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The UCLA Center for Research on Evaluation, Standards, and Student Testing (UCLA/CRESST) and CRESST's subcontractors, University of Southern California Behavioral Technology Laboratory (USC/BTL), the University of Southern California Rossier School of Education (USC/RSOE) and CHI Systems, Inc., have successfully completed the tasks and associated deliverables identified in the Statement of Work distilled from the additions and deletions due to the six grants awarded over the four years of the Knowledge, Models, and Tools to Improve the Effectiveness of Naval Distance Learning (KMT) project. This Final Report summarizes six grants, the tasks, and deliverables. The deliverables are provided as attachments to this report.

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Final Report

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Knowledge, Models and Tools to Improve the Effectiveness of Naval Distance Learning

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FINAL REPORT

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Abstract

The UCLA Center for Research on Evaluation, Standards, and Student Testing (UCLA/CRESST) and CRESST's subcontractors, University of Southern California Behavioral Technology Laboratory (USC/BTL), the University of Southern California Rossier School of Education (USC/RSOE) and CHI Systems, Inc., have successfully completed the tasks identified in the Statement of Work distilled from the additions and deletions due to the six grants awarded over the four years of the Knowledge, Models, and Tools to Improve the Effectiveness of Naval Distance Learning (KMT) project and associated deliverables.

This Final Report summarizes six grants, the tasks, and deliverables. The deliverables are provided as attachments to this report.

Introduction

The Office of Naval Research (ONR) Capable Manpower Future Naval Capability (FNC) program is dedicated to exploiting technologies that will help Sailors and Marines be fully prepared to fight and win in an information-rich, distributed battlespace. The Knowledge, Models, and Tools to Improve the Effectiveness of Naval Distance Learning (KMT) project addresses one of the three Enabling Capabilities identified by the Capable Manpower FNC: "Equip Sailors and Marines with effective mission-essential competencies when and where needed at an affordable cost." It responds to all the objectives specified for the Advanced Distance and Distributed Learning Supporting Technology identified the Capable Manpower FNC as required to achieve this Enabling Capability. These objectives are:

- Develop traditional courseware with learner support tools optimized for Advanced Distributed Learning (ADL) delivery, using ADL coursework authoring capabilities and pedagogically sound principles.
- Develop guidelines and demonstrate effectiveness of ADL techniques in operational settings.
- Develop and demonstrate advanced learner support tools including collaborative and team training methods for ADL.

Grants, Tasks, and Deliverables

Work on the KMT project was supported by six grants awarded over four years. Each grant either redefined tasks and deliverables, deleting or elaborating on some and adding others, making it difficult for the reader to track what was to be done. To clarify KMT tasks and deliverables, we provide this historical narrative summarizing the six grants and their effects on tasks and deliverables and conclude with a consolidation of these effects into a final list of tasks and deliverables.

1. The Initial KMT Grant

To support these objectives, CRESST received a grant in December 2001 to perform the following tasks over a three-year period of performance. The grant funded the first of the three years of the KMT project.

1. Conduct Ethnographic Studies
2. Develop Distance Learning Assessment Models
3. Develop Learning Environment Infrastructure
4. Prototype and Develop Distance Learning Guidelines
5. Test the Distance Learning Guidelines
6. Develop Learner Support Strategies
7. Transition Results to the Operational Environment
8. Program Management

CRESST was responsible for Tasks 2, 7, and 8. Task 1 was performed by a subcontractor, CHI Systems, Inc. A second subcontractor, the University of Southern California Behavioral Technology Laboratory (USC/BTL),[1] performed Task 3. A third contractor, the University of Southern California Rossier School of Education (USC/RSOE), was responsible for Tasks 4, 5, and 6.

2. Amendment to the Initial KMT Grant

In December 2002 an amendment to the initial grant was funded for a three-month effort to (a) complete our FY02 activities in the human performance assessment and authoring areas, (b) refine the design of the Human Performance Knowledge Mapper, (c) improve the validity studies associated with its use in Marine Marksmanship, and (d) submit a set of revised guidelines created to support instructional and assessment authoring, with documentation of the guidelines development methodology. Activities (a), (b), and (c) are extensions of Task 2 above. Activity (d) was an extension of Task 4.

3. The KMT Grant for the Second Year

In December 2002 CRESST received a grant for the second of three years of the KMT award. This award redefined the tasks to be performed. The revised task list is summarized below:

1. *Develop Version 2.0 of the Human Performance Knowledge Mapper.* Enhanced authoring flexibility for measurement of declarative and procedural knowledge; enhanced flexibility for scoring, setting standards, and

[1] USC/BTL was renamed the USC Center for Cognitive Technology (USC/CCT) in 2005. To avoid confusion, the name USC/BTL will be used throughout this final report.

reporting; trials in one or two Navy task(s); documentation; scientific validity study(ies); and reports.

2. *Develop Version 1.0 of the Human Performance Problem Solving Mapper.* Program functionality to represent critical relationships and decisions in Human Performance Problem Solving; trial in embedded Navy task(s); scientific study of technical quality and validity; adaptation of authoring system; documentation; design version 2.0; and reports.
3. *Develop Version 1.0 of the Complex Human Performance Problem Solving System.* Finalize design; implement in software for Web administration, scoring and reporting; apply to one or two Navy task(s); conduct pilot study and study of technical quality; documentation; design version 2.0; and reports.
4. *Develop Assessment Decision Support Tools.* Prepare technical and policy papers on psychometric and statistical issues in implementing the Five-Vector Model; conduct data analyses using available or simulated data; adapt CRESST software to be used to aggregate individual performance reports to provide data ultimately needed for the Five-Vector implementation; and reports.
5. *Develop iRides Performance Simulation-Instruction Delivery System and Authoring System.* Voice I/O capabilities; advanced graphics capabilities; improved student records/data foundations; automatic collection of performance records; extend core instruction features (action monitoring); efficiencies, performance tuning (speed, memory footprint improvements); integrated simulation and instruction authoring; simulation and instruction debugging; integration of COTS graphics authoring and simulation authoring; instruction templates and template interfaces; authoring with instructional strategies; documentation; and reports.
6. *Develop Draft Human Performance Learning and Measurement Guidelines.* Develop draft guidelines in Metacognition and Motivation; implement 02 Guidelines in Navy and Marine example(s); implement Metacognition and Motivational guidelines in Navy domains with examples; self-monitoring instructional module implementation in Navy domain; conduct validity study; and reports.
7. Program Management

This redefinition resulted in a major revision of KMT tasks. First, it eliminated Task 1 and CHI Systems, Inc., as a subcontractor. CHI's first-year work is included in the interim report on rifle marksmanship described below and attached to this final report. Second, the original Task 2, "Development of Distance Learning Assessment Models," was decomposed into three more specific tasks—the new Tasks 1, 2, and 3 above—in addition to development and testing of non-mapper

assessment models. Third, the two original guidelines tasks, Tasks 4 and 5, were combined into the new Task 6. Fourth, the initial Task 6, Develop Learner Support Strategies," was dropped. The initial Task 3 is not affected, corresponding to the new Task 5.

4. The KMT Grant for the Third Year

In January 2004 CRESST received a grant for the third of three years of the KMT award, to continue work on the tasks described above.

5. An Investigation of the Reliability of Knowledge Measures

In January 2004 CRESST also received funding added to the KMT award to conduct an investigation of the reliability of knowledge measures through relational mapping in joint military environments. The purpose of this task was to use the CRESST knowledge-mapping system to assess individual trainee knowledge (i.e., a trainee maps his or her understanding of the domain using the online knowledge mapping tool), and then conduct generalizability and decision studies to examine the psychometric properties of knowledge mapping scores to evaluate the suitability of knowledge mapping as an assessment of trainees' understanding of joint mission-essential tasks.

6. Performance Assessment Tools for Distance Learning and Simulation

In November 2004 CRESST received funding added to the KMT award to build performance assessment tools for distance learning and simulation. The goal was to produce a knowledge-map assessment authoring system that can be used to generate performance assessments integrated with an instructional simulation toolkit provided by a subcontractor, the University of Southern California Center for Cognitive Technology (CCT). The authoring system will support Navy and contractor instructional design/development personnel who are not assessment experts to develop performance-based assessments, including specification of scoring, consistent with modern practices and focused on assessing deep understanding of a domain such as equipment maintenance. The assessments can be embedded in instruction delivered through a simulation-based training system.

The Consolidated Task List and Deliverables

Table 1 summarizes the final, consolidated list of KMT tasks and deliverables distilled from the additions and deletions due to the six grants awarded over the four years of the project. For each task, the table identifies the grant in which it became a requirement, the performer responsible for its completion, and the associated deliverable, designated by a letter, A through F. Deliverables are identified in Table 2. The letter designations correspond to those used in Table 1 to associate tasks to deliverables.

Table 1

The Consolidated List of KMT Tasks and Deliverables

Task	Grant	Performer	Deliverable
1. Conduct Ethnographic Studies (Year 1 only)	1	CHI Systems, Inc.	A
2. Development of Distance Learning Assessment Models	1	UCLA/CRESST	A, B, C
3. Develop Version 2.0 of the Human Performance Knowledge Mapper	2	UCLA/CRESST	D, E
4. Develop Version 1.0 of the Human Performance Problem Solving Mapper	2	UCLA/CRESST	D, E
5. Develop Version 1.0 of the Complex Human Performance Problem Solving System	2	UCLA/CRESST	F
6. Assessment Decision Support Tools	2	UCLA/CRESST	G
7. Develop iRides Performance Simulation-Instruction Delivery System and Authoring System	2	USC/BTL	H
8. Develop Draft Human Performance Learning and Measurement Guidelines	2	USC/RSOE	I
9. Transition Results to the Operational Environment	1	UCLA/CRESST	J
10. Investigate the Reliability of Knowledge Measures	5	UCLA/CRESST	K
11. Performance Assessment Tools for Distance Learning and Simulation	6	UCLA/CRESST	L
12. Program Management	All	UCLA/CRESST	

Table 2

KMT Deliverables

Designation	Title
A	Interim Report: Research on USMC Marksmanship Training Assessment Tools, Instructional Simulations, and Qualitative Field-Based Research
B	Determinants of Rifle Marksmanship Performance: Predicting Shooting Performance with Advanced Distributed Learning Assessments
C	New Tools and Methods for Assessing Risk-Management Strategies
D	CRESST Human Performance Knowledge Mapping System
E	CRESST Human Performance Knowledge Mapping Tool Authoring System
F	An Architecture for a Problem-Solving Assessment Authoring and Delivery System
G	Psychometric Issues Related to the Five-Vector Model
H	iRides Performance Simulation / Instruction Delivery and Authoring Systems
I	What Works in Distance Learning: Guidelines
J	KMT Transitions
K	An Investigation of the Reliability of Knowledge Measures Through Relational Mapping in Joint Military Environments
L	Performance Assessment Tools for Distance Learning and Simulation

Deliverables

Each deliverable is described in the following sections and is attached to this Final Report. The exception is KMT Transitions, which is only described in this report.

A:

Interim Report: Research on USMC Marksmanship Training Assessment Tools, Instructional Simulations, and Qualitative Field-Based Research

The Office of Naval Research (ONR) has funded the UCLA National Center for Research on Evaluation, Standards, and Student Testing (CRESST) and its subcontractor, the University of Southern California Behavioral Technology Laboratories (BTL), to conduct research on the integration of assessment models and tools with instructional simulation authoring and delivery tools designed to support Navy and Marine Corps distance learning (DL). An assessment model is a formal specification of tasks and measures producing data that can be used as evidence to

support inferences about what the learner knows. For this project the assessment models and tools provide precision measurement, analysis, and diagnosis of learner performance guiding selection and delivery of remedial training through the instructional simulations. ONR is also funding CHI Systems, Inc., to conduct field-based qualitative research on Navy and Marine Corps DL implementations to develop practical guidelines and procedures to support effective DL employment in the Navy and Marine Corps.

The initial focus of these research efforts was USMC marksmanship training at the Camp Lejeune Weapons Training Battalion. CHI Systems, Inc., conducted a qualitative field-study-based approach to assess the effectiveness of existing DL while the CRESST/BTL effort used the marksmanship training context to explore new options for DL assessment and training. Following intensive knowledge acquisition to build an appropriate marksmanship knowledge base to guide assessment development and scoring, CRESST created and pilot tested several DL-delivered assessment tools including knowledge mapping, a prior knowledge questionnaire, shot group depiction, a background survey, a self-regulation survey, and an assessment of rifle marksmanship measuring Marines' skill at identifying proper and improper firing positions. Data are still being analyzed, but preliminary results indicate that such cognitive measures in combination with background information can indeed predict shooter performance and do it as well as or better than far more expensive and time-consuming measures. CRESST's data recently collected at Camp Lejeune's Stone Bay Rifle Range indicate that a combination of background variables and cognitive measures predict qualification scores with a multiple regression coefficient of .59. Benchmarks for comparison are the best results obtained using performance on a rifle simulator (Hagman, 1998), which show a correlation of .69, and a Marine's most recent qualification score, which shows a correlation of .40.

To enable use of assessment results in selecting and delivering remedial training, BTL and CRESST have developed and prototyped a way to integrate assessment results and interactive distributed training. Simulations and simulation-centered training modules for marksmanship training were developed using BTL's iRides authoring and delivery systems. iRides and iRides Author, originally developed with ONR support, have continued to be enhanced and extended in the current ONR-sponsored project. Simulation-based training modules have been developed for the Battlesight Zero procedure and shot group analysis. Additional

modules on creating the proper sight picture and data book usage are under development.

CHI's field-based, qualitative study of Marine Corps marksmanship training employed extensive interviews with trainers, trainees, and administrators to provide an overall assessment of training quality. CHI found widespread dissatisfaction with current Phase I training, because of the inconsistency with which it appears to be conducted. Existing advanced technology was found to be little used. Extensive "down time" for the Indoor Simulated Marksmanship Trainer (ISMT) since its introduction has led trainers and trainees to have little confidence in its availability during the brief Phase I training. Problems (whether real or perceived) of skill transfer from the simulator to the real firing range also deterred ISMT usage. In addition, limited number of available computers constrained use of the digitized marksmanship ADL course. The course was also not integrated into the Phase I curriculum in a clear way, leading trainers away from its use.

The combined efforts of CHI, CRESST, and BTL provide an overall picture of the current state of DL in USMC marksmanship training and prototype assessment and instructional simulation tools of potential benefit to USMC marksmanship training through early identification and remediation of Marines likely to shoot poorly. Early identification and remediation could lead to savings in travel cost, time away from the Marine's home unit, the coaches' time on the firing line, the use of firing range capacity, and the cost of ammunition and targets. In addition to savings, early identification and remediation could lead to higher scores overall, fewer UNQs, and more Experts. To realize these potential benefits, the following work should be completed. The first two tasks would require transition funding.

- Validation of the assessments' ability to go beyond prediction of overall shooting performance to identify specific knowledge gaps, predict the impact of the missing knowledge on shooting performance, and identify the remediation required to fill the gap.

- Shrink-wrapping, bullet-proofing, and validating a complete assessment and training package based on the prototypes.

- Qualitative studies of the results of fielding the assessment and training package produced with transition funding, including analyses of how organizational processes adapt (or need to adapt) to make effective use of DL delivery, and guidelines and a supporting case study helping the Navy (via NETC) and Marine Corps (via the DLC) better design and employ DL.

In addition, the following work might be considered for additional R&D funding:

- Integrating assessment and training with the forthcoming Marine LOMAH (Location Of Miss And Hit) system. This may make it possible to assess shooting performance directly and automatically, and to select appropriate training modules based on that performance.

- Hand-held assessment and training modules. These could be used to teach data book activities in the context of real shooting environments, with automatic evaluation and feedback. Advice could be provided on the firing line, and instructors could be automatically alerted about problems. If integrated with the LOMAH system, these hand-held devices could also provide feedback and advice about actual shooting performance.

The deliverable is attached to this Final Report.

B:

Determinants of Rifle Marksmanship Performance: Predicting Shooting Performance with Advanced Distributed Learning Assessments

The UCLA National Center for Research on Evaluation, Standards, and Student Testing (CRESST) is under contract to the Office of Naval Research (ONR) to conduct research on assessment models and tools designed to support Navy and Marine Corps distance learning (DL). The first such application is in support of USMC marksmanship training. In a series of studies we examined the role of cognitive and non-cognitive variables in the prediction of rifle marksmanship performance. Prior research on predicting shooting performance suggests a deceptively complex task sensitive to a variety of variables. The stages-of-skill-development model (Ackerman, 1987, 1992; Fitts & Posner, 1967) suggests cognitive measures will be most sensitive to individuals in the learning phase, and perceptual-motor measures most sensitive to individuals past the learning phase. The role of cognitive variables (knowledge of shooting in particular) is largely unexplored beyond examination of shooting performance across groups receiving different training and instruction.

In a series of studies we were able to predict record-fire performance between .52 to .86, depending on the sample. Bivariate correlations between various measures and record-fire scores were obtained in the .2 to .8 range. Perceptual-

motor measures—intended to reflect experience—were consistently a good predictor of performance. The most recent record-fire score predicted record-fire score at the .3 to .4 range. The best single predictor of record-fire score was the firing line experience survey, which yielded correlation coefficients from .6 to .8. Cognitive measures (aptitude and knowledge related to marksmanship) in less experienced samples related to record-fire score in the .2 to .4 range. No relationships between record-fire score and knowledge measures were found in the more experienced sample. Affective measures (worry, anxiety) predicted record-fire scores in the -.3 to -.6 range and in general, for the affective and firing line experience measures, state measures had coefficients of higher magnitude than the trait versions.

Overall, we have gathered evidence that in general suggests a knowledge component to shooting performance. The results of our studies point to differences in knowledge of rifle marksmanship between participants' pre-classroom training and post-classroom training, between more experienced participants and less experienced participants, between high performers and low performers, and between higher aptitude and lower aptitude participants. Knowledge measures can predict record-fire scores moderately in less experienced samples, and when combined with other variables within the stages-of-skill-processing framework, can predict record-fire scores as well as scores from a rifle simulator.

Rifle marksmanship is a complex psychomotor skill sensitive to variations in the individual, equipment, and environment. It is unlikely that variation in the equipment and environment can be reduced much, thus leaving the individual as the only area for improvement. Given that we have found a cognitive component to rifle marksmanship performance, it may be that improving a Marine's knowledge of rifle marksmanship will have the most cost-effective payoff. Early identification and remediation could lead to increased cost savings in travel, decreased time away from the Marine's home unit, increased throughput on the firing line, increased time coaches spend providing feedback to shooters on the firing line, and lower ammunition and target costs. In addition to cost savings, early identification and remediation could lead to higher scores overall and fewer unqualified Marines.

The deliverable is attached to this Final Report.

C:

New Tools and Methods for Assessing Risk-Management Strategies

At the request of the Office of Naval Research (ONR), we provided the U.S. Navy two tools to help evaluate the process that novice acquisition officers use to integrate risk-management strategies with the federal military acquisition process. The Human Performance Knowledge Mapping Tool (HPKMT) was designed to evaluate the ability of subjects to depict the relationships among the key phases in the acquisition process and subject understanding of risk management. The Decision Analysis Tool (DAT) allowed subjects to use Expected Value and Multi-attribute Utility Theories to evaluate the risks and benefits of various acquisition alternatives, and allowed us to monitor the process subjects used to arrive at a procurement decision. When we evaluated the HPKMT knowledge maps of 17 subjects against expert maps developed by their instructors, we found that subject understanding of incorporating risk management in the acquisition process trended higher, but did not improve significantly. Sequential analysis of data from the DAT allowed us to isolate distinct risk-management strategies, as well as strategies that overly focused on (or ignored) aspects of risk management. The use of a referent to determine the conceptual relationships and strategic acquisition skills necessary to be a skilled acquisition officer are discussed as extensions of this work.

The deliverable is attached to this Final Report.

D:

CRESST Human Performance Knowledge Mapping System

CRESST designed and developed a knowledge mapping tool intended to measure content understanding. The deliverable presents a review of knowledge mapping scoring methods and current online mapping systems, and the overall design, functionality, scoring, usability testing, and authoring capabilities of the system. While there exist several tools available to construct knowledge maps, CRESST's knowledge mapping tool is one of the only systems designed specifically for assessment purposes, the only system that can support multiple assessment formats, and the only system with an empirical base. Limitations of the system and possible next steps are discussed.

The deliverable is attached to this Final Report.

E:

CRESST Human Performance Knowledge Mapping Tool Authoring System

Effective delivery of advanced distributed learning (ADL) training to individuals in a Naval environment requires tools to support the creation and administration of assessment tasks. We have developed a knowledge mapping authoring system intended to be simple and user-friendly in its interface, but highly functional, requiring a minimal number of clicks to navigate. The authoring system is intended to allow a diverse set of users to create, modify, adapt, and reuse knowledge mapping tasks. Various scoring options provide information on student performance on different dimensions and at different levels of stringency. The system stores student data and thus performance can be monitored over time. This report introduces knowledge mapping and provides guidelines on the creation of knowledge mapping tasks, and then describes the operation of the CRESST Human Performance Knowledge Mapping Tool Authoring System.

The deliverable is attached to this Final Report.

F:

Architecture for a Problem-Solving Assessment Authoring and Delivery System

This report describes the design of an authoring system to support the design of problem-solving assessments. A key component underlying the system architecture is a constraint network. In a constraint network, nodes are variables that can assume a range of values and the topology specifies how the variables and values are related (Montanari, 1974). To support assessment design, the system design includes a constraint network describing the permissible relations and states among assessment and problem-solving variables.

The deliverable is attached to this Final Report.

G:

Psychometric Issues Related to the Five-Vector Model

The Navy's five-vector model provides a comprehensive specification of the requirements for performance-based advancement of military personnel. The effectiveness of the model for making performance-based advancement decisions will depend heavily on the psychometric quality of the individual measures and on

the psychometric models that are used to combine the information from the measures that comprise each of the vectors of the model. The psychometric challenges related to the five vectors have some things in common, but each of them also has some unique considerations. We begin by considering the vectors one at a time, and then discuss challenges in combining information across the five vectors to make performance-based advancement decisions. The results of our analysis suggest that it is likely that the measurement information will vary across and within vectors in terms of validity and reliability, that the profile of information is likely to be uneven across vectors, and the information from one vector may even conflict with that from another vector. These properties can be expected to make the tasks of combining and integrating the information across vectors quite challenging.

The deliverable is attached to this Final Report.

H:

The iRides Performance Simulation / Instruction Delivery and Authoring Systems

USC/BTL developed *iRides,* an advanced system for delivering authored interactive graphical simulations and instructional vignettes. The system provides the ability to deliver simulation-based instruction in three ways: as Java applications, as Java applets, and as Java Web Start applications. The latter two options make it possible for these authored interactive graphical simulations and training to be delivered over the Web or any similar network, thereby supporting advanced distributed learning.

A new authoring tool, iRides Author, was developed for developing simulations and instruction that iRides can deliver. This tool is a Java application that provides drawing tools, behavior authoring and behavior debugging interfaces, and instruction authoring and instruction debugging interfaces. The instruction approach supports the development of novel instructional "routines" that can be authored in XML and reused in multiple contexts. The iRides instruction authoring system can be easily extended to provide simple user interfaces that support the development of instruction using such instructional templates.

The applet version of iRides can be delivered as a SCORM-compliant shareable content object (SCO). This feature is currently being exercised in a Marine Corps transition project, in which an iRides SCO collaborates with the MarineNet Learning Management System (LMS).

An additional tool for authoring iRides simulations and training was also produced. This tool, Rivets, is a fast C++ program that has been compiled for three different Unix-type operating systems: Linux, Silicon Graphics IRIX, and Macintosh OS 10.3 or later with X11. It is now possible to author iRides simulations and training on a variety of platforms, including all the Windows platforms from Windows 98 to the present.

The flexible and open architecture of iRides makes it possible to employ this tool in collaboration with other advanced training system components, such as intelligent tutors. Additional work remains to be done to make iRides a plug-in component that can be used with a variety of advanced tutoring system approaches.

The deliverable is attached to this Final Report.

I:

What Works in Distance Learning: Guidelines

Guidelines were produced by using experts to compile research-based knowledge using a standardized format. The following list summarizes guideline categories and experts who developed them:

1. Multimedia Strategies, by Richard Mayer
2. Instructional Strategies, by Richard Clark
3. Learning Strategies, by Myron Dembo and Linda Gubler Junge
4. Assessment Strategies, by Eva Baker, Zenaida Aguirre-Munoz, Jia Wang, and David Niemi
5. Motivation Strategies, by Richard Clark
6. Self-Regulation Strategies, by Harold F. O'Neil and Sanhui (Sabrina) Chuang
7. Management Strategies, by Edward Kazlauskas

A paper version was created and transitioned to the training and education community as a published book. The deliverable, the published book referenced below, is attached to this Final Report.

O'Neil, H. F. (2005). *What works in distance learning: Guidelines*. Greenwich, CT: Information Age Publishing, Inc.

J:

KMT Transitions

Work performed on the KMT project has led to two transitions: (1) marksmanship assessment tools transitioned to the USMC Weapons Training Battalion with $701,000 in 6.4/6.5 funding from the USMC College of Continuing Education; and (2) a risk management decision tool transitioned to the USN Engineering Duty Officer (EDO) School with no additional funding.

The USMC Rifle Marksmanship Coaches Course Toolset

The USMC Weapons Training Battalion seeks to enhance rifle marksmanship proficiency at reduced cost by use of assessment tools measuring knowledge of fundamentals of rifle marksmanship. Four products, collectively called the Rifle Marksmanship Coaches Course Toolset, have been transitioned.

The Evaluation of Shooting Positions module is a Web-based tool that allows the user to manipulate a virtual shooter on a computer display to judge whether the shooter's position is proper or improper. If the user judges any element to be improper, the Marine can adjust the shooter to the proper position. Scoring is automated to enable cost-effective online use in distance learning.

The Data Book Training module provides Web-based interactive training on the use of the data book, used by every Marine to record actual shooting performance and consequent adjustments of rifle sights based upon wind conditions, distance to target, and firing speed. The module also provides interactive training on sight picture, battle sight zero (BZO) and shot group analysis. Learner performance is scored automatically.

The Marksmanship Knowledge Mapper assesses deep understanding of marksmanship knowledge—concepts and procedures and how they're related, with automated scoring to make it cost-effective. The Fundamentals of Marksmanship task delivered by the Mapper assesses knowledge of the cause-effect relations among marksmanship fundamentals. A separate Shot-to-Shot Analysis tool was initially developed as a mapping task but was transitioned into a standalone Web-based module. The Shot-to-Shot Analysis tool assessed the learner's knowledge of the relation of shot patterns to shooter problems, e.g., breath control.

The Marksmanship Inventory Knowledge Assessment module is a Web-based survey measuring a student's knowledge of marksmanship fundamentals that can be quickly administered with automated scoring prior to or following instruction.

Funding for the USMC transition was provided by the USMC College of Continuing Education (CCE): $531,722 in FY04 and $168,582 in FY05, for a total of $700,304.

The USN EDO School Decision Analysis Tool

USC/BTL's iRides system was used to build an application for modeling decisions where it is possible to estimate the probability and utility of the possible outcomes of a series of such decisions. This application can be used to practice this approach to complex decisionmaking. It can also provide instruction about its own usage and about case studies depicted in its interface. The EDO School faculty has incorporated this tool into portions of the EDO basic class.

Deliverables A and B describe the KMT-funded research leading to the USMC transition. Deliverable C describes the research leading to the USN EDO School transition.

K:

An Investigation of the Reliability of Knowledge Measures Through Relational Mapping in Joint Military Environments

The goal of this task was to gather evidence on the effectiveness of online knowledge mapping as a method to assess high-level understanding of specific military domains and tasks. We used the CRESST Human Performance Knowledge Mapping Tool (HPKMT) to assess individual trainee knowledge and then examined the psychometric properties of knowledge mapping scores to evaluate the suitability of knowledge mapping as an assessment of trainees' understanding of joint mission-essential tasks.

Students attending the Joint Special Operations University in Hurlburt, Florida, created three knowledge maps for three content areas: Air Tasking Order (ATO) cycle, Joint Task Force Structure and Function (JTF), and Joint Special Operation

Task Force Structure (JSOTF). Because an insufficient number of participants was provided, we were unable to complete the planned generalizability analysis, but analyses of scoring techniques yielded important information about the quality of the knowledge maps, and the assessments provided valuable information regarding student understanding of JSOU course content.

The student maps were analyzed using three methods: automated criterion-based (expert) assessment, propositional analysis, and structural mapping analysis. The criterion-based assessment showed significantly lower scores for the students as compared to experts for both tasks. The propositional analysis found that the expert and student use of terms and links were fairly proportional, with some exceptions. The structural analysis revealed differences between expert maps and student maps, and differences among students' maps relative to structural complexity. In general, the expert maps had more terms; variable use of source, sinks, and carriers; numerous clusters; and high reachability. Additionally, a comparison of a sample of student maps revealed similar patterns, with more sophisticated maps containing a higher number of terms, links, and clusters as well as level of reachability. In addition to these research results, we were able to create a standalone version of the mapper that has been used in subsequent studies for the military.

The deliverable is attached to this Final Report.

L:

Performance Assessment Tools for Distance Learning and Simulation

Performance assessment tools for distance learning and simulation were developed by extending the UCLA Center for Research on Evaluation, Standards, and Student Testing (UCLA/CRESST) knowledge mapping tool's authoring and scoring functionality and providing the capability to embed a knowledge mapping assessment in simulation-based training developed by the University of Southern California Center for Cognitive Technology (USC/CCT). Products are described in detail including the knowledge mapping tool with authoring and scoring systems, performance-based assessments, an instructional simulation providing interactive training, and the performance-based assessments embedded in the instructional simulation.

The deliverable is attached to this Final Report.

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Baker, E. L., & O'Neil, H. F. (2006). Evaluating web-based learning environments. In H. F. O'Neil & R. S. Perez (Eds.), *Web-based learning: Theory, research, and practice* (pp. 3-20). Mahwah, NJ: Lawrence Erlbaum Associates.

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