapon systems. | Application | Collaborative and Situated learning |
| 7. Define the Battlefield Environment (IPB).<br>a. Establish the aerial area of interest (AOI).<br>b. Identify information gaps and submit RFIs to the S2.<br>c. Analyze the effects of weather on air operations.<br>d. Supervise the creation of the aerial IPB planning overlay.<br>e. Supervise the creation of the aerial AOI overlay.<br>f. Supervise the creation of the ADA battlespace overlay.<br>g. Supervise the creation of the aerial threat battlespace overlay.<br>h. Supervise the creation of the brigade battlefield environment overlay. | Evaluation | Collaborative and Situated learning |
| 8. Evaluate the aerial threat (IPB).<br>a. Analyze aerial threat factors.<br>b. Determine likely aerial avenues of approach (AAAs).<br>c. Determine air threat capabilities and vulnerabilities.<br>d. Supervise the creation of the Air Defense doctrinal template.<br>e. Determine target selection priorities for air strikes. | Evaluation | Collaborative and Situated learning |
| 9. Coordinate airspace command and control.<br>a. Monitor airspace management.<br>b. Resolve potential conflicts concerning the use of airspace.<br>c. Determine the effects of artillery fires on air operations.<br>d. Supervise the development of the airspace utilization overlay. | Synthesis | Collaborative and Situated learning |

| | | |
|---|---|---|
| e. Supervise the development of the air defense situation overlay. | | |
| 10. Access tactical situation and operations (Battle Tracking).<br>a. Track current air defense system status.<br>b. Process reports.<br>c. Produce Air Defense estimate.<br>d. Determine weapon systems coverages.<br>e. Determine early warning coverages.<br>f. Hook air tracks.<br>g. React to air track alerts on the Battlefield Situation Display (BSD).<br>h. Generate an air strike warning message. | Evaluation | Collaborative and Situated learning |

This task/skills analysis was completed for six C2 systems: AMDWS, ASAS, AFATADS, FBCB2, GCCS-A, and MCS (both light and hardened). The six systems were chosen because of their emphasized importance to the ABCS 6.4 release as identified by the PEO3CT (Mazzucchi, 2003).

The completed matrix of tasks processed through the Adaptive Learning Ecology is located in Appendix B.

With completion of the skills analysis, commonalities across courses and across separate ABCS applications can be provided. The research team was able to compare frequency or reoccurrence of tasks/skills and measure the types of learning – as categorized by Bloom's Taxonomy of knowledge, comprehension, application, synthesis, analysis and evaluation skills – provided in the Army digital training coursework reported in the TRW document.

The Figures 6 - 11 summarize the learning domain foci of each of the system's collected set of introduction, operator, integrator and leader (decision-cycle) training courses.

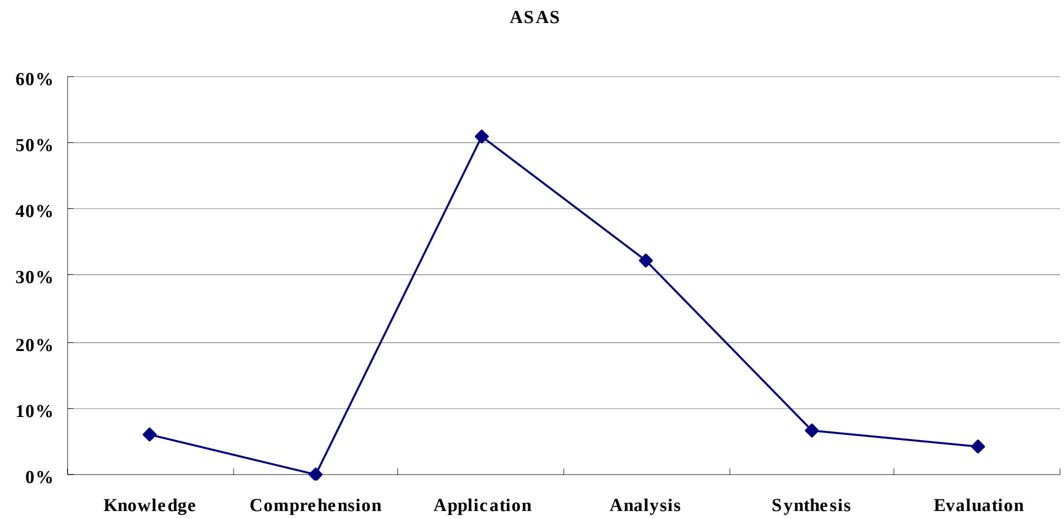


**Figure 6 ASAS Training Summary**

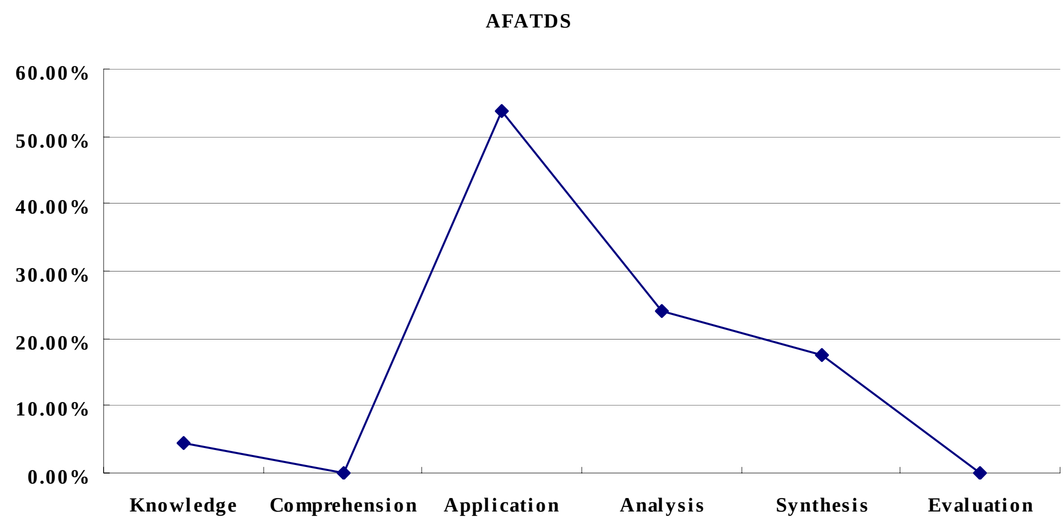


**Figure 7 AFATDS Training Summary**

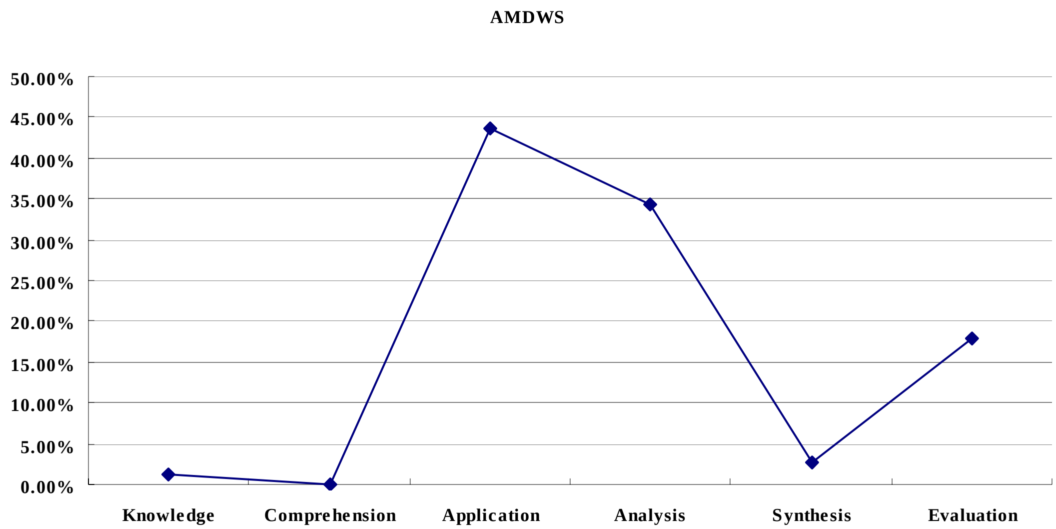


**Figure 8 AMDWS Training Summary**

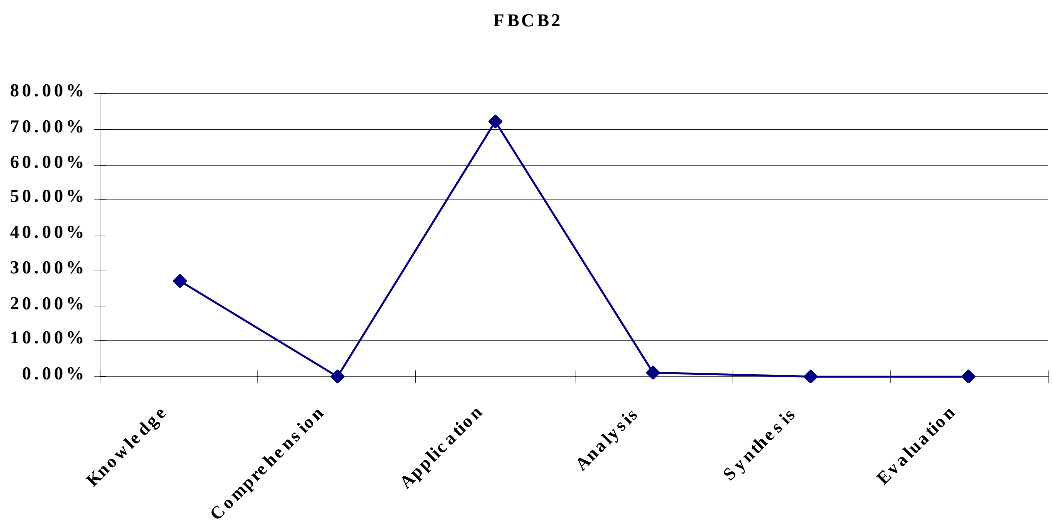


**Figure 9 FBCB2 Training Summary**

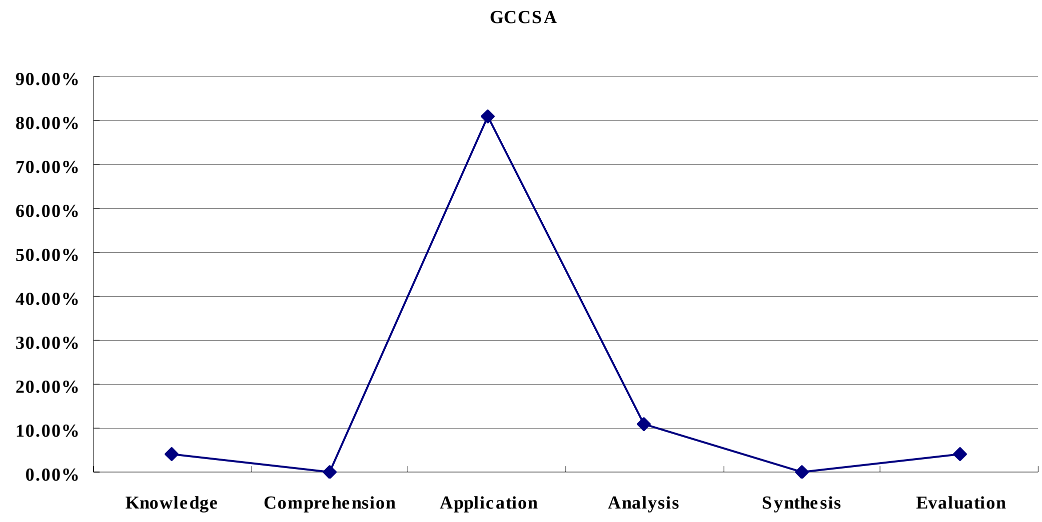


**Figure 10 GCCSA Training Summary**

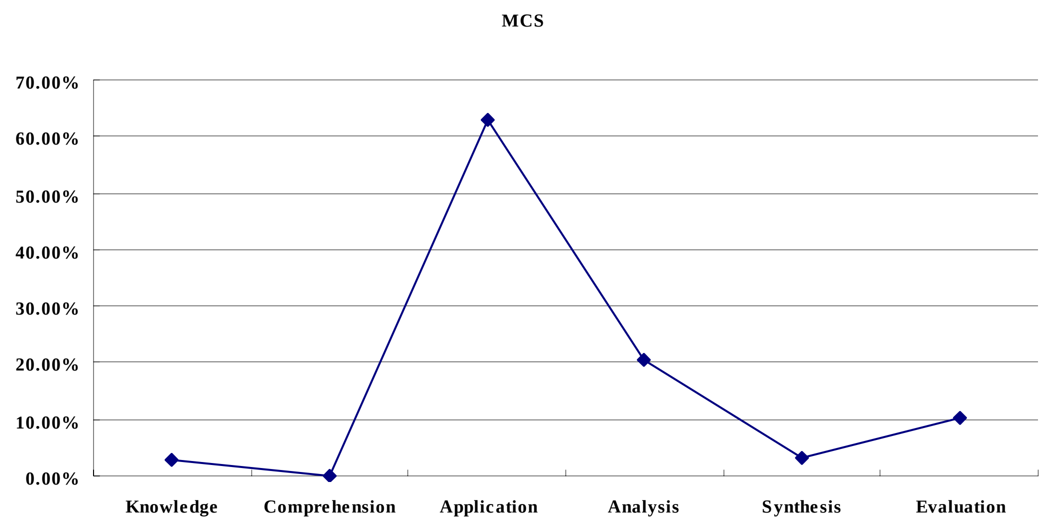


**Figure 11 MCS Training Summary**

Across the systems, most of the suggested training tasks belong to application and analysis, with moderate amount to synthesis and evaluation, and little to knowledge and comprehension.

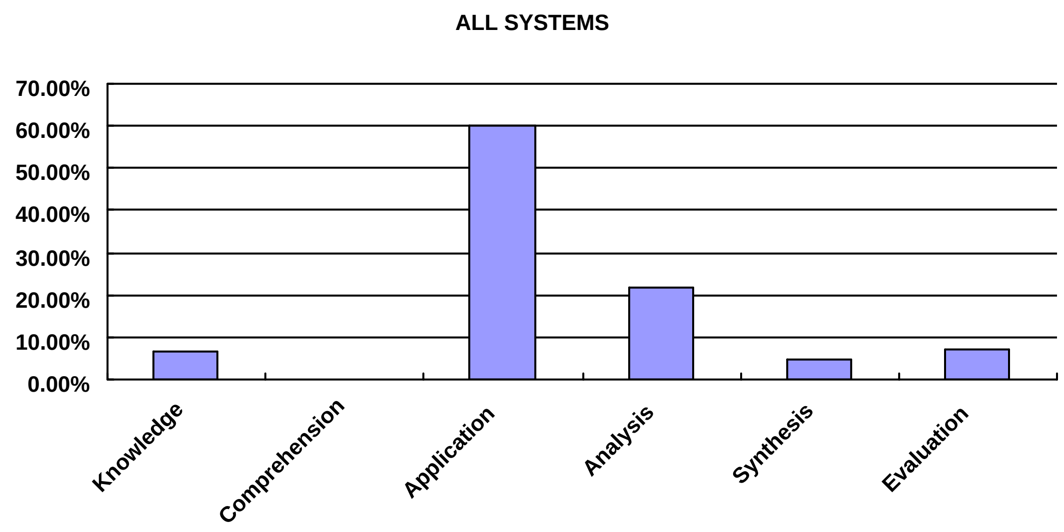


**Figure 12 All Systems Training Summary**

This comparative analysis revealed a heavy emphasis on application skills, which is not surprising since the majority of courses are meant for digital systems operations training. However, this also suggests improvements can be made to the entire training cycle.

If knowledge/comprehension skills – understanding overall system functions and their purposeful utilization in tactical missions – are well-established in the introductory courses, operator and leader training will be more relevant and meaningful. Soldiers will understand the significance of their roles and responsibilities to the tactical mission supported by digital systems. Likewise, if synthesis and evaluation skills – the higher-order cognitive skills of visualization, sense-making and decision-making – are taught in introductory and operator courses, soldiers will be able to develop earlier reasoning and strategy skills utilizing the digital systems.

This suggests a pull-push process of pulling in higher-order cognitive skills backward and pushing the knowledge and comprehensions skills forward within the training cycle.

## *Best Practices and Technologies Matrix for Distance Learning*

The best practices, inventory of current technologies, and forecast of promising emerging technologies from research conducted in Task A were aligned to the Army training domain, instructional needs, and the cognitive requirements of the digital skills.

An accounting of current Army courses offered for digital skills training also was constructed by Mike Nomura of the Institute for Advanced Technologies and can be found in Appendix A. This closer look at the Army digital skills training courses assisted our evaluation of the skills taught, the training strategies, and the utilization of Distance Learning (DL) technologies and techniques in use today.

Current DL implementations for digital skills training fall mostly in the categories of two-way video-teleconferencing (without learning management support packages) and traditional e-learning products, such as online “page-turner” manuals and simple multimedia presentations. Few products contain learning support, assessment features or rich media.

Most U.S. Army digital skills training happens in the classroom or unit setting without distance learning technology support.

There is tremendous potential to incorporate DL technologies for immediate value-add to Army digital skills training.

## Research Conclusions

A gap analysis – the difference between "what is" and "what should be" – was applied to the research. The results of a gap analysis can provide insights into what is missing between goals and outcomes.

The analysis allows identification of opportunities for implementation of Distance Learning techniques and technologies. The strengths and weaknesses within the training regimen – noting those skills that are well-covered versus those that need more instruction and/or reinforcement – can be tracked. Significantly, patterns emerge that can direct efforts toward high-impact variables: where the most critical needs can be addressed by DL and where the most significant gains or impacts can be realized.

Throughout the research, the processes and nature of expertise were considered as guideposts on how to improve performance, to increase retention and to build to higher-order thinking skills more rapidly in the training cycle (shorten the distance between crawl-walk-run).

The analysis of digital skills -their sorting into knowledge, comprehension, application, analysis, synthesis, and evaluation domains and their matching to instructional strategies-provided a framework with which to consider Distance Learning techniques and technologies appropriate to achieving learning objectives. Combined with the insights of the BCTC stakeholders and literature on digital skills training, digital transformation, and the cognitive science of learning, recommendations for improving training can be based on theory and practice.

Among the overarching recommendations:

- Evaluate the effectiveness, implementation and support requirements of any new learning technology through focus group and field testing trials;
- Maximize training time with Distance Learning environments that support self-development and informal learning opportunities;
- Develop instruction in small learning chunks that can be accomplished in short bursts;
- Structure core curriculum to use various types of delivery methods (integrate multiple training methods – and learning technologies – into the program of instruction);
- Provide more information management and help resources – "just in time" information, reference documents, job aids and other performance support tools – in training and operational environments;

- Use learning portals such as the Army Knowledge Online (AKO) and the capabilities of the Defense Communications Tool Suite (DCTS) to support communities-of-interest and communities of practice as self organized learning networks;

- Integrate training of computer skills with training of battle command skills;

- Develop and use automated performance measurement and feedback tools for diagnosis of learning needs and for delivery of appropriate training;

- Provide more in-depth introductory training that enables knowledge and comprehension of the purpose and value of digital systems to the whole of mission objectives;

- Introductory training must begin with an overview of the entire system and a soldier's role within that system. Interacting with other systems must be introduced early in training and be an integral part of sustainment training to gain an understanding of the system interrelationships;

- Pull higher-order thinking skills into introductory and operator courses;

- Use small learning groups that enable peer support and tutoring, expert modeling, and flexible roles;

- Provide reach-forward to After Action Reviews (AAR) and Center for Army Lessons Learned (CALL) to instructional designers, trainers and learners;

- Keep instruction scenario- and problem-based; focus on accomplishing tasks and mission rather than buttonology;

- Focus learning performance on the successful completion of the products of Military Decision Making Process and other artifacts common to the TOC;

- Integrate analog and digital training in preparation for plugged and unplugged operations;

- Provide a variety of instructional resources from which soldiers can select for skill remediation or sustainment. Use the paradigm of "show-me-how," "tell-me-how," and "let-me-do" instructional activities;

- Provide training support materials for day-to-day use of digital tools in garrison; and

- Use software simulations and remote control applications to provide distance "hands on" equipment exercises.

Also, focus early and often on the most critical skill requirements. Criticality sorting is a method of identifying key performance tasks, time on task and impact of task outcomes. The most important – and repetitive – tasks within both analog and digital TOCs involve battle tracking with graphics and overlays, monitoring and maintaining situation maps, evaluating situations, preparing recommendations and acting upon orders. In a report on battle staff training requirements in digital units (Felton et al. 2003), battle staff non-commissioned officers ranked, in order of importance, their training needs as follows:

- Digital Skills
- Battle Tracking
- Military Decision Making Process (MDMP)
- Intelligence Preparation of the Battlefield (IPB), and
- Plans and Operations Orders (OPLAN/OPORD).

Common, collective and critical battle command tasks should be reinforced in all cycles of digital skills training and should set the context for all instructional content.

## *Recommendations and Scenarios*

Based on the research analysis – grounded in a classical instructional systems design approach of analyzing digital skills content and learning objectives, learner characteristics, theories of learning and instructional strategies, and media selection techniques – recommendations for Distance Learning interventions are provide with solution scenarios as examples.

Recommendations are based on practical considerations of effectiveness, ease of implementation and training support requirements, time and cost savings, context of use across Army training domains, sensitivity to reusability and ease of updating content, and most importantly from the perspective of the critical needs identified by BCTC stakeholders and the Army research literature on digital transformation.

The recommendations consider near-term, intermediate and long-range solutions. That is, technologies that are readily available now (near-term), that can be realized in the next two-three years (intermediate), or that may take five-plus years to develop and deploy (long-range).

The technologies selected represent 12 primary applications of Distance Learning:

1. Interactive Multimedia Instruction (IMI)
2. Computer-Mediated Communications (CMC)
3. Software Simulations
4. Remote Control of Applications
5. Knowledge Bases
6. Intelligent Tutoring Systems
7. Low-level Desktop Simulations
8. Digital Aids
9. Electronic Performance Support Systems (EPSS)
10. Automated Performance Assessment and Feedback
11. Massive Multiplayer Online Games (MMOG)
12. Agent-Based Systems

These categories represent a current "snapshot" of digital distance training applications; it is by no means exhaustive or conclusive of the rapid evolution of online learning environments. In truth, many of these tools are being combined for more comprehensive and sophisticated tool "suites" rather than being used as single-point solutions.

The best learning solutions often incorporate multiple tools and variable usages to maximize learning personalization and customization. The integration of these toolsets form the basis of a proposed "fluid learning system" that is articulated in Task D "Digital Warrior Architecture" of this research subcontract.

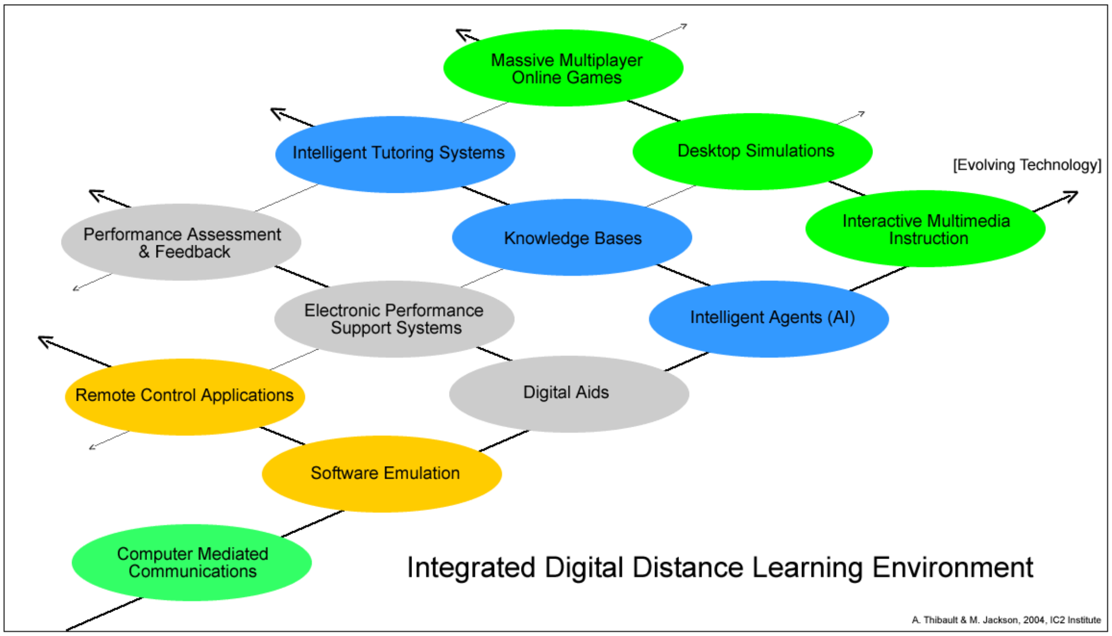


**Figure 12 Combined Instructional Technologies Create Integrated Digital Learning Environment**

## Interactive Multimedia Instruction (IMI)

IMI is an excellent choice for introductory courses and self-paced individual learning. This is the present state of practice for delivering web-enabled interactive instruction. It can provide various levels of interaction and assessment and can be used when there are a large number of learners distributed throughout multiple locations. There are two delivery approaches for IMI; one is stand-alone IMI that is delivered off line, as through a CD-ROM, and the other is delivered online over the Internet/Intranet.

Good IMI includes three main components: 1) unlimited and self-paced access to the learning content, 2) assessment and feedback features, and 3) a practice environment.

The BCTC's *ABCS Introductory Training* and the PEOC3T's *ABCS Overview* CD are great examples of IMI for digital skills.

We recommend that more introductory training be provided through IMI tools. The training should focus on the C4ISR system's features and the benefits of the features. This type of training is more like marketing or "awareness" training and provides "know-that" versus "know-how" information (Feldstein, 2004).

There are numerous authoring tools to create IMI. They vary in feature sets such as assessment and learning management capabilities and levels of interactivity. Price points and requirements for expertise to use the authoring tools also vary considerably.

A low-cost, simple to use tool is Impactica for Powerpoint. This application allows the author to animate, add voice narration and stream Powerpoint presentations over the Internet. The compression technology within the tool reduces file size by 95%. Since the Army uses Powerpoint as its chief presentation software, it would be easy to adopt this technology.

A more costly solution (in both price point and the knowledge acquisition for usability), but one that yields more features and interactivity, is represented by IMI authoring tools such as Blackboard and WBT's TopClass. These are widely used in the public schools and higher education by educators with little technical experience or training.

Among the most robust toolsets – and therefore representing highest price and time resources of personnel – are the high-end multimedia authoring tools such as Macromedia's Director, Flash and Authorware. Technical programmers, artists and interactive designers are required to build learning products with these tools (Feldstein, 2004).

## Computer-Mediated Communications (CMC)

CMC is communication that is exchanged over a computer network. It provides collaboration features such as chat, whiteboards, shared applications, audio, document storage, instant messaging, and video conferencing.

CMC technologies already are widely used by the Army. The Defense Collaboration Tool Suite (DCTS) includes many consumer-off-the-shelf (COTS) CMC products, including NetMeeting, CUSeeMe, and Envoke. Other tools such as Groove Networks – a rich collaborative suite of tools for conferencing, file sharing, chatting, sharing calendars, and more – are being rapidly adopted by the Joint Interoperability Test Command (JITC).

We recommend that since the DCTS is already the approved communications and collaboration suite of the Army and Joint Forces, that it be further extended to support digital skills training through self-development, peer collaboration and technical support.

Collaborative peer-to-peer spaces can be formed for community-of-interest and community-of-practice learning, shared desktop application utilities can be used with remote users, and training content be delivered through DCTS.

Another option is to use the DCTS as a "wrapper" application around the digital systems for soldiers to access additional help and learning resources not embedded in the digital systems themselves.

Another toolset to note within the CMC category are the Live Virtual Classroom technologies. This technology goes beyond traditional two-way video-teleconferencing to enable sophisticated, multi-participant online learning environments that contain numerous learning support tools. Presentations can be viewed live or made available for asynchronous, on-demand playback. Among the most popular and stable tool suites for Live Virtual Classrooms are MediaSite Live, WebEx, and Eluminate.

## Software Simulations

There is tremendous growth in COTS software simulation authoring tools on the market. A few common criteria for selection of an appropriate software tool include ease of use of the simulation tool, flexibility, compatibility, hardware platform, authoring support, and ability to put simulations on the Internet.

There are three types of authoring tools for software simulation that have emerged on the market (Feldstein, 2004). The first type of authoring tool allows training developers to import screen captures, assemble them along a timeline and add interactions through scripting. These tools are inexpensive but are time-consuming to produce learning content and require instructional design expertise. KnowledgeQuest's Expert Author is an exemplar of this tool set.

A second class of authoring tool captures what the author sees on the video monitor and records all the activity. After recording the task in real-time, the author can add text and other instructional elements. These tools do not offer very sophisticated experiences, but are inexpensive and not difficult to produce. TechSmith's Camtasia Studio and Macromedia's Robodemo are market leaders in this category.

A third class of authoring tools is just emerging that can actually understand the interactions between the user and the software. More costly and time consuming to produce, these authoring tools include intelligent "performance support" tools to provide instant feedback and cues to learners. The current best tools in this new market line are Epiance's Epiplex and Knowledge Product's OnDemand.

Software simulations can be great additions to Operator training for sustainment and delta training. They also can be chunked in small, discrete instructional units to be used as job aids throughout the training cycle.

## Remote Control of Applications

Remote control applications span a wide range of applications, from huge server farms hosting multiple applications, to remote users, to simple desktop control features that reboot, shutdown, or restart a single machine remotely.

Simple machine-to-machine connections can be made with software tools such as Expertcity's GoToMyPC, Symatec's PC Anywhere, and CrossTec's NetOp Remote Control.

Other remote control systems such as Robotel provide hardware-based computer collaboration features that enable instructors, in computer-classrooms, to teach, train, coach and interact with their students in a simple, real-time manner.

A more complex solution is offered by Citrix that consolidates access to applications and information on centralized servers. The user desktop is never touched, and the application can be deployed or updated instantly.

An example of the Citrix solution in the Army context of digital skills training is the ABCS Proof of Principle (PoP 3) or Secure Distributed Digital Training System (SD2TS) project that demonstrated remote control of applications via a thin client login into a secure server farm. A single rack of servers maintaining the individual ABCS applications can be accessed from any remote, Internet-accessible location.

The value proposition for remote control of applications is that there is no need for light or hardened equipment. Standard commercial PCs or laptops can connect to the ABCS application via thin client. This reduces ABCS hardware/software requirements, at the same time ensuring the most current version of each system is being taught (no version control or upgrade issues to worry about at the remote site).

The disadvantage to this solution is the requirement of two PCs to support one learner, that is, the student PC and the server PC (the system only supports one user per server). Therefore, remote control applications require significant cost investments up front. Ongoing maintenance costs are nominal to any other IT network operations. Remote control of applications should be considered by Army DTF/CTCs.

Indeed, hands-on learning is the best way to learn digital systems. Maintaining numerous light and hardened installations of the application in numerous locations and on numerous systems is more costly than maintaining centralized servers.

## Knowledge Bases

A knowledge base is the storage of information about a domain represented in a machine-processable format. The knowledge can be rules, facts or other representations of information. The data is usually input manually and is sorted into an ontology specific to its domain subject. To remain current and relevant, knowledge bases must be maintained by humans, usually experts in the domain field.

The Army already uses simple knowledge bases in online portals such as the Army Center for Lessons Learned (CALL). Knowledge is retrieved through engines that search databases.

But there are much more sophisticated knowledge management technologies that enable knowledge to be communicated and packaged for training.  Furthermore, good knowledge management maximizes organizational agility and innovation and enables the production and application of knowledge for learning across the organization.

Knowledge base systems provide direct access to expert knowledge and to subject matter experts (SMEs). Learners can benefit greatly from the previous experiences of others – much as the Army uses After Action Reviews (AARs) to capture and distribute pertinent knowledge. Information visualization aids such as topic maps and concept maps can provide learning supports to explore new information and scaffold new knowledge.

Improved natural language processors, semantic web and inference engine research, and intelligent agents are quickly advancing the state of knowledge bases into true knowledge management and knowledge generation tools (see Agent-Based Systems below and the Focused Knowledge Base project profiled in Task A of this subcontract).

Knowledge bases, as well as featured knowledge management tools, are widely used throughout industry and government; there are more than 1500 software solutions vendors for these markets, including SAP, IBM, Copernic Technologies, and Computer Associates.

Providing knowledge bases of technical information and field reports about ABCS practices and user experiences can enhance organizational learning and improve soldier access to learning resources.

## Intelligent Tutoring Systems (ITS)

An ITS provides structured representation of a specific knowledge domain, some kind of model of the learner, and inference rules that can reason about the models and generate learning strategies. ITS is an adaptive form of programmed instruction that monitors student activities and generates feedback.

There are many ITS solutions around; each one must behave intelligently, not actually be intelligent. They must be able to:

- accurately diagnose students' knowledge structures, skills, and styles
- diagnose using principles rather than preprogrammed responses
- decide what to do next
- adapt instruction accordingly
- provide feedback (Hartley and Sleeman, 1973)

The US Army is a long-time user of ITS, including systems for ABCS skills training such as the *FBCB2/Tactical Decision Making Intelligent Tutoring System*. Companies such as Stottler Henke Associates and MÄK Technologies work directly with the Research Development and Engineering Command-Simulation Technology Center (RDECOM-STC) in the development of ITS.

Because of its rule-based or inference capabilities, ITS is a good solution for training and sustaining digital TTPs.

## Low-level Desktop Simulations

Simulations offer certain advantages to training with actual equipment or in real job actions. They 1) offer practice environments for tasks too dangerous to be practiced in the real world; 2) increase the opportunity for practice on tasks that occur infrequently but should be kept up-to-date; 3) are available when the actual equipment cannot be used;

4) contain structured instructional features that enhance learning experience; and 5) provide cost savings to training on operational equipment (Howell, 2003).

Simulated practice environments are scenario- or case-based in design, provide task authenticity and fidelity, and can include simulated adversaries and teammates. Learning supports such as examples worked, skill scaffolding, feedback and coaching, increased learner control, open and exploratory learning environments, and highly structured learning events can be included in the simulation (Howell, 2003).

An example of a best practice in low-level desktop simulation is the Digital Warrior proof of principle produced as Task C of this subcontract. The Digital Warrior proof of principle simulates a Tactical Operations Center (TOC) in which the learner acts as a battle captain engaged in battle tracking and command. The scenario is driven by task maps of digital TTPs and SOPs. A highly configurable scenario builder toolset allows for customization of essential scenario elements such as METT-TC (Mission, enemy, terrain, troops and weather, support, and civil considerations) for full-spectrum learning exercises. Pedagogical principles inform the learning, assessment, feedback, and learning supports within the system. See Task C, Digital Warrior Proof of Principle, and Task D, Digital Warrior Architecture, for more information.

Interactive desktop simulations can be applied as a low-cost alternative to simulators and field exercises. Desktop simulations should be considered in the training of individual and collective digital tasks. Appendix C contains two checklists regarding cognitive techniques and human factors to apply when simulating the operation of computerized systems.

There are a wide variety of authoring tools for simulation. The Macromedia Director and Flash products are popular tools for creating web-deliverable simulations.

Like other forms of interactive multimedia, the production requirements for good desktop simulation include specialized technical skills and significant development time. However, if modifiable content and context tools are included to allow adaptive reuse, the investment can realize significant benefits to ongoing training.

## Digital Aids

Digital aids are simply electronic job aids designed to facilitate correct performance of task by extending the user’s capability to retain and utilize information.

The Army’s products for MDMP are good examples of checklists and charts as job aids.

Good job aids provide little expository prose and enable learners to select the exact information they want to know (Feldstein, 2004). Digital job aids can take the form of small simulations of task steps, quick access to “how-to” descriptions in text or visual formats, and other features common to automated help desk systems, such as frequently asked questions.

We include in this category personal digital assistants (PDAs), also known as "handhelds." These small, mobile devices can easily be equipped for job aids. There are numerous software packages that can be utilized on PDAs and mobile phones. DataViz.com provides PDA access to Microsoft Office applications. Students can self-diagnosis problem learning areas with assessment software from Assessa.com. Animations and small simulations can be produced for handhelds with J2ME programming. The site Handango.com provides a good library of COTS applications for PDAs and mobile phones.

Also included in this category is automated helpdesk systems such as Computer Associates' Unicenter Service Desk. This suite provides online knowledge tools and self-service tools that include decision trees and natural-language searches of documentation.

Utilization of job aids can improve sustainment training along the entire spectrum of Army digital skills.

## Electronic Performance Support Systems (EPSS)

EPSS is meant to run simultaneously with other applications to provide support for the user in accomplishing tasks. An EPSS can provide as-needed information and deliver just-in-time training. As a knowledge support, the EPSS provides pertinent information and anticipates the user's knowledge needs to obtain and organize appropriate information. As performance support, EPSS pulls appropriate training packages and documentation, and can connect learners to other users and experts.

A good EPSS should provide a seamless environment with the application. There are various levels of sophistication of performance support software.

A basic example is the Microsoft Agent research (the little "Paperclip" helper that appears when using Microsoft Office products). With the Microsoft Agent authoring tools, developers can create a performance tool that monitors the learner activities within the application and provides information back through displaying text on screen or by computer-synthesized speech.

More sophisticated EPSS software such as Epiplex from Epiance provide network-based performance modules for workflow and performance support, training and simulation, knowledge management, collaboration, troubleshooting, and on-line administration.

## Automated Performance Assessment and Feedback

Assessment is an important component of effective training. It is used to evaluate student progress toward learning goals and to provide students with guidance and feedback to improve performance.

The best type of assessment tools integrate seamlessly into the instruction to measure authentic performance. But traditional assessment tools, such as multiple-choice questions, can be used to test knowledge recall. In online environments, the assessment component is the main method for feedback. It provides learning progress status to the student and can help in the development of metacognition (learning how to learn). Assessment and feedback enables students to be strategic in their own learning process.

Automated assessment tools can track and monitor many learners simultaneously and provide important information to the instructor about learner needs, enabling adaptation of instruction to meet identified needs.

The Army may consider using both norm- and criterion-referenced assessment models (normative assessment uses the achievement of the group to set standards; criterion assessment establishes standards based on the achievement of defined performance objectives). Also, self-assessment tools tend to work best when combined with feedback and guidance from instructor.

One immediate use of assessment for digital skills training is to place soldiers into the appropriate training courses. Soldiers interviewed in classes at the BCTC and in field exercises noted that much of the training information they receive is repetitive and that they often must wait through long portions of known content. A remedy to this dilemma is to pre-test knowledge and sort soldiers into required training needs areas.

There are a number of easy-to-use web-based test generation tools – such as WebQuizBuilder  and Questionmark software– that could be used to properly sort students into the classes that they need; or that could be used to connect them to the online resources they most need.

Learning Management Systems such as WebCT and Blackboard have assessment components that are widely used by corporate trainers and academic educators.

Among the best in class in online assessment tools – in terms of security, usability and feature sets – are Vantage's IntelliMetric, and Prometric's Test Development/ Delivery/ Management Services.

Technical skills certification testing tools are available from PearsonVUE.

## Massive Multiplayer Online Game (MMOG)

MMOGs allow many players to interact within an immersive game environment simultaneously through the Internet. Developed first as entertainment video games, common MMOG genres include role-playing games, real-time strategy games, and first-person shooter games.

MMOGs extend scenario simulations to a massively distributed level, with many players competing and/or cooperating. James Paul Gee in his book *What Video Games Have to Teach Us About Learning and Literacy* (2003) notes the ability of game environments to "situate meaning in multimodal space through embodied experiences to solve problems and reflect…" (Gee, p. 48).

Gee further argues that digital games exemplify good pedagogical practices and salient aspects of how people learn: Human learning occurs in context, is active, is social, and is reflective.

The U.S. Army is investigating the use of MMOGs for training and recruiting purposes. The *America's Army* recruiting title has attracted more than 1,000,000 users. And the Army has partnered with There Inc. to develop a game in which multiple players battle in an asymmetrical, virtual environment.

The main constraints to using "games for learning" in the military training domain are the high costs of development. Immersive, realistic and challenging 3D game worlds can cost anywhere from $2 million to $40+ million to develop.

Rapid diffusion of digital media technologies – including commercial game engines – means production toolsets are available and cost levels are affordable for wider adoption. However, the personnel expertise to create games requires a highly specialized team of designers, artists, programmers, media producers, and interactive instructional designers.

Whereas there is no clear proponent in the traditional Army training community, these technologies deserve further examination for their massive scaled training opportunities (Kauchak, 2003).

## Agent-Based Systems

Agent-based systems employ artificial intelligence, machine learning, and the monitoring of user activities to provide performance assistance and information management services. Some examples of tasks that can be provided by agent-based systems are intelligently directed data mining, automated or semi-automated application management, and productivity management.

Agent-based systems must interoperate with client applications and databases running on one or many computers. It is a non-trivial function of information architecture and requires engineering expertise of client-side and server-side software and hardware.

The machine agents may communicate with humans using combinations of text, graphics, speech, facial expression and voice recognition. They also may communicate directly with other systems and users to affect processes.

Intelligent agents have been compared to "personal assistants" or "private tutors." Some people call them "dumb agents" because of the difficulty to create machine-algorithms that mimic human cognitive processing and context sensitivity. But the field of agent-based technologies is developing rapidly, especially in neural networks (mimic nervous systems) and expert systems (mimic cognitive processing).

In the Task A technology audit of this subcontract, several artificial intelligent research projects are outlined, including the Neuro-Evolving Robotic Operatives research at the $IC^2$ Institute. This research has important implications to the ability to create intelligent and adaptive non-player characters (such as Red forces) within simulations.

The future evolution of agents will revolutionize training as machine-intelligent systems better serve human learning and performance improvement. Its implication for Army training is this: The training platform, will be the planning platform, will be the rehearsal platform will be the execution platform; meaning training, rehearsal, and execution platforms will interoperate seamlessly.

In the near future, the agent will become the common interface.

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