THE EFFECTS OF COGNITIVE READINESS IN A SURFACE WARFARE SIMULATION

by

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DEDICATION

I dedicate this dissertation and doctorate degree in Educational Psychology and Technology from the University of Southern California to my mother Mrs. Amalia Barriere, my grandmother Maria E. Barriere, my aunt Maria Timotea Rivas (who taught me how to read and write in Spanish), and my grandfather Luis David Barriere whose wisdom and powerful story telling inspired me to be who I am today. Thank you for all your prayers, unconditional love and support. I owe you for who I am today.

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ABSTRACT

This study investigated the effects of cognitive readiness in a Navy simulated environment, the simulation being the Multi-Mission Team Trainer. The research question that drove this study was: will simulations increase cognitive readiness? One of the tasks of Navy sailors is to deal with unpredictable events. Unpredictability in the military is considered to be one of the major characteristics, especially in battle. These officers must be prepared to react to these complex and unpredictable environments and simultaneously sustain competence in their performance. In this research such performances were driven by cognitive readiness. Increasing cognitive readiness amongst sailors can result in being able to recognize patterns in chaotic situations, modify problem solutions, and implement plans of action.

This investigation was composed of a pilot study and a main study at the US Navy. The pilot study examined specific problem solving measures in simulation. The design involved measures before and after the Multi-Mission Team Trainer. All sailors (participants) took the cognitive readiness measures (domain independent measures) that were composed of a problem solving questionnaire (control strategies, self-efficacy, effort and perseverance, worry, and elaboration), teamwork questionnaire (adaptability, coordination, decision making, interpersonal, and leadership, and communication), and a creativity questionnaire

(fluency, flexibility, originality, and elaboration). The measures from the pilot study were the same used for the main study. All scales have acceptable reliability.

The main study included fifty four participants and three instructors who were given the same measures from the pilot study. The domain specific problem solving questions that were given to students included one retention, and one transfer question. Thus, the retention of participants was 24% and the transfer of participants was 9%. The significant cognitive readiness findings included higher levels of teamwork interpersonal and leadership skills, and creativity- elaboration ($p=.05$), following the simulation. Self-Efficacy and retention showed to be positively correlated. Creativity-flexibility and fluency resulted to be negatively correlated to transfer. This study could contribute to the understanding about increasing the cognitive readiness of US Navy sailors in order to be able to respond to unpredictable and complex events in a competent way.

CHAPTER I: INTRODUCTION

Background of the Problem

In the Navy sailors often train using simulations. Through simulations sailors are trained through realistic scenarios. The goal of this training is to increase their problem solving skills in order to transfer such skills to novel and real life situations. Unanticipated tactics, new technological capabilities, novel applications of existing technologies, and surprise are often characteristics of combat engagements (Fletcher 2004). Since the most predictable characteristics of military operations is unpredictability, how do we prepare military personnel for the unexpected? (Fletcher, 2004).

The context for this research is in the Navy's South Coast Naval School (SCNS-pseudonym). The goal of is to provide a continuum of professional education and training in support of Surface Navy Requirements that prepares officers to serve at sea.

The South Coast Naval School offers a four level continuum of training from entry level officer training aboard ship up to senior officers assigned to major commands. The four levels of course are designed to train division officers, department heads, prospective executive officers, prospective commanding officers, and those selected for major commands. Each course is taught by officers of higher rank that have more experience and that require higher levels of knowledge, skills, and attitudes (Fox, 2007). The department head course is the second of the four levels of the South Coast Naval

School courses and is intended for officers with mid-level responsibilities aboard ship. This study focused on training sailors in air defense simulator and surface warfare - Multi- Mission Team Training. The Multi-Mission Team Trainer is a simulation used in the South Coast Naval School which provides tactical sensor, command, and control for simulations by ship and air combat. The simulator Multi-Mission Team Trainer also provides the necessary tools to train combat team supervisory personnel in the tasks that they must perform during the course of a mission. The Multi-Mission Team Trainer is designed to be a re-configurable multi-platform trainer. This study investigated the effects of cognitive readiness in a Navy simulated environment, the simulation being Multi-Mission Team Trainer.

Purpose of the Study

The purpose of the study was to increase the cognitive readiness of sailors who would be using the Multi-Mission Team Trainer. Cognitive Readiness is the mental preparation (including skills, knowledge, abilities, motivation, and personal disposition) an individual needs to establish and sustain competent performance in the complex and unpredictable environment of modern military operations (Fletcher, 2004).The Multi-Mission Team Trainer was adopted as the simulator due to the feasibility in the South Coast Naval School. The general problem in training is how to improve the results of training by providing the best training and assessment possible.

Moreover, the definition that will be used for this research is that of O'Neil, Perez, and Baker (in preparation). Cognitive readiness denotes the mental preparation for effective changes in response to altered situations in this fast- changing world. The term readiness denotes in the military a preparation or readiness to be effective in mission. Such term is used to distinguish combat readiness from combat effectiveness. O'Neil, Perez, and Baker (in preparation) view cognitive readiness through a knowledge, skills, and attributes (KSA) lens, i.e., knowledge is domain specific, skills are domain specific and domain independent, but attributes are relatively domain independent.

Furthermore, simulations are important in the Navy setting because they outline the advantages of increasing safety, economy, environmental impact, and public relations. Furthermore, children and adults are required to interact with computers and simulators in all settings. Schools and organizations, and job training are finding that simulators are effective in reducing educational and training costs (Rifkin, 1994). There is also evidence that demonstrate that computer games and or simulations teach people more effectively (Cassidy, 2003; Jenkins, 2002). The frequency of computer games and simulation use, and the generated revenue show no signs of stopping or slowing. In 2004, $7.3 billion was spent on computer and video game software in the United States, breaking down eight titles every second of every day, according to the Entertainment Software Association (ESA) (2004). For these reasons it is imperative that we investigated the effectiveness of simulators, especially in the Navy.

Significance of the Study

This study attempted to analyze the effects of cognitive readiness in a surface warfare simulation and provide feedback for the Navy's Multi-Mission Team Trainer (air defense and surface warfare scenarios). The research on the effects of cognitive readiness in an air defense simulation and surface warfare simulation course was conducted in order to improve the problem solving skills in a Navy setting. In today's world, it is imperative that the training that sailors receive is effective and contributes to force readiness. Effective training is critical. In the Navy, sailors train using scenarios within training simulations. In addition, the goal for this research was to increase the knowledge of the role of cognitive readiness and simulation.

CHAPTER II

LITERATURE REVIEW

The literature began by defining what simulation is, the relevancy to the research, and the areas that are unanswered. It is expected that simulations will increase cognitive readiness. For example, it is expected that the increase of simulation will increase content understanding, problem solving skills, and self-regulation. Furthermore, the literature review explores the relevancy of cognitive readiness, and problem solving. The literature review was conducted by searching in PsycINFO, ProQuest, and PsycARTICLES, from the years 1990 to current. In addition, the researcher limited the search to English only, peer-reviewed journal articles or book chapters from 1999-2008. In addition to using search terms to find articles the researcher also reviewed the reference of several dissertations. However, for the purpose of this research the researcher used mostly online journal articles. The terms that were included for simulation were: *simulation games, computer games, simulation military, simulation Navy, and simulators.* The articles that were chosen were empirical studies which dealt with the Navy setting. There were nineteen articles on simulation/simulators that were found. However, only eleven were used in the literature review due to the relevance to this study. The article, a research review *Using Computer Games and Simulations for Instruction: A Research Review*

(2006) by J.D. Fletcher and Sigmund Tobias provided a condensed review of the literature from 1992 to 2005.

Simulation

Definition of Simulation

U.S. Navy units train in live, virtual, constructive, or mixed simulations of battlefield environments (Meliza, Stephen, and Goldberg, 2005). For the purpose of this study the definition that will be used, is the one stated by Gredler (1996). Simulations are a dynamic set of relationships among several variables. Simulations change over time and reflect authentic causal process. Many organizations are moving towards simulations due to the accessibility, flexibility, cost-effectiveness, and learning quality. The use of new technologies is justified by the premise that it can improve learner's learning. Gredler (1996), suggests the simulations may be particularly appropriate for teaching about ill structured content domains. In these domains authentic, complex, and dynamic problems are encountered that require flexible access to knowledge from various sources. Moreover, much of the evidence emerging from evaluations and explorations of simulation suggests that teaching institutions while they are pursuing the specific goals of efficiency and flexibility, many of the resulting courses lack the informed design capable of providing enhanced learning.

Live simulation refers to the most realistic type of simulation. Live simulations entail real people using real equipment and performing in real venues. The training can be dangerous because the participants are almost exposed to the same risk as in real life. However, the scenarios can be scripted, resulting in lessening the danger. The rules of engagement also play a factor and prevent lethal use of force (Brooks et.al, 2004; Yardley, Thie, Schank, Galegher, & Riposa, 2003).

Virtual simulation refers to real people operating simulated equipment in a simulated environment. Most of US military aviators receive their basic training in simulators. The last type of simulation is constructive. Constructive simulation refers to all elements being simulated, military personnel, equipment, and environment (Brooks et. al., 2004). For the purpose of this study, virtual simulation will be the focus.

Why is the use of simulations important in training? The merits of simulations include facilitating learning by doing and triggering motivation. Also the engagement of learners in a simulated experience of the real world, makes learning practical (Mayer, Mautone, & Prothero, 2002). Educators and trainers began to take notice of the power and potential of simulators for education and training back in the 1970's and 1980's (2002). Simulators were hypothesized to be useful for instructional purposes and provide benefits such as; (1) complex and diverse approaches to learning processes and outcomes (2) interactivity (3) ability to address cognitive as well as affective learning issues (4) motivation for learning (O'Neil, Wainess, & Baker, 2005).

Instructors in the military, medicine, and business setting have applied simulators for training (Mayer et al. 2002). By using simulations, military personnel can practice flying and combat skills; medical students can practice diagnosis skills; and business leaders can practice fiscal, economic trading, and managerial decision-making skills (Dempsey, Haynes, Lucassen, & Casey, 2002).

One of the major strengths of simulations is that they enable students to practice skills under realistic conditions and facilitate learning. Liberman and Linn (1991) argued that computer based simulations may be particularly useful in helping students to develop self-directed learning strategies, and in assisting students to apply knowledge in realistic settings O'Neil and Fisher (2004) conducted a literature review for games (mostly simulations) that concluded that simulations have the potential to facilitate learning in five ways: (1) enhance thinking skills (2) facilitate metacognition (3) improve knowledge and skills, (4) improve attitudes, and (5) promote motivation..

Dede (2005), also argued that learning in a well designed digital contexts can lead to the replication in the real world of behaviors in simulated environments. Schank (2005) agreed as well and stated that learning-by-doing is always more effective than learning-by-telling and that it is best accomplished through complex, high fidelity simulations that engage learners at the highest possible level.

Effective problem solving in a simulation can potentially place a large cognitive load on working memory (Sweller, 2006). Thus there is a need to have a scaffolding

component, while there are a number of definitions, what they have in common is that scaffolding is an instrumental method that provides support during learning by reducing cognitive load. These processes provide learning goals, monitoring procedures, feedback, selection methods, hints, prompts, and various advance organizers (2006).

Significance of Simulation

Simulations are used in many environments as a mechanism to train personnel and increase effectiveness. Measurements should be embedded in the simulations, both to facilitate the design, administration, scoring, and reporting of traditional forms of instruction and to evaluate interventions that use technology to teach (Baker & O'Neil, 2008). The long term benefit of combining technology and accountability is the intent to measure and report performance. Simulation also has other potential advantages, such as ensuring safety, overcoming training limitations, and protecting the environment.

Maximizing skills, like problem solving through simulation training is the goal. In order to do so, knowledge acquisition and retention in extremely short periods becomes tractable if there is comprehensive and accurate information on the trainee's background. The increase of metacognition skills could be potentially increased as a result of simulation.

Another effect of simulation is the thinking skills of information processing, reasoning, inquiry, creation, and learning strategies (O'Neil, 1978). Simulation had a role to play in enhancing cognitive skills and processes that also apply in educational

situations (Pillay, Brownlee, & Wilss, 1999). Researchers have argued that simulations help improve students' skills in practical reasoning (Wood & Stewart, 1987).

Also, the development of knowledge and skills are improved through simulation training. Simulation training requires interaction with virtual-world situations and could potentially lead to the improvement of complex real-world motor skills such as driving on highways or piloting airplanes (Arthur et. al. 1995). The benefit of such training was based on the fact that learners were exposed to various simulated situations, they developed knowledge of the different domains (Maguill, 1993).

Assessment of Simulation

There are multiple ways of assessing learning through simulators. O'Neil, Wainess, and Baker (2005) generated suggestions in a game context which can also be applied to simulation. For example, one could assess the training effects of a game by examining trainee's ability to solve criterion problems, their application of declarative and procedural knowledge, willingness to raise or lower game challenge, their self-reports, and records of their play. Evaluation questions to be answered about the cognitive and affective effects of games or simulators should concern the four levels of Kirkpatrick (1994).

Kirkpatrick's four levels of evaluation are known in the training industry. A four model consisting of (1) reaction, (2) learning, (3) behavior, and (4) results. According to

this model evaluation should always begin with level one and progress as time and money allows it, and move sequentially (Hoffman, 2004). Kirkpatrick described a four-level evaluation system that handles most of the questions anyone may want to ask about training systems. For the relevance of this study only two levels of Kirkpatrick might be used to evaluate the effectiveness of a simulator. Level 1, reaction and level 2, learning can be used as an evaluation tool.

Level 1 is reaction, the trainee's reaction to the program and their level of satisfaction. Level 2 is learning, the extent in which participants change attitude, improve knowledge, and increase skills (Mehrotra, 2001). Level 3 is behavior, occurs after the training, and is the extent in which change in behavior has occurred because the participant has attended the training program. Level 4, results, refers the organizations benefits and the final results due to the participant attendance (Clark & Estes, 2002).

Level 1 Reactions

Reaction evaluation is usually conducted with a few questions that ask participants whether they like and value the program. These questions can be asked before a program starts, during a program, and at the end of a program. Level 1 indicates people who are motivated to persist and to invest effort in the performance program. Positive reactions do not indicate whether they gained anything useful or will use information after the program is finished. Reaction information also does not tell you whether a successful program will support the organizational goals. The benefit of Level

1 information is that it tells you about the motivational impact on the participants (Mehrotra, 2001).

An example, is the study conducted by Baker, Prince, Shrestha, Oser, & Salas (1993), which surveyed 112 military aviators and their reactions to the Crew Resource Management simulation. Their reactions included that they felt good about learning, and most agreed on the importance of the Crew Resource simulator.

Level 2 Learning

Level 2 evaluation targets the impact of all programs while they are being implemented. If a knowledge gap is being closed with a training program, this level examines the learning that takes place during the training course. If a performance improvement gets off track, Level 2 serves as an early warning and an opportunity to make corrections. The assessment should be based on the task analysis used to design the training.

The evaluation conducted by Helmreich, Merritt, & Wilhelm (1999), which surveyed pilots in several organizations after completion of Crew Resource Management simulator stated that in level 2, learning, no specifications of skills were taught, decay in attitudes were not immediately apparent but some decay over time.

Level 3 Behavior

Level 3 is applying what the learner has acquired to real practice or on the job. The evaluation designed ensures that the program or training has a positive influence on job performance, for example a training transferring to a job.

Level 4 Result of the Program

Level 4 evaluation-results, is the highest level of evaluation in Kirkpatrick's (1994) evaluation framework, and most complicated. Salas (2001) pointed out the complexity of this level. Evaluators are looking for evidence that the programs have influence the organization by comparing pre and post test or experimental and control groups, to recognize the possibility that some variable s could have contributed to the results. For example, applying Kirkpatrick's framework for evaluating an aircrew training program (Salas, 2001), the researcher reviewed 58 published accounts of training programs to determine its cost-effectiveness, and found the results uncertain. However, as pointed out by the researcher (Salas, 2001), evidence shows the effectiveness of the program had been found, such as reduction in accident rates.

Summary of Simulation

Simulations are important in the Navy in order to facilitate learning and training. The literature suggests (O'Neil & Fisher, 2004) that simulations enable students to practice skills under realistic scenarios. As a result, simulations create a very important tool in the training of Navy personnel. The positive outcome of having simulators is that

it can increase the metacognition of sailors, develop level knowledge of different domains and be exposed to different environments. Moreover, simulations can assist the students in the assessment of performance. For example, simulations can track the student's ability to solve criterion problems, application of knowledge, self reports and records of their play.

Simulations can enable sailors to practice skills under realistic conditions in which can facilitate their learning and increase their cognitive readiness. A possible example, is that sailors can practice flying and combat skills and as a result be able to competently react to unpredictable environments. In conclusion, the literature finds (Sweller, 2006), that simulations provide learning goals, monitor procedures, provide feedback, prompts, assessments, and various advance organizers. Therefore, resulting in a crucial tool in the Navy to train and assess sailors. Furthermore, this study hypothesizes that simulators will increase cognitive readiness. The next section will define cognitive readiness and the relevancy to simulators.

Cognitive Readiness

This section reviewed the definition of cognitive readiness, the competencies of cognitive readiness that were used for this research (eg. problem solving, decision making, teamwork, and creativity), and the significance and assessment of cognitive

readiness. This study measured the effects of cognitive readiness by incorporating measures in a simulation environment.

Definition of Cognitive Readiness

Cognitive readiness is the mental preparation (including skills, knowledge, abilities, motivations, and personal dispositions) an individual needs to establish and sustain competent performance in the complex and unpredictable environment of modern military operations (Fletcher, 2004). Moreover, cognitive readiness can be conceived as a set of three basic abilities: 1. recognize patterns in chaotic situations, 2. modify problem solutions associated with these patterns as required by the current situation, and 3. implement plans of action based on these solutions (Fletcher, 2001).

Table 1 (below) has been adopted from Morrison and Fletcher (2001) and identifies ten competencies that form a basis for cognitive readiness. Competencies are defined as "sets of behaviors that are instrumental in the delivery of desired results or outcomes"(Bartram, Robertson, & Callinan, 2002, p.7). The competencies include: 1) leading and deciding, 2) supporting and cooperating, 3) interacting and presenting, 4) analyzing and interpreting, 5) creating and conceptualizing, 6) organizing and executing, 7) adapting and coping, and 8) enterprising and performing (Bartram, 2005).

Table 1: Fletcher's Cognitive Readiness Competencies

Situation Awareness	It is defined as the ability to perceive and comprehend oneself in relationship relevant to present environment (Endsley, 1988). It is measured by simulated operations. Practice and feedback in complex simulated environments have improved situation awareness.
Memory	Able to recall and/or recognize in the current operational situation patterns that will lead to likely solutions. The two theoretical mechanisms are encoding specificity and transfer of appropriate processing.
Transfer	Being able to apply what is learned in one context to a different performance context.
Meta-cognition	Execution function of thought to monitor, assess, and regulate one's own process.
Automaticity	Process that requires only limited conscious attention.
Problem Solving	Ability to analyze the current situation.
Decision-Making	Emphasis is on recognizing learned patterns and reviewing courses of action.

Mental Flexibility and creativity	Ability to generate, adapt, modify, to variable situations.
Leadership	Combination of technical, conceptual, ethical, and interpersonal competencies that encourage support to others.
Emotion	Able to perform complex tasks under the stress and confusion of modern military operations.

Moreover, O'Neil (in preparation) modified Fletcher's model (see figure 1). The O'Neil Cognitive Readiness Model provides a comprehensive framework for understanding, training, and evaluating cognitive readiness (O'Neil, Perez, and Lang, *in preparation*). In this model, three key constructs are shown; knowledge, attributes, and strategies. The knowledge includes domain-specific knowledge for developing cognitive readiness in the specific domain. There are eight competencies or skills: situation awareness, adaptive expertise, creativity, resiliency, problem-solving, adaptability, decision-making, and teamwork. This study will focus on four competencies that specifically apply to the South Coast Naval School setting: problem solving, decision making, creativity, and teamwork.

Figure 1: CRESST Cognitive Readiness Model (in preparation)

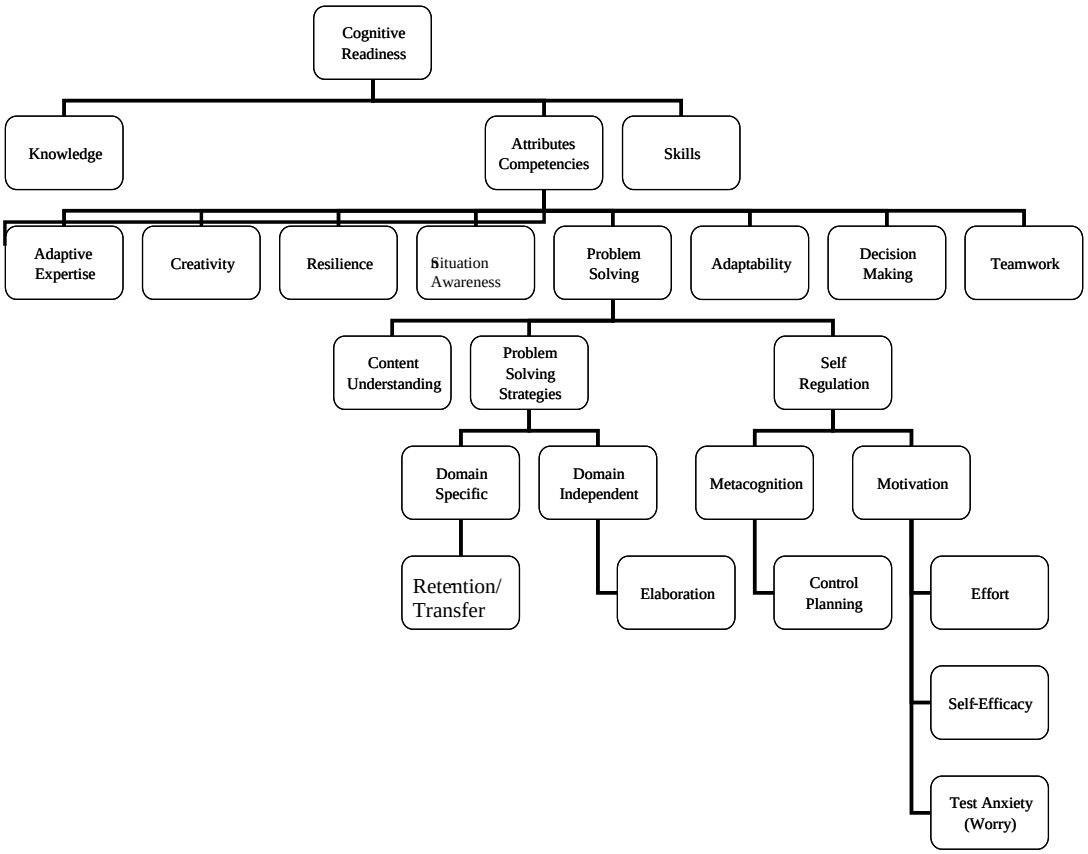


Table 2 defines the competencies of CRESST's cognitive readiness model (in preparation). However, four of the competencies (problem solving, decision making, teamwork, and creativity) were the focus for this research (O'Neil, in preparation). The bolding in Table 2 indicates competencies investigated in this research.

Table 2: CRESST's Cognitive Readiness Competencies

Adaptive Expertise	Entails a deep comprehension of conceptual structure of the problem domain. Knowledge must be organized and structures must be flexible. Adaptive experts understand when and why particular procedures are appropriate or not (Zaccaro & Banks, 2004).
Creativity	Includes the sensitivity to problems, fluency, novel ideas, flexibility, synthesizing, analyzing, complexity, originality, elaboration, and redefinition (O'Neil, Abedi, & Spielberger, 1994).
Resiliency	A class of phenomena characterized by patterns of positive adaptation in the context of significant adversity or risk (Masten & Reed, 2002).
Situation Awareness	Ability to perceive and comprehend oneself in relationship relevant to present environment (Endsley, 1988).
Problem-Solving	Problem solving is content understanding, problem solving strategies, and self-regulation (O'Neil, 1999).
Adaptability	An effective change in response to an altered situation (Mueller-Hanson, 2005).
Decision-Making	Use of information about their current situation to help evaluate the utility of potential courses of action (O'Neil, Chung, and Herl, 1999).

Teamwork	A trait of the individual that predisposes the individual to act as a team member. There a six processes: (a) adaptability, (b) coordination, (c) decision-making, (d) interpersonal, (e) leadership, and (f) communication (O'Neil & Baker, 2003).

Teamwork/ Decision Making

The measurement approach is to view teamwork skills as a trait of the individual that predisposes the individual to act as a team member (O'Neil, Wang, Mulkey, and Baker, 2003). A trait is a characteristic in a person that is relatively enduring (intelligence or personality). O'Neil, Wang, Mulkey, and Baker (2003), state that there are various definitions of teams. However, they state that the following are useful ones: (a) Teams are composed of two or more people who share a common goal. (b) Teams are composed of members of a working group identified as a team. (c) A team is a set of two or more people who interact dynamically, interdependently, and adaptively in working toward a common and valued goal who have been assigned specific roles and have limited life span of membership (Baker & Salas, 1992).

The taxonomy (O'Neil, Chung, & Brown, 1997) is made up of six teamwork processes. These skills include (a) adaptability- recognizing problems and responding appropriately; (b) coordination- organizing team activities to complete a task on time; (c)

decision making- using available information to make decisions: (d) interpersonal- interacting cooperatively with other team members; (e) leadership-providing direction for the team: and (f) communication- clear and accurate exchange of information.

Teamwork skills included decision making. *Decision-making* capability affects the ability to capitalize on available information. Effective teams use information about their current situation to help them evaluate the utility of potential courses of action. Effective individuals and teams employ decision making that takes into account all available information (O'Neil, Chung, and Herl, 1999). It is expected that decision making processes emerge when the nature of a relationship is unknown. Members need to assess the quality of the relationship based on their knowledge of the domain. It is expected that content knowledge play a significant role in how decision-making process play out.

Creativity

According to O'Neil, Abedi, & Spielberger (1994), there are many definitions of creativity but the one that was adopted is by Torrance (1989). Torrance has been involved in teaching and the measurement of creativity. According to Torrance (1989) creativity includes sensitivity to problems, fluency, novel ideas, flexibility, synthesizing, analyzing, complexity, originality, elaboration, and redefinition. Some of the factors underlying Torrance's definition of creativity and the Test of Creative Thinking are adapted from Guilford's Structure of Intellect Model.

Based on the constructs of the Torrance Test of Creative Thinking (TTCT), a multiple-choice paper- and- pencil test was developed. The purpose of developing this new instrument was to shorten the amount of time required for the administration and scoring of creativity tests. Abedi and Schumacher (2002) constructed a 60-item multiple choice test to measure creativity. The reliability and validity of this test were examined in the study conducted in Spain on a group of 2,270 students (Villa, Auzmendi, & Abedi, 1996). This study used data from the Spain Study (Villa, Auzmendi, & Abedi, 1996) and employs a latent-variable modeling approach for assessing reliability and concurrent validity.

Significance of Cognitive Readiness

The importance of cognitive readiness derives from the characteristics of unpredictability that the military personnel face in battle. According to Fletcher (2004), unpredictability is the most predictable characteristic of military operations. The cognitive readiness vision is to optimize the human contribution to joint war fighting, and achieve the revolutionary war-winning capability articulated in the Department of Defense Joint Vision 2010. According to the Department of Defense achieving cognitive readiness will ensure that the war fighter is mentally prepared for accomplishing the mission, the war fighter is performing at his/her optimal performance level, the tools and

techniques for preparing the war fighter are the most effective and affordable (Etter, Foster, and Steele, 2000).

Fundamentally, cognitive readiness focuses the science and technology efforts on addressing the critical need for increased capability and adaptability from the human component on weapon systems in a progressively more complex, dynamic, and resource-limited environment (Etter, Foster, and Steele, 2000). The joint war fighter is challenged by the potential of simultaneous, multiple, geographically separate, high-or-low intensity conflicts, as well as peacekeeping, counterterrorism, and disaster support missions.

Assessment of Cognitive Readiness

Cognitive readiness skills are trainable and assessable. O'Neil, Perez, and Lang (in preparation), provide an example of how situational awareness can be improved by conducting practice and feedback in complex, simulated environments. Metacognition can be improved by exercises designed to increase awareness of self-regulatory processes (Hacker, 2001). Problem solving abilities in many tasks can be improved through practice with feedback and learning (Fletcher, 2004).

Moreover, CRESST Cognitive readiness model (in preparation) can be used as a framework for model-based assessment. Each of the three key constructs of cognitive readiness- knowledge, attributes, and strategies- can be assessed individually. The assessment of the three constructs (e.g., the domain-specific knowledge, the competencies, and the specific skills) may denote cognitive readiness and can predict

performance (O'Neil, Perez, and Lang, in preparation). An example, that Bartram (2005) provides is that of the competencies being a framework for making predictions from measures of competency potential (ability, personality, and motivation) to ratings of actual work performance. Each of the eight predictors is shown to predict different area of job performance consistently across jobs, measurement instruments, and cultural contexts.

Some of the studies that O'Neil, Perez, and Lang (in preparation) stated which have evaluated cognitive readiness are that of Sommer, Whitman, Borkowski, Gondoli, Bruke, Maxwell, & Weed (2000). Another study conducted by Wood, Lugg, Hysong, and Harm, (1999) which dealt with psychological adaptation to extreme environments used questionnaires and a sliding scale ranging from 0 to 100 and open-ended questions.

Fletcher (2004) pointed out that many aspects of cognitive readiness can be measured and assessed but need systematic development. Fletcher (2004) points out that the reliability, validity, and the precision for the evaluation of cognitive readiness need to be developed.

Summary of Cognitive Readiness

In order to prepare units and individuals to deal with unexpected scenarios, cognitive readiness must be in place. Through cognitive readiness learners will be able to recognize patterns, modify problem solutions, and implement plans of action based on these solutions. Cognitive readiness provides a framework for understanding,

training, and evaluating. The key constructs that determine cognitive readiness are knowledge, attributes, and strategies. The main advantages of cognitive readiness and its competencies is that it also provides integrating measures in the domain, such as ability, personality, and motivation scales (Bartram, 2005).

Problem Solving

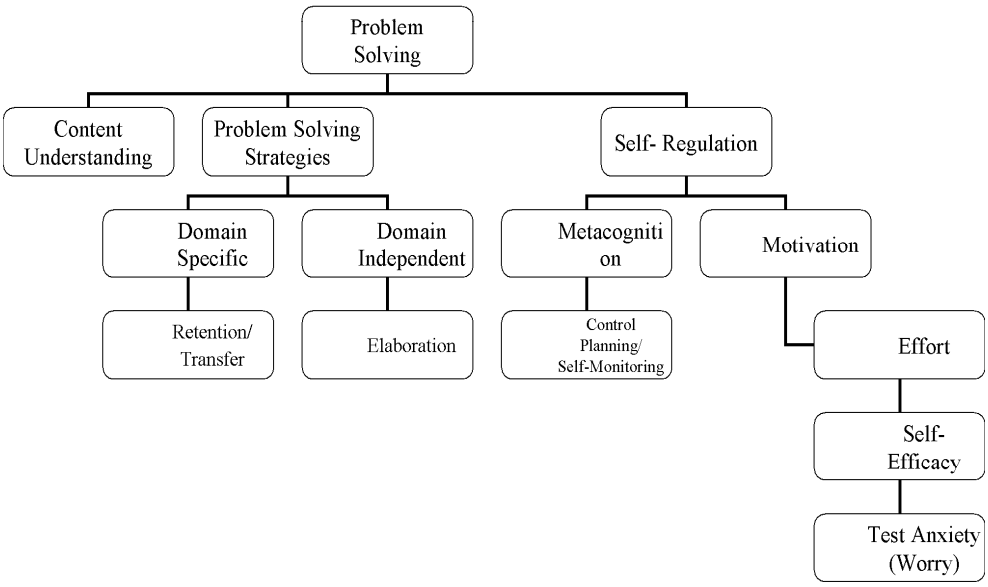
Problem solving is an important skill that is needed in training using simulations. Problem solving is one of the family of cognitive demands that can be required in many subject areas (Mayer, 1996). Problem solving skills fill a gap by allowing students to use what they have learned to successfully solve new problems or learn new skills. Mayer and Wittrock, (1996), state that problem solving is the "cognitive processing directed at achieving a goal when no solution method is obvious to the problem solver" (p.3).

Definition of Problem Solving

A problem exists when the solver has a goal but does not know how to reach it, so problem solving is mental activity aimed at finding a solution to a problem (Baker & Mayer, 1999). Problem solving has four characteristics: (1) cognitive- because it occurs in the problem solver and can only be inferred from behavior; (2) process-based because it manipulates or transforms knowledge; (3) directed- because it is intended to help achieve a goal that is not directly achievable, and (4) personal- because it depends on the existing knowledge and skills of the problem solver (Baker & Mayer, 1999).

The CRESST model of problem solving (1999) is adapted from the problem-solving models of Glaser, Raghavan, and Baxter (1992) and Sugrue (1995). There are three components of problem-solving, adopted from O'Neil (1999, 2007), which is the theoretical framework for this study as may be seen in figure 2. This model is analyzed into three components, content understanding, problem solving strategies, and self-regulation (O'Neil, 2007 revised).

Figure 2: O'Neil's Problem Solving Model (in preparation)



According to this model, a successful problem solver sailor needs to possess: (a) content knowledge- understand something, (b) problem solving strategies- have skills to solve problems, and (c) metacognition- plan and monitor problem solving progress, and (d) have motivation to solve problems (O'Neil, 1999).

The definitions of each construct for the O'Neil problem solving (in preparation) model are: *Content understanding.* In this problem solving model, the content understanding is the understanding of domain knowledge. It is defined as a person's ability to understand significant facts, procedures, concepts, and principles related to the domain knowledge of content (O'Neil, 1999).

Problem solving strategies. Problem solving strategies are categorized into domain-specific problem solving strategies and domain-independent problem solving strategies.

Domain-specific problem strategies are task-dependent strategies. Domain-specific problem solving strategies are strategies in a particular field of study or subject, such as the application of the tactical strategies (surface warfare) in the Multi-Mission Team Trainer question (Chen, 2005). In this study, domain-specific problem solving strategies will be the strategies sailors acquire to successfully complete the Multi-Mission Team Trainer. The following are the retention and transfer question.

Retention Question:

- Write an explanation of how you solve the tactical problem scenario.

Transfer question:

- Write some ways of improving the scenario used in the Multi-Mission Team Trainer.

Domain-independent problem strategies are general strategies. Domain-independent problem solving strategies are strategies that are not linked with a specific domain. Baker and O'Neil (2002) state, "Domain-independent analyses focus on the subject matter as the source of all needed information… domain independent analyses are those that attempt to capture the general strategies that are in us across subject matters" (p. 619).

Self-regulation. Self-regulation refers to the extent that learners are metacognitively, motivationally, and behaviorally active in the learning process to control their learning and reach their goals (Zimmerman, 1989). In this problem solving model, self-regulation is composed of metacognition and motivation. Metacognition includes planning/self-monitoring and motivation contains effort, self-efficacy, and test anxiety (worry).

In order to be effective in a simulation the process of self- regulation must take place in order to increase skill acquisition. Learners might not automatically self-assess, therefore one way is to have them periodically self-assess their progress. By making performance improvements salient, such monitoring should raise self-efficacy, sustain self-regulation, and promote skills (Pintrich & Schunk, 2002). Self-assessment enhances goal setting effects on performance when goals are informative of one's capabilities. In a study conducted by Schunk and Ertmer (1999), self-assessed learners were able to

produce comparable results when coupled with a process or product goal. Constant self-assessment can raise achievement outcomes.

Self-regulated learners are proactive to incorporate various self-regulated processes (e.g. goal setting, self observation, self-evaluation) with task strategies and self-motivational beliefs. Students who have been trained in self-regulation processes during learning, such as goal setting, self-monitoring, and self-reflection processes, display high levels of motivation and achievement (Shunk, 1996; Wook, Bandura, & Bailey, 1990).

Planning and self-monitoring are important characteristics of self-regulated learners. Self-regulated learners usually plan how to effectively check their progress (Zimmerman, 1998). When it is necessary, they will change their learning strategies or modify their goal (Zimmerman, 1998).

Motivation is defined as “the process whereby goal-directed activity is instigated and sustained” (Pintrich & Schunk, 2002, p. 5). Motivation is something that instigates people to learn, directs people to move forward, and sustains people to keep going on (Ormrod, 2006).

Effort is one significant index of motivation. Motivated sailors usually expend more mental effort to learn difficult material. Effort and self-efficacy are strongly correlated. Sailors who have high self-efficacy beliefs would like to spend more effort when a task is perceived difficult (Pintrich & Schunk, 2002).

Self-efficacy is identified by Bandura (1986, p.391) as “people’s judgments of their capabilities to organize and execute course of action to attain designated types of performance.” Self-efficacy beliefs contribute to motivation as well as student learning achievement. Students with high self-efficacy beliefs have a higher level of motivation and better achievement (Zimmerman, 1990).

Test anxiety refers to phenomenological, physiological, and behavioural responses to thoughts about negative events or consequences such as failure on an exam or an evaluative situation (Speilberger,1980). The phenomenological responses are categorized into two components: worry (cognitive) component and emotional (affective) component (Speilberger, 1980). Worry is the cognitions associated with test anxiety. When sailors have high test-anxiety, they are more likely to worry and will not be able to answer a question in a test or finish the test.

Significance of Problem Solving

An important conclusion from the researched literature (O’Neil, 1999) is that problem solving skills should be learned within the context of realistic problem-solving situations. This approach suggested the modeling of how and when to use strategies in realistic tasks. As technology becomes more integrated with problem solving it becomes increasingly more important to find ways of evaluating what students are learning through simulations.

Assessment of Problem Solving

According to Mayer (2002), problem solving is one of the most significant competencies whether in job settings or in schools, and, as a result, teaching and assessing problem solving has become one of the most significant educational and training objectives. Mayer (2008) argues that there are two forms of assessments: (a) tests of conceptual knowledge, including open-ended verbal questions involving troubleshooting, redesigning, and explaining; and (b) tests of strategic knowledge, including behavioral assessment of learners' strategies in solving transfer problems. Research in cognitive science suggests that problem-solving performance depends on the coordination of several different kinds of domain specific knowledge, including facts, concepts procedures, and strategies (Anderson, et. al., 2001).

O'Neil (1999) has pointed out that problem solving is a critical competency requirement of college students and employees. As a result, consistent and high quality assessments for problem solving skills are of importance. Reports or findings on problem solving assessment are thought to help trainers and organizations to assist in allocating resources to meet particular gaps (Baker & Mayer, 1999).

The CRESST model of learning, Baker (1995) posits five families of cognitive learning: content understanding, collaboration, communication, problem solving, and metacognition. The five families describe the range of cognitive learning in which

learners engage; they are seen as working together to influence overall learning. Content understanding is the first type of learning of subject matter content. Assessment of content understanding should evaluate not only basic factual knowledge, but also a deeper level of understanding of the subject area (Herman, 1992, Linn, Baker & Dunbar, 1991).

These assessment models includes the following activities: simulating prior content area knowledge, reading primary source documents containing new information, and writing an explanation of important issues that integrates new concepts with prior knowledge. Understanding is assessed by examining overall content quality, prior knowledge, principles, and use of resources (Klein, O'Neil, Dennis, Baker, 1997).

The value of assessing problem solving- processes is that data on such processes can provide evidence of what a learner is doing while carrying out a task. Process evidence can be used, to help evaluate the extent to which a task evokes expected problem-solving behaviors, help explain performance differences between subgroups, or aid in task validation. Measures of problem solving processes, when used in accordance with measure of knowledge and problem solving performance, can provide a more comprehensive picture of the learner.

According to Baker & O'Neil (2002), in order to improve quality of measurement in problem solving, four things must be considered: (1) intentions and

skills of assessment designers, (2) the range of performance that counts as problem solving; (3) ways in which validity evidence can be sought (4) the degree in which measurement produces results that generalize across tasks and contexts.

Problem solving can be a focus of computer interventions that are dedicated to a particular content area and for which appropriate solutions are known in advance (e.g. to land an F-14 on a carrier deck through simulation), where the goal is to determine whether the trainee has enough specific knowledge and strategies to accomplish one or more tasks needed to meet a known standard. The approach to solving problem is to determine the characteristics of challenging conditions (e.g. high seas for the aircraft carrier deck landing) and figure out which of a series of procedures to apply (Baker & O'Neil, 2002). A problem solving task may be very difficult, the learner may need strategies to apply in order to recover from error (e.g. danger to an aircraft or ship).

Another approach to the assessment of content understanding is to evaluate learner's underlying knowledge structures. Research on memory suggests that knowledge is complex semantic networks (Jonassen, Beissner, & Yacci, 1993: Rumelhart & Ortony, 1977). By eliciting learner's specific information from students we can attempt to assess these cognitive structures.

Measurement of Content Understanding

In the cognitive theory of learning, it is stressed that learned knowledge should be organized into long-term memory for later access (Mayer, 2008). The expertise literature suggests that experts' understanding of domain knowledge is awareness not only of the concepts but also of the connections among the concepts (Schau & Mattern, 1997). To assess content understanding CRESST has used both essay-based explanation tasks (e.g. Baker et. al., 1995) and knowledge mapping tasks (1995). A concept map is a graphical representation of information consisting of nodes and links or labeled links. Nodes correspond to concepts within a particular subject area or domain: links indicate relationships between pairs of concepts (or nodes), and labels on each link explain how two concepts are related. Learners create concept maps by identifying important concepts and generating and appropriately labeling the links between those concepts. This approach assumes that a deep understanding in a subject domain allows an individual to conceive a rich set of interrelationships among important concepts within that domain.

Simulators have the ability to capture process differences (Chung & Baker, 1997; Schacter, Herl, Chung, & O'Neil, 1999; Stevens, Ikeda, Casillas, Palacio-Cayetano, & Clyman, 1999) and provide a pattern of emerging competence based on time, strategy, and response of the learner. Second, simulators have the ability to make difficult-to-perceive processes visible. Third, simulators can provide online scoring and feedback.

Measurement of Problem Solving Strategies

Problem solving has to have an intuitive component (continual monitoring and understanding of context and changes) and a resulting level or degree of automaticity.

In dealing with simulations, problem solving can be in a third form, dealing with simulations and problems for which there is not a known solution, but present a fast changing scenario, for instance, with change of probability of existing faults occurring as "surprises" during the examination sequence. In this case the students, incorporates useful strategies in order for procedures or actions to optimize the outcome.

In simulations, learners can also demonstrate their expertise through certain tasks. In this environment the learner can submit the articulation of problem and receive feedback. The learner can apply their strategies and procedures to solve the problem (Baker & O'Neil, 2002).

Summary of Problem Solving

Problem solving strategies help students analyze a situation, help solve new problems and/ or learn new skills. The literature states (Mayer, 1990), that problem solving is the process of transforming a given situation into a desired situation when no obvious method of solution is available to the problem solver. The model that has been adopted for this proposal is the O'Neil's Problem solving model (revised 2007). The three components that will be analyzed are content understanding, problem-solving strategies, and self-regulation. The literature also concludes (O'Neil, 1999) that problem

solving skills should be learned within the context of realistic situations. Therefore, simulators are a vehicle to display such situations.

Problem solving skills are an imperative component in understanding the capabilities of sailors in the Navy. Therefore, it is important for sailors not only to acquire problem solving skills but also to be able to measure the process. The assessment can be both, evaluation of the search and evaluation of knowledge integration (Baker, et.al., 1995). According to Chung & Baker (1997), simulators can capture problem solving strategy differences and provide patterns of emerging competence based on time, strategy, and response of the learner. The goal is for sailors to increase their problem solving skills and transfer their capability to live scenarios.

CHAPTER III

Methods

Research Question

Research Question: Will a simulation increase cognitive readiness?

Hypothesis 1: There will be an increase of scores between the pre and post cognitive readiness questionnaire.

Research Design

In February 2008, the researcher conducted her study at the South Coast Naval School. In addition to her study, there was another study conducted simultaneously that focused on the formative evaluation of the Multi- Mission Team Trainer. However, this study focused on a specific task (surface warfare scenario) to test the cognitive readiness of sailors before and after the Multi- Mission Team Trainer.

The study was composed of two phases: a pilot study and a main study. The pilot and main study took place after it was approved by the USC Review of Human Subject (see appendix A). The pilot study was conducted in January 2008 and the main study was conducted in February 2008. The design involved measures before and after the Multi-Mission Team Trainer. In addition, the feasibility of the study procedures was investigated in order to make sure that lessons learned would be implemented for the main study. All students took a set of questionnaires that were given to assess the

environment, the feasibility and understandability of the procedures for participants and instructors. The questionnaire included three constructs of cognitive readiness. The four constructs were problem solving, teamwork, decision making, and creativity. There were a total of 117 items. The number of participants in the main study was fifty-four.

However, only fifty-two students out of the fifty-four took the open-ended questions as they stated they had a high stakes test to take (main study). In addition, three expert instructors were also given the open- ended questions that tested retention and transfer knowledge. The questions specifically pertained to the cumulative surface case scenario.

Pilot Study

The pilot study focused on one specific simulation, the Multi-Mission Team Trainer (MMTT). The scenarios were provided from the air defense module. There were three students participants who filled out the questionnaire and two instructors. The purpose of the pilot study was to understand if the environment was feasible and understandable for the participants and instructors, and asses the time that would take to fill out the questionnaire. Finally, the pilot study was conducted to find out participants' cognition towards the Multi-Mission Team Trainer and the entire simulation process.

The cognitive process mapper was going to be an alternative in case that the Multi Mission Team Trainer would not be feasible. The cognitive process mapper was

developed by CRESST (National Center for Research on Evaluation, Standards, and Student Testing) is considered to be an advancement of concept maps. It is a simulation for assessing content knowledge. The cognitive process mapper is composed of three sections, 1. data repository, 2. decision inventory, and 3. action item. For each item a value can be assigned indicating how important that particular datum or relationship is. This provides valuable assessment data on what the learner "thinks" about the information, and can elicit important errors in thinking, such as decision making biases (Wainess, 2007). However, the cognitive process mapper was not used.

Students were asked to create concept maps using software on a standalone personal computer. Figure 3 is a table of concepts produced and given to students. The items in the concept list are reduced per the guidance of the South Coast Naval School.

Figure 3: Table of Concepts

Build the map in five steps.

1. Place major ***Events*** in the appropriate distance region (*far*, *medium*, *close*).
2. Place ***Information Sources*** and connect them to the appropriate ***Events*** or other ***Information Sources***.
3. Place ***Purposes*** and link them to the appropriate ***Events***.
4. Place ***Tools*** used to implement events and link them to the appropriate ***Events***.
5. Add ***Actors*** and link them to the appropriate ***Events***, ***Information Sources***, or other ***Actors***.

CONCEPT

Event	***Information Sources***	***Purpose***	***Tools***	***Actors***
Engagement	Air Route	Employ Chaff	CIWS	AIC
ID	Altitude	Reduce RCS	Decoys	Air
Intent	Change	Unmask Batteries	Guns	DCA
Maneuver	Country of Origin		Surface to Air Missile	OOD
	ECM			TAO
	IFF			
	Illuminate (response to)			
	I&W			
	O/S Caps and Lims			
	Profile			
	Query			
	Speed			
	Threat Capabilities			
	VID			
	Warn (response to warning)			
	Wind			
	Wings Call			

RELATION

conducts
determines
has
orders
part of
recommends
supervises
to
uses

However, the Multi Mission Team Trainer ended being the most feasible simulation for this study.

Multi-Mission Team Trainer (MMTT)

The Multi-Mission Team Trainer (MMTT) provides tactical sensor and command and control (C2) simulation for use by ship and ship/air combat teams and strike group staff supervisory-level personnel. The Multi-Mission Team Trainer system supports a

wide range of training operations, it can be run as a stand-alone multi-ship/multi-aircraft trainer, or can be interfaced to existing training devices to upgrade or enhance current training capabilities.

The Multi-Mission Team Trainer system provides the necessary tools to train combat team supervisory personnel in the tasks that they must perform during the course of a mission; Develop the decision-making and communications skills of ship and ship/air combat teams and strike group supervisory-level personnel. The Multi-Mission Team Trainer is designed to be an easily re-configurable multi-platform trainer. It uses software modules to simulate generic shipboard and aircraft Combat Systems and console. Wherever practical, operating procedures for trainee stations have been modeled after procedures and formats implemented in the actual equipment that the station is designed to represent. The following are case scenarios given to students via the Multi Mission Team Trainer (see table 3) . For the purpose of the pilot study the air defense scenarios were adopted due to their feasibility. The air defense case scenarios were acquired from a colleague who had several experiences observing the Multi Mission Team Trainer and who had been working with the South Coast Naval School in various projects.

Table 3: Multi-Mission Team Trainer- Case Scenario- Air Defense

Scenario 1:	Commercial flight then a bad guy ID the commercial track ID the bad guy Shoot the bad guy down
Scenario 2:	Commercial and two bad guys in sequence ID the commercial track ID the first bad guy ID the second bad guy Reports Shoot the bad guys down
Scenario 3:	Same as scenario 1, but have an F18 ID the commercial track ID the bad guy Send the F-18 for VID, escort, and kill Reports Shoot the bad guy down
Scenario 4:	Same as scenario 2, but have an F-18 ID the commercial track ID the first bad guy (a MIG- 21, not a threat to the MEU) Send the F-18 for VID and escort- ideally no kill because the second guy is an MEU threat ID the second bad guy (SU-27, a threat to the MEU) Reassign the F-18 for VID, escort, and kill Reports Shoot the bad guy (s) down- ideally, the SU-27
Scenario 5:	Littoral and close to shore, so time pressure, peacetime, ideally don't shoot, two groups of three ships, one with an MEU ID commercial tracks, including Cessna Report

Table 4 explains the different acronyms and abbreviations in the air defense case scenarios.

Table 4: Acronyms and Abbreviations

Terms	Definitions
F-18	Airplane- Fighter (United States)
VID	Visual Identification
MEU	Mission Essential Unit
SU-27	Russian Design Jet Fighter
ID	Identification
MIG-21	Russian Design Jet Fighter

Participants

The participants consisted of three navy sailor students and two instructors. The three student participants completed the 117-item questionnaire and provided feedback on the questions. They also responded to the open-ended retention and transfer question on air defense case scenarios. The purpose of interviewing the two instructors was to obtain an expert opinion.

Measurement

Part of our methodology was to assess if sailors will demonstrate better cognitive readiness after a simulation. Therefore, a number of instruments were adopted for various measurement purposes. The cognitive readiness measure consisted of (a) problem solving questionnaire (b) teamwork questionnaire, and (c) creativity questionnaire.

Cognitive Readiness Measure

The cognitive readiness measure was composed of a problem solving questionnaire, teamwork skills questionnaire, and creativity questionnaire. The problem solving questionnaire was composed of three scales from the Student approaches to learning (SAL) questionnaire developed by the Organization for Economic Co-operation and Development (OECD, Artelt, 2005; Baumert et al., 1998; Baumert, Klieme et. al., 2000; Peschar, 2004). The reliability and validity of these three measures in the SAL questionnaire have been analyzed and validated by the cross national study conducted by Marsh et al. (2006). The self-regulation questionnaire also included a test anxiety scale adopted from the Test Anxiety Inventory (Speilberger, Gonzalez, & Taylor, 1980).

The following scales were included in the problem solving questionnaire for this study: Self-efficacy, control strategies, elaboration, effort and perseverance, and test anxiety.

Teamwork Skills Questionnaire

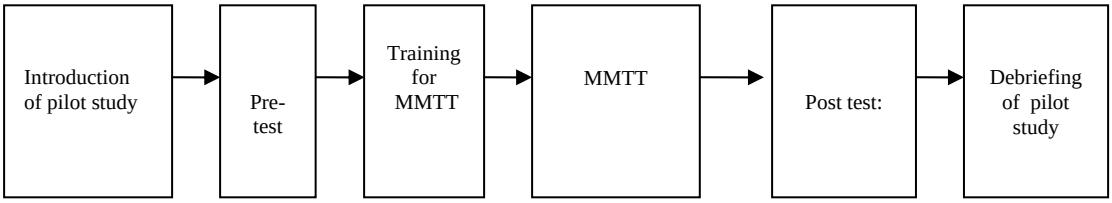
The teamwork questionnaire had six subscales. The subscales were: coordination, decision making, leadership, interpersonal skills, adaptability, and communication. There were total of 36 items in this questionnaire. The older version of the teamwork questionnaire was given to students. The fifty-four students were required to read the following directions to answer the questions. This set of questions is to help us understand the way you think and feel about working with others. Read each statement below and indicate how you generally think or feel. Indicate by marking an X on the appropriate box. There is no right or wrong answers. Do not spend too much time on each question. Item responses ranged from (1) almost never, to (2) sometimes, (3) often, and (4) almost always. The reliability reported by O'Neil (2003) for the version used in this study ranged from .84 to .90.

Creativity Questionnaire

The creativity measure was adopted from Abedi and Schumacher (2002), this questionnaire consisted of 60 items, multiple choice test. Fifty- four students answered this questionnaire.

Procedure

Figure 4: Pilot Study Flow Chart



The pilot study began with the researcher introducing the measures and providing a pre-test to the students and later a post-test. Participants in the study first filled out a problem solving questionnaire, teamwork questionnaire, and creativity questionnaire.

In this study, the researcher modified previous researcher's problem-solving measures of retention and transfer (Mayer 2004, Chen 2005) to measure domain specific problem solving strategies. The researcher measured participants' problem-solving strategies with a set of retention and transfer questions. These problem-solving strategy

questions of retention and transfer are modified from Mayer and Moreno's (1998) problem solving question list which were both used in the pilot and main study.

Debriefing

During the debriefing, the investigator thanked the participants for their time and effort. The investigator asked the participants to write down their suggestions or feelings on the debriefing sheet. The investigator also prompted a discussion about their feedback in terms of the assessments and overall experience.

Results of the Pilot Study

The research method and procedure of the pilot study were feasible, with the South Coast Naval School specific measures being: problem solving questionnaire, teamwork questionnaire, and creativity questionnaire. Further the research content was selected from the Multi-Mission Team Trainer. In this study the researcher modified previous researchers' problem solving measures of retention and transfer questions (open-ended). For this research, the retention question was "Write an explanation of how you solve the tactical problem scenario. Be as specific as to the tactical scenarios." The transfer question stated "Write some ways of improving the scenario used in the Multi-Mission Team Trainer."

Main Study

In the end of February 2008, the investigator conducted the main study. The main study was conducted with the Multi Mission Team Trainer and paper and pencil

questionnaires, just like the pilot study. However, due to the schedule of classes at South Coast Naval School the content of the class changed. The course for the main study concentrated on surface warfare scenarios instead of air defense. Moreover, for the main study students were also given a retention and transfer question to answer which pertained to the culminating surface warfare scenario. Three experts instead of two were also given the same scenario and retention and transfer questions just like the students. Participants in the main study were requested to take the cognitive readiness questionnaires before experiencing the Multi-Mission Team Trainer and after they were done with the surface warfare module. They filled out the cognitive measure that included problems solving, teamwork, and creativity questionnaires, the same as those in the pilot study. In addition to this study, one other study was conducted respectively by another investigator (Mr. Sutter Fox) at the same time (Sutter, in preparation). The study focused on the formative evaluation of a surface warfare simulator to improve problem solving.

Method

Participants

There were fifty eight participants and three instructors in the main study. However, only fifty-four participants took the pre and post test for the cognitive readiness measures. The participants that were sampled were from the South Coast Naval School. The participants were enrolled in the surface warfare module. The three experts had 12,

10, and 7 years of experience respectively. There were a total of three surface warfare case scenarios that were given to the experts. The experts had to classify all three case scenarios from lowest cognitive readiness to highest cognitive readiness. The following was the surface warfare case scenario that was given to the experts:

Table 5: Surface Warfare Case Scenarios

Scenario 1:	• Build and maintain an RMP • Recommend various organic helicopter weapons to accomplish mission. • Successfully employ the SUW weapon systems. • Execute OTH-T engagement
Scenario 2:	• Build and maintain a recognized maritime picture • Identify battle space management considerations • Implement, determine, and implement the appropriate MIO Operations procedures • Implement TAO immediate actions for Search and Rescue
Scenario 3:	• Build a recognized maritime picture • Maintain a recognized maritime picture • Manage their battle space • Recommend various organic helicopter weapons to accomplish mission • Successfully employ the optimal shipboard SUW weapons systems. • Execute OTH-T engagement • Conduct SAG Operations

Table 6 below explains the levels of cognitive readiness that all three experts agreed upon. Since all three experts agreed that all three surface warfare case scenario required higher levels of cognitive readiness, the researcher asked them to please identify

from lowest to highest. Therefore, the following chart explains how they categorized the scenarios. Scenario one was considered to require the lowest level of cognitive readiness. Scenario two required an intermediate level of cognitive readiness. Scenario three required the highest level of cognitive readiness.

Table 6: Surface Warfare Case Scenario-Cognitive Readiness

Scenario 1: (requires lowest cognitive readiness)	• Build and maintain an RMP • Recommend various organic helicopter weapons to accomplish mission. • Successfully employ the SUW weapon systems. • Execute OTH-T engagement
Scenario 2: (intermediate cognitive readiness level)	• Build and maintain a recognized maritime picture • Identify battle space management considerations • Implement, determine, and implement the appropriate MIO Operations procedures • Implement TAO immediate actions for Search and Rescue
Scenario 3: (requires highest cognitive readiness)	• Build a recognized maritime picture • Maintain a recognized maritime picture • Manage their battle space • Recommend various organic helicopter weapons to accomplish mission • Successfully employ the optimal shipboard SUW weapons systems. • Execute OTH-T engagement • Conduct SAG Operations

Table 7 below describes and defines the abbreviations and acronyms that were used in the surface warfare case scenario.

Table 7: Acronyms/Abbreviations

Terms	Definitions
RMP	Recognized Maritime Picture
MIO	Maritime Interception operations- Efforts to monitor, query, and board merchants international waters to enforce sanctions.
TAO	Tactical Action Officers- key person who makes decisions
SUW	Surface Warfare
OTH-T	Over the Horizon targeting
SAG	Surface Action Group

The above case surface warfare case scenarios were obtained from the South Coast Naval School and created by the instructor (experts) who taught the surface warfare component (see appendix F).

The goal of surface warfare case scenario three was to train the Tactical Action Officer and the Surface Warfare Commanders to communicate, build and maintain recognize maritime picture using organic sensors while operating in a surface action group, make proper track and conduct a detect to engage sequence in a wartime rules of engagement environment against multiple hostile over the horizon surface tracks.

Measures

The measures are divided into two categories, domain specific and domain independent. The cognitive readiness questionnaire (domain independent) included a problem-solving, teamwork, and creativity measure which was given to all fifty-four participants.

Domain Specific Problem Solving Measure

The following were the retention and transfer questions that were given to the students and experts pertaining to the surface warfare case scenario three: Write an explanation of how you solve the tactical problem scenario. Be specific as to the tactical scenarios. Write some ways of improving the scenario used in the Multi-Mission Team Trainer. The questions were related to the surface warfare case scenario three, which required the highest level of cognitive readiness. There were two versions of the retention and transfer questions. One version was given during the pilot study only to the two experts that were interviewed. After obtaining feedback, the retention and transfer questions were refined and given to the students during the post test (main study).

The goal was to compare the responses between the expert and student learners. The investigator and the retired naval captain (Mr. Sutter Fox) thoroughly reviewed each response from the experts and from the students. The idea units were based both on the performance objectives and responses of the students. The responses from the experts

were created into item units and compared to the responses of the students. The responses of the students were also converted into idea units. The total number of idea units for the retention and transfer scores were ten. Therefore, the total number of points possible for students to obtain for each retention and transfer question were ten.

They were given three scenarios to rank from highest to lowest cognitive readiness. The directions stated: How would you categorize the following Multi-Mission Team Trainer scenarios as requiring cognitive readiness? The likert scale consisted of four choices ranking from 1 (almost never), 2 (sometimes), 3 (often), and 4 (almost always). The pilot study consisted of the scenario being air defense. However, due to the course and timing of the main study the scenario changed to surface warfare.

The three experts ranked the Surface Warfare case scenarios as follows:

Table 8: Response of scenario ranking

	Scenario 1	Scenario 2	Scenario 3
Expert 1	3	4	4
Expert 2	4	3	4
Expert 3	4	4	4

As seen on table 9 (below), all three experts agreed that all scenarios required higher levels of cognitive readiness. After the three experts ranked the scenarios the investigator still wanted to know overall which one in their opinion was the one that required the least and highest level of cognitive readiness. The experts all agreed that overall scenario one was the one that required the least and scenario three required the highest level of cognitive readiness.

Table 9: Overall scenario ranking from highest to lowest

	Scenario 1	Scenario 2	Scenario 3
Expert 1	Least	Intermediate	Highest
Expert 2	Least	Intermediate	Highest
Expert 3	Least	Intermediate	Highest

Moreover, the open-ended questions (retention and transfer) were given to students in order to analyze how well they performed in comparison to the experts. The interrater reliability was conducted by the investigator and a retired naval captain. The experiences of the retired naval captain include thirty-four years of military service. His operational assignments included service aboard five ships, six air stations, and two group offices. His administrative experience includes the service headquarters in Washington DC, and US Pacific Command.

For the retention and transfer questions both raters gathered and created an item category from the answers that were provided by the experts. For example, after both raters created their own list they discussed and combined items into one single list, which included all three expert responses. After, thorough review the raters read each of the student's responses for retention and mapped the items to that of the experts, as may be seen in table 10 below. There were a total of ten idea units for the retention expert categories. The ten idea units were the following: 1. communication, 2. coordinate/organize, 3. recognize maritime picture (RMP), 4. Search Plan, 5. Identify and classify contacts, 6. contact, 7. visual identification, 8. maintain surprise/ emissions control (EMCON), 9. best weapons, and 10. battle damage assessment (BDA). The same procedure was conducted for the transfer question. The idea units were also aligned to the objectives of the three surface case scenarios (see appendix).

Table 10: Cross Reference Between Performance Objectives and Idea Units

Performance objectives	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1.		X								
2.			X	X	X		X			
3.		X	X	X	X	X	X			
4.									X	
5.									X	
6.						X	X		X	
7.	X	X						X		

The marks on table 10 (above) indicated the performance objectives that were mapped onto the idea units. The performance objectives were the following: 1. manage their battlespace, 2. build a recognized maritime picture, 3. maintain a recognized maritime picture, 4. recommend various organic helicopter weapons to accomplish mission, 5. successfully employ the optimal shipboard SUW weapon system, 6. execute over the horizon targeting engagement, and 7. conduct surface action group operations. Every performance objective, mapped onto one or more of the idea units. Likewise, every idea unit, mapped onto at least one of the performance objectives. The exception was battle damage assessment idea unit, which is one idea unit that emerged from participant's responses and was not in the performance objectives.

The two raters analyzed one by one the responses of the students and mapped the answers to those of the students. Each student was given one point when the two items

matched. The total number of transfer units that were derived from the three expert responses consisted of ten, as see in table 11 below.

Table 11: Item Units for Transfer question

1. Increase scenario Fidelity
2. Improve link modeling
3. Improve Tactical aircraft employment
4. Improve reporting procedures
5. Add ability to organize assets other than own ship
6. Improve gunfire simulation
7. Improve environment modeling
8. Improve missile attack coordination
9. Improve optical sight
10. Improve bridge/CIC coordination

Domain Independent Problem Solving Measure

Problem Solving Measure

The domain independent problem solving questionnaire was composed of a subset of twenty-three total items. The subscales included were: control strategies (metacognition), academic efficacy (self-efficacy), effort and perseverance and test anxiety (worry component), and elaboration. The details of each subscale of the trait self-regulation questionnaire are as follows:

Metacognition (control strategies) describes students that used self-evaluation and self-monitoring during their learning process (Marsh et. al., 2006). A four-point Likert scale, ranging from almost never, sometimes, often, to almost always, was used to

measure metacognition. The reliability of metacognition was .83 (Marsh et al., 2006). A sample question is “When I study, I force myself to check to see if I remember what I have learned” (Marsh et al., 2006).

Academic efficacy (Self-Efficacy) is the “people’s judgment of their capabilities to organize and execute course of action to attain designated types of performance.” Self-efficacy also refers to the one’s belief in his or her ability to complete a difficult task to overcome barriers to reach the goal successfully through efforts (Marsh et.al., 2006). A four point Likert scale ranging from almost never, sometimes, often, to almost always was used to measure this subscale. The reliability of the academic self-efficacy measure was .83 (Marsh et. al., 2006). A sample question to measure self-efficacy was: “I am confident I can understand the most complex material presented by the teacher” (Marsh et al., 2006).

Effort and perseverance. Learners spend more effort when they are motivated. Effort and perseverance are positively related to students’ achievement (Pintrich & Schunk, 2002). A four-point Likert scale, ranging from almost never, sometimes, often, to almost always, will be used to measure effort. The reliability of the effort measure is .83 (Marsh et. al., 2006). A sample question for this subscale is “When studying, I keep working even if the material is difficult” (Marsh et al. 2006).

Test anxiety (worry). The test anxiety inventory (TAI) is a self-report inventory that measures two components worry and emotionality. Worry relates to the cognitive

concerns about the consequences of failure. Emotionality refers to the reactions of the automatic nervous system that is evoked by evaluative stress (Speilberger et al., 1980). The reliability of the test anxiety measure is .92 (Speilberger et al., 1980). A sample question to measure the worry component of test anxiety was "Thoughts of doing poorly interfere with my concentration on tests" (Speilberger et al., 1980).

Teamwork Measures

The main study used the same teamwork measure questionnaire as the pilot study. There were a total of thirty-six questions. The measurement approach is to view teamwork skills as a trait of the individual that predisposes the individual to act as a team member (O'Neil, 2003). The taxonomy is made up of six teamwork processes. The skill include (a) adaptability- recognizing problems and responding appropriately, (b) coordination- organizing team activities to complete tasks on time, (c) decision making- using available information to make decisions, (d) interpersonal- interacting cooperatively with other team members; (e) leadership- providing direction for the team; and (f) communication- clear and accurate exchange of information.

An example of the adaptability subscales is: "When I work as part of a team, I can identify potential problems readily." An example of the coordination subscales is: "When I work as part of a team. I allocate the tasks according to each team member's abilities." An example of example of decision-making is: "When I work as part of a team, I

understand and contribute to organizational goals." An example of interpersonal is: "When I work as part of a team, I interact cooperatively with other team members." An example of leadership is: "When I work as part of a team, I exercise leadership." An example of communication is:" When I work as part of a team, I ensure the instructions are understood by all team members prior to starting the task" (Spector, Ohrazda, Schaack, & Wiley, 2005, pg. 146).

The item responses ranged from (1) almost never, to (2) sometimes, (3) often, to (4) almost always. The reliability reported by O'Neil (2003) for the version used in this study ranged from .84 to .90.

Creativity Measures

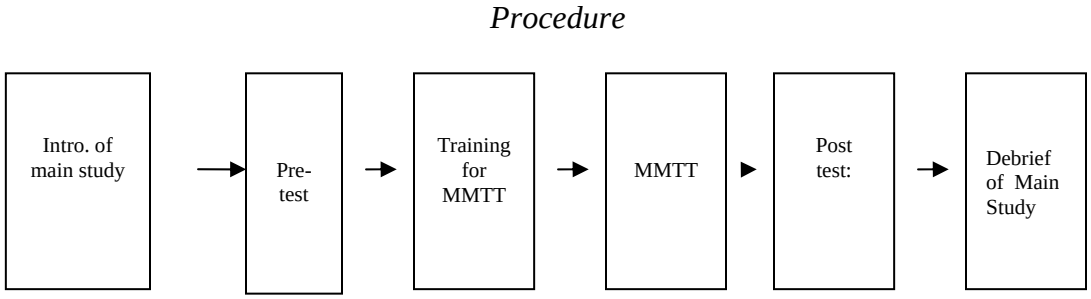
The creativity questionnaire was composed of sixty multiple choice items and was adopted from Abedi and Schumacher (2002). There were four subscales. The subscales consisted of fluency, flexibility, originality, and elaboration. According to Abedi & Schumacher (2002) who adopted the definitions from Torrance & Goff (1989) fluency refers to ability to produce large numbers of ideas, flexibility (ability to produce a variety of ideas or use a variety of approaches), originality (ability to produce new, unusual, innovative ideas), and elaboration (ability to fill in the details). An example of the fluency question is: "How well do you express your ideas?" An example the flexibility question is "How do you approach a complex task?" An example of the originality question is "Do you find that you usually like to try new things?" An example of the

elaboration question is “When something unfair happens to you, can you figure out all of the reasons behind that event?”

The directions given to the students were the following: This set of questions is to help us understand your level of creativity in different situations. Read each statement below and bubble in one answer per question. Do no spend too much time on each question. The multiple-choice test is based on the original version of a creativity test constructed and validated in Tehran by Abedi in 1983. Reliability and validity were examined in a study conducted in Spain on a group of 2,270 students (Villa, Auzmendi, & Abedi, 1996).

Each of these measures of creativity yields four different subscales: Fluency, Flexibility, Originality, and Elaboration. Fluency has 22 items, Flexibility has 11 items, Originality has 16 items, and Elaboration has 11 items. Each item has three options (choices) ranging from the least to the most creative response. Internal consistency coefficients of the creativity test were estimated using the classical Cronbach alpha. Concurrent validity coefficients were estimated by correlating the scores of the creativity test subscales with the criterion measures. Internal consistency and concurrent validity coefficients were also estimated by utilizing multiple indicators through the application of structural equation modeling.

Figure 5: Main Study Flow Chart



The main study began with the researcher introducing the measures and providing a pre-test to the students and later a post-test. Participants in the study first filed out a problem solving questionnaire, teamwork questionnaire, and creativity questionnaire. After, all participants answered the retention and transfer questions. The retention and transfer questions were also answered by three experts. The experts consisted of three instructors who had been teaching the surface warfare 12, 10, and 7 years respectively.

Debriefing of the Main Study

The process of debriefing after the main study was the same of the pilot study. The investigator first thanked the participants for their time and patience in the study. The investigator asked participants to write down their suggestions or feelings toward the process they had undergone.

CHAPTER IV

RESULTS

Data collected in this study was analyzed by using the Statistical Package for the Social Sciences (2006). The statistical procedure included both descriptive and inferential statistics. The scale of problem solving was analyzed first (subscales: self- efficacy, elaboration, worry, anxiety, control strategies, effort and perseverance). Then the teamwork questionnaire was analyzed, the subscales included cognition and interpersonal. Next, the subscales of the creativity measure were presented. The subscales were flexibility, fluency, elaboration, and originality. The pre and post test were analyzed via Pair T-Test and correlations. Last, the interrater reliability of the retention and transfer questions were analyzed. The results based on the research question and one hypothesis were summarized. The numbers were truncated to two significant digits.

Descriptive and Inferential Statistics

Table 12 shows the mean and standard deviations for all subscales. For all subscales the mean for pre and post test were approximately the same.

Table 12: Subscales: Items, Means, and Standard Deviation

Subscales	No. of Items	Mean	Std. Deviation
Pre CS	5	15.68	2.35
Post CS	5	15.55	2.57
Pre SE	4	12.55	2.80
Post SE	4	12.96	2.51
Pre E & P	4	12.55	2.44
Post E & P	4	12.75	2.47
Pre Worry	8	10.53	4.46
Post Worry	8	10.57	4.35
Pre P-Elab	4	9.38	1.74
Post P-Elab	4	9.40	1.80
Pre Adapt	5	16.15	2.52
Post Adapt	5	16.91	2.12
Pre Coord.	5	15.83	2.23
Post Coord.	5	16.23	2.14
Pre DM	6	19.38	2.80
Post DM	6	19.81	2.72
Pre Interper	6	16.06	1.85
Post Interper	6	16.85	1.87
Pre Lead	7	22.60	2.56
Post Lead	7	23.23	2.41
Pre Comm	7	22.06	2.56
POST Comm	7	22.45	2.55
Pre C-Flu	17	37.92	6.00
Post C-Flu	17	38.13	6.05
Pre C-Flex	13	28.30	5.16
Post C-Flex	13	28.72	3.95
Pre C-Orig	16	37.55	5.69
Post C-Orig	16	38.30	4.32
Pre C-Elab	10	22.74	3.33
Post C-Elab	10	23.45	2.56
Ret. Score	10	2.38	2.24
Tran- Score	10	.94	1.15

Table 13 shows the alpha reliability of the pre and post test scores for all subscales and the retention and transfer question. The alpha reliability for all subscales ranged from .50 to .93.

Table 13: Alpha Reliability for all Subscales

Subscales	Alpha Reliability (Pre-test)	Alpha Reliability (Post-Test)	Alpha Reliability (Reference)
Control Strategies	.68	.80	.83 (Marsh, et. al. 2006)
Self-Efficacy	.87	.82	.83 (Marsh, et. al. 2006)
Effort and Perseverance	.81	.85	83 (Marsh, et. al. 2006)
Worry	.92	.93	.92 (Marsh, et. al, 2006)
Problem Solving-Elaboration	.72	.69	.83 (Marsh, et. al. 2006)
Teamwork-Adaptability	.69	.78	.84 (O'Neil, 2003)
Teamwork-Coordination	.60	.66	.84 (O'Neil, 2003)
Teamwork-Decision Making	.75	.78	.84 (O'Neil, 2003)
Teamwork-Interpersonal	.56	.69	.84 (O'Neil, 2003)
Teamwork-Leadership	.48	.55	.84 (O'Neil, 2003)
Teamwork-Communication	.57	.65	.84 (O'Neil, 2003)
Creativity-Fluency	.86	.74	.79 (Abedi,2002)
Creativity-Flexibility	.75	.85	.53 (Abedi,2002)
Creativity-Originality	.76	.83	.64 (Abedi,2002)
Creativity-Elaboration	.50	.79	.64 (Abedi,2002)

Problem Solving Measure

Problem Solving was assessed through a questionnaire that was based adopted from the Student Approaches to Learning (SAL), which was developed by the Organization for Economic Co-Operation and Development (OECD, Artelt, 2005; Baumert et al., 1998; Baumert, Klieme et. al., 2000; Peschar, 2004). The questionnaire consisted of twenty-five items and was a four- point Likert scale, ranging from almost never, sometimes, often, to almost always. The subscales included self-efficacy (4 items), elaboration (4 items) , test anxiety (worry) (8 items) , control strategies (5 items), and effort and perseverance (4 items). Each subscale will be analyzed first descriptively and then inferentially. The hypothesis stated that there would be an increase of scores from the pre to post test.

Control strategies

Control Strategies was measured via the control strategies subscale, cognitive readiness questionnaire. Table 14 below, shows the mean and standard deviation for the pre and post control strategies subscale. The mean for the pretest and post test was (15.68) and (15.55). The means were approximately the same. The independent variable was the time of which the constructs were measured, ie.. before and after the surface warfare

simulation. The T-test shows that there in no statistical significance between the pre and post test control strategies subscale (t=.44, df= 53, p=.65).

Table 14: Control Strategies- Mean and Standard Deviation (N=54)

	Mean	Std. Deviation
Pre Control Strategies	15.68	2.35
Post Control Strategies	15.55	2.57

Self-efficacy

Self-efficacy was measured via the self-efficacy cognitive readiness questionnaire. Table 15 below, shows the mean and standard deviation for the self-efficacy pre and post test. The mean score for the pre-test was 12.55 and for the post-test 12.96.

A pair sample T-Test was conducted on each subscale to determine if there was any difference and significance between the pre test and post test. The independent variable was the time of which the constructs were measured, ie.. before and after the surface warfare simulation. The pair T-Test shows that there was no statistical significance, (t=1.4, df=53, p=.15).

Table 15: Self-Efficacy -Mean and Standard Deviation (N=54)

	Mean	Std. Deviation
Pre Self- Efficacy	12.55	2.85
Post Self- Efficacy	12.96	2.51

Effort and perseverance

Effort and perseverance was measured via the effort and perseverance cognitive readiness questionnaire. Table 16, below depicts the mean and standard deviation. The mean was 12.51 for the pre test and 12.75 for the post test, being approximately the same. The independent variable was the time of which the constructs were measured, ie.. before and after the surface warfare simulation. The pair t-test showed no statistical significance, (t=.90, df= 53, p=.33).

Table 16: Effort and Perseverance- Mean and Standard Deviation (N=54)

	Mean	Std. Deviation
Pre Effort & Pers.	12.51	2.44
Post Effort & Pers.	12.75	2.47

Worry

Worry scales was measured via the worry subscale cognitive readiness questionnaire. Table 17 below, depicts the mean and standard deviation. The mean for pre test was (10.53) and the mean for the post test was (10.57). The mean was approximately the

same. The independent variable was the time of which the constructs were measured, ie.. before and after the surface warfare simulation. The pair T-Test showed that there is no statistical difference (t=.06, df =53, p=.94).

Table 17- Worry- Mean and Standard Deviation (N=54)

	Mean	Std. Deviation
Pre Worry	10.53	4.46
Post Worry	10.57	4.35

Elaboration

Elaboration was measured via elaboration subscale cognitive readiness questionnaire. Table 18 below, shows the means and standard deviation between the pre and post test. The mean for the pre test was 9.38 and the mean for the post elaboration was 9.40. The independent variable was the time of which the constructs were measured, ie.. before and after the surface warfare simulation. The pair sample T-Test demonstrated that there was no statistical significance between the pre and post test (9.3, 9.4), (t=.10, df=53, p= .91).

Table 18: Elaboration -Mean and Standard Deviation (N=54)

	Mean	Std. Deviation
Pre P Elab	9.38	1.74
Post P Elab	9.40	1.80

Teamwork Measure

Teamwork was assessed via a cognitive readiness questionnaire that was given before and after the simulation. There were thirty-six items in this questionnaire, which consisted of six scales (adaptability-5 items, coordination-5 items, decision making-6 items, interpersonal-6 items, leadership- 7 items, and communication-7items). Moreover, each subscale will show the mean, standard deviation, and results for the paired T-Test.

Teamwork- adaptability was measured via O'Neil et. al. teamwork questionnaire. Table 19 below, shows that Teamwork- adaptability mean and standard deviation. The mean was pre-test (16.15) and the post-test (16.91). The independent variable was the time of which the constructs were measured, ie. before and after the surface warfare simulation. The pair T-Test showed it was statistically significant, (t= 2.6, df=53, p=.01).

Table 19: Teamwork- Adaptability- Mean and Standard Deviation

	Mean	Std. Deviation
Pre- Adapt	16.15	2.52
Post- Adapt	16.91	2.12

Teamwork- coordination was measured via the O'Neil et. al. teamwork questionnaire. Table 20 below, describes the mean and standard deviation for the pre and post test for coordination. The means are approximately the same, pre test (15.83) and post test (16.23). The independent variable was the time of which the constructs were

measured, ie.. before and after the surface warfare simulation. The paired T-Test showed that there is no statistical significance, (t= 1.4, df= 53, p= .16).

Table 20- Teamwork- Coordination- Mean and Standard Deviation

	Mean	Std. Deviation
Pre-Coordination	15.83	2.23
Post- Coordination	16.23	2.14

Teamwork-decision making was measured via O'Neil et. al teamwork questionnaire. Table 21 below, shows the mean and standard deviation for pre test (19.38) and post test (19.81) for decision making. The independent variable was the time of which the constructs were measured, ie.. before and after the surface warfare simulation. The pair T-test shows that Teamwork-decision has no statistical significance, (t= 1.2, df= 53, p=.21).

Table 21: TW-Decision Making- Mean and Standard Deviation (N=54)

	Mean	Std. Deviation
Pre- Decision Making	19.38	2.80
Post- Decision Making	19.81	2.72

Teamwork-interpersonal was measured via O'Neil et. al. teamwork. Table 22 below, shows the mean and standard deviation for Teamwork- Interpersonal. The pretest mean was (16.06) and the post test mean was (16.85). The independent variable was the time of which the constructs were measured, ie.. before and after the surface warfare simulation. The pair T-Test showed that there is statistical significance, (t=3.1, df=53, p=.00).

Table 22: Teamwork- Interpersonal (N=54)

	Mean	Std. Deviation
Pre-Interpersonal	16.06	1.87
Post- Interpersonal	16.85	1.85

Teamwork- leadership was measured via O'Neil et. al teamwork questionnaire. Table 23 below, shows the mean and standard deviation for Teamwork-. The
Mean for the pre test was (22.60) and the mean for the post test was (23.23). The independent variable was the time of which the constructs were measured, ie.. before and after the surface warfare simulation. The pair T-test showed that there is a statistical significance, (t= 2.2, df = 53, p=.02).

Table 23: Teamwork- Leadership- Mean and Standard Deviation (N=54)

	Mean	Std. Deviation
Pre- Leadership	22.60	2.55
Post- Leadership	23.23	2.41

Teamwork- communication was measured via the O'Neil et. al. teamwork questionnaire. Table 24 shows the mean and standard deviation for Teamwork- communication. The mean was 22.06 (pre-test) to 22.49 (post-test). The independent variable was the time of which the constructs were measured, ie.. before and after the surface warfare simulation. The pair T-test showed that the results were not statistically significant, (t= 1.3, df= 53, p=.18).

Table 24-Teamwork- Communication- Mean and Standard Deviation

	Mean	Std. Deviation
Pre- Communication	22.06	2.56
Post- Communication	22.49	2.55

Creativity Measure

Creativity was assessed through a questionnaire that was given before and after the simulation. The creativity questionnaire had four subscales, which included, flexibility (13 items), elaboration (10 items), originality (16 items), and fluency (17 items). The creativity measured was given before and after the surface warfare simulation. The tables below will show the mean, standard deviation, and T-Test to determine if the results were significant.

Fluency

Creativity- fluency was measured via Abedi's creativity questionnaire. Table 25 below shows the mean and standard deviation for fluency. The fluency mean went from 37.92 (pre-test) to 38.13 (post-test). The independent variable was the time of which the constructs were measured, ie.. before and after the surface warfare simulation. The pair T-Test shows that there is no statistical significance, (t= .28, df=53, p=.78).

Table 25: Creativity: Fluency- Mean and Standard Deviation (N=54)

	Mean	Std. Deviation
Pre Fluency	37.92	6.00
Post Fluency	38.13	6.05

Flexibility

Creativity- flexibility was measured via Abedi's creativity questionnaire. Table 26 below, shows the mean and standard deviation for pre and post test. The mean for the pre test is 28.30 and 28.72 for the post test. The independent variable was the time of which the constructs were measured, ie.. before and after the surface warfare simulation. The pair T-Test showed that there is no statistical significance, (t= .90, df= 53, p= .37).

Table 26: Creativity- Flexibility- Mean and Standard Deviation (N=54)

	Mean	Std. Deviation
Pre- Flexibility	28.30	5.16
Post- Flexibility	28.72	3.95

Originality

Creativity- originality was measured via Abedi's creativity questionnaire. Table 27 below, shows the mean and standard deviation for the originality subscale. The mean for the pre test was 37.55 and the mean for the post test was 38.30. The independent variable was the time of which the constructs were measured, ie.. before and after the surface warfare simulation. The pair T-test showed that there is no statistical significance, (t=1.4, df= 53, p= .16).

Table 27: Creativity- Originality -Mean and Standard Deviation (N=54)

	Mean	Std. Deviation
Pre Originality	37.55	5.69
Post Originality	38.30	4.32

Elaboration

Creativity- elaboration was measured through Abedi's creativity questionnaire. Table 28 below shows the mean for the pre elaboration score was 22.74 and the mean for the post elaboration score was 23.45. The independent variable was the time of which the constructs were measured, ie.. before and after the surface warfare simulation. The pair T-Test showed it approached significance, (t=1.9, df=53, p=.05).

Table 28: Creativity- Elaboration- Mean and Standard Deviation (N=54)

	Mean	Std. Deviation
Pre C- Elab	22.74	3.33
Post C- Elab	23.45	2.56

In order to investigate the test-re test reliability of the measured used in the study the pre test was correlated with the post test. As may be seen below, the correlation ranges from .53 to .75.

Correlation Matrix

Table 29: Correlations- Pre and Post Test

Subscales	No. of Items	Pre-Test / Post-Test
Control Strategies	5	.61**
Self-Efficacy	4	.69** .
Effort and Perseverance	4	.72**
Worry	8	.53** .
Elaboration	4	.71**
Adaptability	5	.61**
Coordination	5	.54**
Decision Making	6	.57**
Interpersonal	6	.49**
Leadership	7	.66**
Communication	7	.56**
Fluency	17	.59**
Flexibility	13	.75**
Originality	16	.72**
Creativity Elaboration	10	.62**
Retention/Transfer	10 each	.12

**: Correlation is significant at the 0.01 level (2-tailed).

In order to test the relationship between the sub scales and retention and transfer measure, a correlation between subscales was conducted. The pre test variable was correlated with the retention and transfer measure. The correlations amongst the pretest and retention ranged from -.02 to .14. Only the correlation between self-efficacy and retention was significant. The correlations amongst the pretest and transfer ranged from -.03 to .10. There was no relation on transfer for the cognition retention measures.

Table 30: Correlations- Pre-Test-Retention and Transfer

Subscales – Pre- Test	Retention	Transfer
Control Strategies	.14	.00
Self-Efficacy	.27*	-.12
Effort and Perseverance	.06	.10
Worry	-.23	.09
Elaboration	.00 .	-.09
Adaptability	.00 .	.02
Coordination	-.16	-.05
Decision Making	-.13	.06
Interpersonal	-.00	-.03
Leadership	-.17	-.07
Communication	-.12	.02
Fluency	-.02	-.08 .
Flexibility	.05	-.20
Originality	-.03	.-15
Creativity Elaboration	.15	-.08 .
Transfer	.12	

* Correlation is significant at the 0.05 level (2-tailed).

In order to test the reliability between the subscales (post-test) and retention and transfer measure, correlations were conducted. The post test measure was correlated amongst the retention and transfer. The correlations for the post test and retention measure range from -.06 to .26.

Table 31: Post-Test- Retention and Transfer

Subscales – Post-Test	Retention	Transfer
Control Strategies	.09	-.19
Self-Efficacy	.26	-.17
Effort and Perseverance	.11	-.01
Worry	-.14	.08
Elaboration	.08	-.19
Adaptability	-.07	-.07
Coordination	-.06	-.11
Decision Making	-.10	-.11
Interpersonal	.03	-.11
Leadership	.03	-.04
Communication	-.11	-.08
Fluency	.07	-.29*
Flexibility	.02	-.34*
Originality	.04	-.24
Creativity Elaboration	.17	-.25

* Correlation is significant at the 0.05 level (2-tailed).

Interrater Reliability of Domain Specific Problem Solving Measurement

Interrater reliability is widely used term for the extent to which independent coders evaluate a characteristic of a message or artifact and reach the same conclusion. It measures only "the extent to which the different judges tend to assign exactly the same rating to each object "(Tinsley & Weiss, 2000, p. 28). A score for a retention question or a transfer question was the total number of the idea units in the student's answer that matched the experts' idea units. The experts list for the retention question included ten idea units. The experts list for the transfer questions included ten idea units. The total possible score for each retention and transfer questions was ten. There were a total of fifty-two students and three experts.

The retired naval captain and the researcher first read all the responses provided by the three experts. After each rater read each response individually both agreed upon writing two separate sets of idea units. The result was ten idea units for the retention question and ten idea units for the transfer question. After having the two sets of idea units it was compared to that of the students.

Table 32 below, shows the frequency of the retention scores of students. The largest percent (27.8%) of students received a two as a score out of ten total possible points. The least number of students (1.9%) received an eight out ten total possible points. It is interesting to note that 24% of received a score of zero.

Table 32 : Frequency of Retention Scores – Students (N=52)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	13	24.1	24.1	24.1
	1	8	14.8	14.8	38.9
	2	15	27.8	27.8	66.7
	3	4	7.4	7.4	75.9
	4	2	3.7	3.7	79.6
	5	3	5.6	5.6	85.2
	6	4	7.4	7.4	92.6
	7	3	5.6	5.6	98.1
	8	1	1.9	1.9	100.0
	Total	52	100.0	100.0	

Table 33 below shows the frequency of the transfer scores of students. The largest percentage (44.4%) received the score of zero out of ten possible points. The lowest percentage (1.9) received the score of 6 out of ten possible points.

Table 33: Frequency of Transfer Scores – Students (N=52)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	24	44.4	44.4	44.4
	1	1	1.9	1.9	46.3
	2	15	27.8	27.8	74.1
	3	10	18.5	18.5	92.6
	4	3	5.6	5.6	98.1
	6	1	1.9	1.9	100.0
	Total	52	100.0	100.0	

Table 34 (see appendix G) shows that for each answer the student provided, it was matched with the expert. If the responses were the same students received a point. The total points possible were ten. The average score was 2.42, standard deviation, 2.26.

Table 35 (see appendix H) shows the scores that the two raters gave each student for the retention question. After a thorough discussion between the two raters a consensus was achieved in order to finalize with one score. The Kappa analysis was conducted in order to analyze the interjudge reliability, .93. Table 36 (see appendix I) reflected the scores for the transfer question. The idea units from the three experts were mapped to that of the students. The average score for the transfer was .096 and standard deviation 1.17. Table 37 (see appendix J) shows the scores that the two raters gave students for the transfer questions. After a thorough discussion the rater came to a consensus to obtain one score. Kappa analysis was conducted in order to obtain the interjudge reliability. The reliability was .93.

Tests of the Research Hypothesis

Research Question One:

Will a simulation increase cognitive readiness?

Hypothesis 1: There will be an increase of scores between the pre and post cognitive readiness questionnaire.

With the exception of teamwork- interpersonal and leadership, and creativity-elaboration, the T-test for each of the subscales showed no statistical significance. The

correlations that were statistically significant were self-efficacy and retention (.27) and creativity- fluency (-.29) and flexibility with transfer (-.34).

The measures were divided into two categories domain independent (which included the problem solving, teamwork, and creativity) and domain specific (which included retention and transfer questions). It was hypothesized that post test scores were going to be higher than the pre test scores. The mean for each subscale (pre and post test) showed that they were approximately the same and not significant. The domain independent problem solving measure was composed of five subscales. The subscales were: self-efficacy, elaboration, worry, control strategies, and effort and perseverance.

For example, the mean for self-efficacy went from (12.55) to (12.96) approximately the same. The mean for control strategies went from 15.68 to 15.55, the mean for effort and perseverance went from 12.55 to 12.75, the mean for worry went from 10.53 to 10.57, and the mean for elaboration went from 9.38 to 9.40. None of the means were significantly different. In addition, the relationship between the domain independent problem solving strategies and the retention and transfer questions indicated that there were no significant relationships.

The alpha reliability for problem solving consisted of the following: control strategies (pre: .68, post: .80), self-efficacy (pre: .87, post: .82), effort and perseverance (pre: .81, post .85), worry (pre: .92, post: .93), elaboration (pre: .72, post: . 69). The alpha

reliability ranged from .68 to 93, which stated that most of the problem solving, domain independent measures were reliable, greater than .70.

The teamwork measure consisted of six subscales. The six subscales were coordination, communication, decision-making, interpersonal, leadership, and adaptability. Two subscales were statistically significant. Teamwork interpersonal and leadership were statistical significant. The mean for Teamwork interpersonal went from 16.06 to 16.85. The mean for Teamwork- Leadership went from 22.60 to 23.23. The mean for the subscales that were not statistically significant are adaptability (16.15, 16.91), coordination (15.83, 16.23), decision making (19.38, 19.81), and communication (22.06, 22.45). The measure for interpersonal and leadership subscales were statistically significant. Thus, interpersonal dealt with interacting with other team members and leadership dealt with providing direction for the team (Marshal et. al, 2005) which increased after exposure to the Multi Mission Team Trainer. Unexpectedly, teamwork decision making was not significant.

The alpha reliability for teamwork consisted of the following: adaptability (pre: . 69, post: .78), coordination (pre: .60, post: .66), decision making (pre:75, post:.78), interpersonal (pre: .56, post: 69), leadership (pre:.48, post: .55), communication (pre: .57, post: .79). The reliability ranged from .48 to .79. Some of the measures showed to be below .70 and thus may need revision.

The creativity subscales included flexibility, elaboration, originality, and fluency. All of the subscales with the exception of creativity- elaboration were not statistically significant. The mean for creativity elaboration went from 22.74 to 23.45. Thus creativity-elaboration increased after exposure to the MMTT. Creativity-elaboration meant the abilities to fill in the details (Abedi & Schumacher, 2002), which approach statistical significance (P=.05).

The means for the rest of the subscales were the following: originality (37.55, 38.30), fluency (37.92, 38.13), and originality (37.55, 38.30). The alpha reliability for creativity consisted of the following: fluency (pre:.86, post:.74), flexibility (pre:.75, post: .85), originality (pre:.76, post: .83), and elaboration (pre: .50, post: .79). The reliability ranged from .50 to .86. All of the creativity subscales (with the exception of elaboration pre-test) showed to be reliable and greater than .70.

The overall alpha reliability of all the subscales for the pre and post test ranged from .50 to .93. The subscales that were below .70 were control strategies (pre-test), problem solving (elaboration-post test), teamwork adaptability (pre-test), teamwork-coordination (pre and post), teamwork-interpersonal (pre and post), teamwork-leadership (pre and post), and creativity-elaboration (pre-test). These scales may also need revision.

The correlations of all subscales with the retention question (pre-test) ranged from -.03 to .27, with self-efficacy being positively correlated with retention and showing statistical significance. The correlations with all subscales and the retention question

(post-test) ranged from -.06 to .17, showing no statistical significance. The correlations of all subscales and the transfer question (pre-test) ranged from -.08 to .00, showing no statistical significance. The correlations of all subscales and the transfer question (post-test) ranged from -.34 to .08, showing that fluency (-.29) and flexibility (.-34) were statistically significant but unexpectedly negative. It may be that SWOS education focuses on "school solutions" and does not reward fluency and flexibility. The correlation between retention and transfer was .12, showing no statistical significance. The correlations of all subscales (pre and post) ranged from .49 to .72.

The domain specific problem solving strategies were tested via a modification of Mayer's retention and transfer questions (1998). The retention question was: Write an explanation of how you solved tactical problems in the Multi Mission Team Trainer scenario you just completed? The transfer question was: Write an explanation of how you would improve the Multi Mission Team Trainer Scenario, that you just completed, to train for a complex and unpredictable warfare environment.

The answers from students were compared to that of three experts from the South Coast Naval School (navy setting). The two raters (the researcher and a retired naval captain) scored each response provided by the fifty-four students and provided a score that ranged from one to ten. This process was performed twice, one for the retention question, and one for the transfer question. The two raters provided independently provided each student with a score, later the raters, agreed upon any discrepancies, and

reached a consensus. In order to find the interjudge reliability the researcher conducted a Kappa analysis. The kappa was .93 (after truncation) for both retention and transfer, which indicates a high reliability.

In summary the hypothesis stated that there would be an increase of scores between the pre and post cognitive readiness questionnaire due to simulation intervention. This hypothesis was partially confirmed. The results consisted of teamwork-interpersonal and leadership and creativity-elaboration were statistically significant. Creativity- elaboration was approximately statistically significant, p=.05. Further some cognitive readiness attributes were significant, i.e. self-efficacy and retention (.27), and creativity flexibility (-.29) and fluency (-.34) and retention. The relationship with transfer was not unexpected given the data, i.e. the average performance was .096 compared to experts and 24 individuals out of 52 received a score of zero.

CHAPTER V

Summary, Discussion, and Implications

This chapter will focus on the summary, discussion, and implications of the study conducted.

Summary

This study examined the effects of cognitive readiness in a surface warfare simulation. The purpose of the study was to determine if student's cognitive readiness increased from the pre test to the post test, the intervention being the Multi Mission Team Trainer simulation (a surface warfare case scenario). There was one group of participants which was composed of fifty four students. The intervention lasted seven days and the questionnaire approximately took 40 minutes for students to complete. The Multi Mission Team Trainer surface warfare simulation took approximately one and a half hours. There was a pre test composed of three different scales: problem solving (self-efficacy, elaboration, test anxiety, control strategies, and effort and perseverance), teamwork (adaptability, coordination, decision making, interpersonal, leadership, and communication), and creativity (flexibility, elaboration, originality, and fluency). The same measures were used for the post test.

Teamwork- interpersonal (p=.0) and leadership (p=0.2) were considered to be statistically significant, creativity- elaboration approached statistical significance

(p= .05). Self-efficacy and retention were positively correlated (.27). Creativity fluency (-.29) and flexibility (-.34) showed to be negatively correlated to transfer.

Discussion

This study proposed to examine the effects of cognitive readiness via a simulation intervention. The simulation being the Multi Mission Team Trainer in the area of surface warfare was the intervention. The cognitive readiness questionnaire was given before and after the Multi Mission Team Trainer. The participants were composed of fifty four students and three experts. Results provided by the study provided some evidence supporting the hypothesis that students increase their scores from the pre test to the post test via simulation intervention. However, the correlations amongst each subscale with retention and transfer demonstrated that there were few relationships that were statistically significant. Moreover, according to the literature it was expected that simulations would increase cognitive readiness. It was expected that the increase of simulations will increase content understanding, problem solving skills, and self-regulation (O'Neil, in preparation).

Findings on Problem Solving Measure

Problem solving measures consisted of two domains, domain independent and domain specific. The domain independent measures which consisted of control strategies, self-efficacy, effort and perseverance, worry, and elaboration, showed that there was no

statistical significant relationship with retention and transfer questions. With the exception of the correlation of self-efficacy and retention (which was statistically significant. .27), the domain specific questions that were based from Mayer's retention and transfer questions showed that there were no correlation between the measures and the rest of the subscales.

One hypothesis that might explain why there was little relationship between the domain independent measures and the retention and transfer questions is because students were less than optimally motivated. The day in which the questions were given was after students had a Multi-Mission Team Trainer simulation scenario (one and a half hour), had taken the post questionnaire (40 minutes), and had to take their final exam for the class (2 hours). The final exam was high stakes whereas the Multi Mission Team Trainer performance was low stakes. As the participants had chosen the Navy as a career the exam was a must and thus high stakes. In contrast, participants knew that the cognitive readiness questionnaire and retention and transfer questions were for this research study and thus were low stakes. This research data was not provided to the instructors and thus could not affect their grade.

These tasks might have also caused the students to experience cognitive overload. Cognitive overload theory is based on a cognitive architecture that consists of a limited working memory, with partly independent processing units for visual and audio information, which interacts with an unlimited long-term memory (Kirshner, 2001).

There are three different types of cognitive load theory, intrinsic, extraneous, and germane (Kirshner, 2001). For the purpose of this research, intrinsic and extraneous are the relevant and applicable explanations. Intrinsic cognitive load is determined by the interaction of the materials under study and the expertise of the learner. One person may be able to handle several pieces of information and call on stored schemata to handle one or more items (Van Merrienboer & Ayres, 2005). The extraneous load depends on the way tasks are presented to the learner. One way to overload the working memory is to present a diagram and written word simultaneously. Shifting the written work to spoken word relieves the visual memory of some information and the auditory memory assumes the burden (van Merrienboer & Ayres, 2005). Thus the retention and transfer data probably underestimates participant's true performance in the Multi-Mission Team Trainer.

Moreover, the measures for problem solving might have been written in a more comprehensive and explicit manner. For example, for future research, the retention and transfer questions can be incorporated as part to the education program in order for students to have gained that prior knowledge tested by retention questions. For future research the researcher might want to choose different measures for the domain independent problem solving strategies, such as adaptive expertise, resiliency, and adaptability.

Findings on the Teamwork Measure

The teamwork measure which was adopted from O'Neil (2005) showed that interpersonal and leadership increased significantly after the Multi Mission Team Trainer experience. Instructional strategies for teamwork skills training include the use of multiple strategies. An instructional strategy to support teamwork might include concepts or a kind of strategy where the learner is able to recognize unfamiliar examples of procedures or actions belonging to a particular group or category of knowledge (Marshall, O'Neil, Chen, Kuehl, and Abedi, 2005).

The post-test teamwork-interpersonal scale in this study shows having the highest means from all subscales. These results were consistent with a study conducted at the U.S. Marine Corps (Marshall, O'Neil, Chen, Kuehl, and Abedi, 2005). These findings are also consistent with O'Neil who found that interpersonal skills scale had the highest mean score of all the scales (Marshall, O'Neil, Chen, Kuehl, and Abedi, 2005). However, O'Neil et. al. also concluded that leadership had lowest mean score, which is not the case for this study.

Teamwork is a common desired of many and school environments that use collaborative problem solving techniques. The results of this study indicate the measurement of teamwork processes can be accomplished in a reasonably reliable and much timely manner.

Findings on the Creativity Measure

The measurement for creativity was adopted from Abedi (2006). The elaboration subscale approached statistical significance (p=.05). Elaboration was defined as the ability to fill in the details. The rest of the subscales were not statistically significant. Unexpectedly, were the correlations which demonstrated that the more fluency and flexibility the less transfer knowledge performance (which was statistically significant) was gained by students. Fluency was defined as the ability to produce large numbers of ideas, and flexibility, the ability to produce a variety of ideas or use a variety of approaches (Abedi & Schumacher (2002). This result was unexpected.

The study conducted by Abedi- Shumacher (2002) in Spain provided an opportunity to compare the traditional internal consistency and concurrent validity of the creativity test. The results of analyses based on the traditional approaches indicated that the concurrent validity coefficients were not high. The results also revealed relatively low correlations between the academic achievement measures and the creativity measures. The mean for elaboration (which consisted of 11 items) was 2.40, the standard deviation was 0.28, and the alpha reliability was .61 (Abedi & Schumacher, 2002).

Abedi (2002) found that creativity-elaboration indicated that creativity and academic abilities were related in this sample, but they were not the same or even highly correlated constructs. Moreover, it can be concluded from the results of this study to modify the creativity test items in order to be more domain specific to the navy setting in

new and upcoming studies. Also, a more thorough rubric needs to be developed in order to score the creativity scales. The process is two-fold, present a stimulus and have participants generate as many possible responses to the stimulus. Scoring involves counting popular, unusual/ original scores.

Findings on Problem Solving Questions (Retention and Transfer)

The two questions adapted from Mayer on retention and transfer, were not significantly significant with each other. The correlations indicated that student's performance on the different cognitive readiness measures did not correlate well with retention and transfer. However, the retention and transfer measures were reliable with some validity information. The current Multi Mission Team Trainer has no process or outcome performance measures. The measures created for this study could be use for assessment in surface warfare and could be created for other areas such as air defense and anti submarine warfare.

Implications

There are two types of implications for this study, one is research based and the other is practice based. One researched based implication is that more constructs of cognitive readiness should be tested in order to have a better understanding of the effects of cognitive readiness in a surface warfare simulation. Other competencies like

adaptability, and resiliency, should also be measured in order to create a better assessment of the effects of cognitive readiness.

One possible alternative is to have other measures that are tested to be valid and reliable. The study only concentrated on three measures because they were feasible, reliable, and valid. The three measures included problem solving adopted from PISA (Marsh, 2006), Teamwork adopted from O'Neil (2003), and Creativity adopted from Abedi (2002). All the components from the cognitive readiness model should be measured. The components include adaptive expertise, creativity, resiliency, situational awareness, problem solving, adaptability, decision making, and teamwork.

In addition, as an initial small-scale investigation, this study provides promise that larger scale experimentation may provide more stable and statistically significant estimates of the relationship between teamwork measures, such as adaptability, coordination, decision making, leadership, and interpersonal process, and outcome measure such retention and transfer knowledge via the Multi Team Trainer simulation.

This study has shown that the use of simulations can be effectively incorporated in assessing the relationships among the increase of cognitive readiness. However, more retention and transfer scaffolding needs to be in place and aligned with the curriculum, feedback, and assessments. For example, there should be more direct instruction on the case scenarios and simulations in order for students to build more prior knowledge. In order to improve performance at the retention and transfer level, the goals and objectives

of the case scenarios must be in alignment with the goals and objectives of the written and simulated test.

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Appendices

Appendix A

UNIVERSITY OF SOUTHERN CALIFORNIA
UNIVERSITY PARK INSTITUTIONAL REVIEW BOARD
FWA 00007099
Approval Notice for Exempt Applications (Contingencies have been met)
Date: Tue Nov 20 16:35:46 2007
Principal Investigator: Harold O'Neil
Faculty Advisor:
Co-Investigators: F Sutter Fox
Donna Ayala
Project Title: Surface Warfare Simulation
USC UPIRB # UP-07-00378
The University Park Institutional Review Board (IRB) designee requested modifications/clarifications to the above referenced study on **11/07/2007**.
It is noted that the required responses were provided as requested by the IRB. The IRB
determined that your project meets the requirements outlined in 45 CFR 46.101 (categories 1 &
2) and qualifies for exemption from IRB Review. IRB Exemption of this study was granted on
11/20/2007.
The UPIRB has made minor revisions to the Information Sheet . The marked document is
attached for your records. Please use the document when making revisions in the future. The
researchers should use both the Information Sheet and the Release Form. The Release Form for
grades is used to obtain explicit written permission to access grades and evaluations. The

Release Form is kept separate from the data.
Your study is exempt from the regulations under 45 CFR 46; however, in order to be compliant
with the principles of the Belmont Report, the UPIRB recommends that you use the revised
documents when recruiting or enrolling potential subjects. The recruitment document and
Information Sheet (and Release Form) will not be stamped by the UPIRB, but can be accessed
under the “Documents” tab in the study workspace in iStar.
https://istar-
Page 2 of 2
The researchers are reminded that permission must be obtained from the research site. The
policies and procedures from those entities must be followed when conducting research. It is the
researchers’ responsibility to make sure all local polices and procedures are adhered to, as well
as UPIRB and USC Policies and Procedures. The University of Southern California, according
to addendum DoD N-A0060 to its FWA 00007099, has agreed to abide by Department of
Defense - Department of the Navy regulations and policies for the protection of human research
subjects and this protocol has been reviewed accordingly.
Sincerely,
Scott Maul, Ph.D.
Program Specialist, University Park IRB
Attached Documents:
Certified SWOS Release Form.doc
SWOS informed consent_staffrev112007.doc
Funding Source(s):
Funding Agency: NAVY
Contract or Grant Number: 0070 G HC 650
PI of Project: Harold O'Neil
Title of Project: FORMATIVE EVALUATION AND THE EFFECTS OF COGNITIVE
READINESS IN A SURFACE WARFARE SIMULATION TO IMPROVE PROBLEM

Appendix B

STUDENT INTRODUCTION

Thank you for agreeing to participate in our survey for the effects of cognitive readiness in a surface warfare simulation. It will take approximately 30-40 minutes to complete the questionnaires. Your participation in this study is completely voluntary. Please try to answer as many statements as you can. It is very important for us to learn your opinions. Your survey responses will be strictly confidential and data from this research will be reported only in the aggregate. If you have questions at any time about the survey or the procedures, you may contact Ms. Donna Ayala at dayala@usc.edu, Mr. Sutter Fox at ffox@usc.edu. Or if you have questions regarding your rights as a research subject, call Mr. Sid Kushner of the IRB Board at 213-537-5027.

Thank you very much for your time and support.

Appendix C
Problem Solving Questionnaire

Service Number:_____

Directions. A number of statements that people have used to describe themselves are given below. Read each statement and indicate how you generally think or feel by marking one of the responses. There are no right or wrong answers. Do not spend too much time on any one statement. Remember, mark the answer that seems to describe how you *generally* think or feel.

		Almost Never	Some-times	Often	Almost Always
1.	When I study, I try to relate new material to things I have learned in other subjects.	1	2	3	4
2.	Thinking about my grade in a course interferes with my work on tests.	1	2	3	4
3.	I'm certain I can understand the most difficult material presented in texts.	1	2	3	4
4.	When I study, I start by figuring out exactly what I need to learn.	1	2	3	4
5.	I freeze up on important exams.	1	2	3	4
6.	When studying, I work as hard as possible.	1	2	3	4
7.	When I study, I figure out how the information might be useful in the real world.	1	2	3	4
8.	During exams I find myself thinking about whether I'll ever get through school.	1	2	3	4
9.	I'm confident I can understand the most complex material presented by the teacher.	1	2	3	4

		Almost Never	Some-times	Often	Almost Always
10.	When I study, I force myself to check to see if I remember what I have learned.	1	2	3	4
11.	The harder I work at taking a test, the more confused I get.	1	2	3	4
12.	When studying, I keep working even if the material is difficult.	1	2	3	4
13.	When I study, I try to understand the material better by relating it to things I already know.	1	2	3	4
14.	Thoughts of doing poorly interfere with my concentration on tests.	1	2	3	4
15.	When I study, I try to figure out which concepts I still haven't really understood.	1	2	3	4
16.	I'm confident I can do an excellent job on assignments and tests.	1	2	3	4
17.	When studying, I try to do my best to acquire the knowledge and skills taught.	1	2	3	4
18.	I seem to defeat myself while working on important tests.	1	2	3	4
19.	When I study, I figure out how the material fits in with what I have already learned.	1	2	3	4
20.	I'm certain I can master the skills being taught.	1	2	3	4

	Almost Never	Some-times	Often	Almost Always
21. During tests I find myself thinking about the consequences of failing.	1	2	3	4
22. When I study, I make sure that I remember the most important things.	1	2	3	4
23. When studying, I put forth my best effort.	1	2	3	4
24. During examinations I get so nervous that I forget facts I really know.	1	2	3	4
25. When I study, and I don't understand something I look for additional information to clarify this.	1	2	3	4

SCORING KEY

Scale/Item	Item No.
Elaboration	
When I study, I try to relate new material to things I have learned in other subjects.	1
When I study, I figure out how the information might be useful in the real world.	7
When I study, I try to understand the material better by relating it to things I already know.	13
When I study, I figure out how the material fits in with what I have already learned.	4
Self Efficacy	

Scale/Item	Item No.
I'm certain I can understand the most difficult material presented in texts.	3
I'm confident I can understand the most complex material presented by the teacher.	9
I'm confident I can do an excellent job on assignments and tests.	16
I'm certain I can master the skills being taught.	20
Effort and Perseverance	
When studying, I work as hard as possible.	6
When studying, I keep working even if the material is difficult.	12
When studying, I try to do my best to acquire the knowledge and skills taught.	17
When studying, I put forth my best effort.	23
Control Strategies	
When I study, I start by figuring out exactly what I need to learn.	14
When I study, I force myself to check to see if I remember what I have learned.	10
When I study, I try to figure out which concepts I still haven't really understood.	15
When I study, I make sure that I remember the most important things.	22
When I study, and I don't understand something I look for additional information to clarify this.	25
Test Anxiety (Worry)	
Thinking about my grade in a course interferes with my work on tests.	2
I freeze up on important exams.	5
During exams I find myself thinking about whether I'll ever get through school.	8

Scale/Item	Item No.
The harder I work at taking a test, the more confused I get.	11
Thoughts of doing poorly interfere with my concentration on tests.	14
I seem to defeat myself while working on important tests.	18
During tests I find myself thinking about the consequences of failing.	21
During examinations I get so nervous that I forget facts I really know.	24

Teamwork Questionnaire
Appendix D

Service Number: _____

Directions: This set of questions is to help us understand the way you think and feel about working with others. Read each statement below and indicate how you generally think or feel. There are no right or wrong answers. Do not spend too much time on each question.

	Almost Never	**Some-times**	**Often**	**Almost Always**
1. When I work as part of a team, I exercise leadership.	**1**	**2**	**3**	**4**
2. When I work as part of a team, I ensure the instructions are understood by all team members prior to starting the task.	**1**	**2**	**3**	**4**
3. When I work as part of a team, I understand and contribute to the organizational goals.	**1**	**2**	**3**	**4**
4. When I work as part of a team, I teach other team members.	**1**	**2**	**3**	**4**
5. When I work as part of a team, I interact cooperatively with other team members.	**1**	**2**	**3**	**4**
6. When I work as part of a team, I allocate the tasks according to each team member's abilities.	**1**	**2**	**3**	**4**
7. When I work as part of a	**1**	**2**	**3**	**4**

team, I know the process of making a decision.				
8. When I work as part of a team, I know the process of making a decision.	**1**	**2**	**3**	**4**
9. When I work as part of a team, I conduct myself with courtesy.	**1**	**2**	**3**	**4**
10. When I work a part of a team, I ask for the instructions to be clarified when it appears not all the team members understand the task.	**1**	**2**	**3**	**4**
11. When I work as part of a team, I help ensure the proper balancing of the workload.	**1**	**2**	**3**	**4**
12. When I work as part of a team, I know how to weigh the relative importance among different issues.	**1**	**2**	**3**	**4**
13. When I work as part of a team, I lead when appropriate, mobilizing the group for high performance.	**1**	**2**	**3**	**4**
14. When I work as part of a team, I respect thoughts and opinions of others in the team.	**1**	**2**	**3**	**4**
15. When I work as part of a team, I can identify potential problems readily.	**1**	**2**	**3**	**4**
16. When I work as part of a team, I communicate in a manner to ensure mutual understanding.	**1**	**2**	**3**	**4**
17. When I work as part of a team, I do my part of the organization in a timely manner.	**1**	**2**	**3**	**4**
18. When I work as part of a team, I prepare sufficiently to	**1**	**2**	**3**	**4**

make a decision.				
19. When I work as part of a team, I lead the team effectively.	**1**	**2**	**3**	**4**
20. When I work as part of a team, I treat others with courtesy.	**1**	**2**	**3**	**4**
21. When I work as part of a team, I willingly contribute solutions to resolve problems.	**1**	**2**	**3**	**4**
22. When I work as part of a team, I seek and respond to feedback.	**1**	**2**	**3**	**4**
23. When I work as part of a team, I track other team member's progress.	**1**	**2**	**3**	**4**
24. When I work as part of team, I solicit input for decision making from my team members.	**1**	**2**	**3**	**4**
25. When I work as part of a team, I demonstrate leadership and ensure team results.	**1**	**2**	**3**	**4**
26. When I work a part of a team, I adapt readily to varying conditions and demands.	**1**	**2**	**3**	**4**
27. When I work as part of a team, I listen attentively.	**1**	**2**	**3**	**4**
28. When I work as part of a team, I am able to change decisions based upon new information.	**1**	**2**	**3**	**4**
29. When I work as part of a team, I try to bring out the best in others.	**1**	**2**	**3**	**4**
30. When I work as part of a team, I recognize conflict.	**1**	**2**	**3**	**4**
31. When I work as part of a	**1**	**2**	**3**	**4**

team, I clearly and accurately exchange information.				
32. When I work as part of a team, I emphasize the meeting of deadlines.	**1**	**2**	**3**	**4**
33. When I work as part of a team, I accept individual differences among members.	**1**	**2**	**3**	**4**
34. When I work as part of a team, I identify needs or requirements and develop quality/timely solutions.	**1**	**2**	**3**	**4**
35. When I work as part of a team, I pay attention to what other are saying.	**1**	**2**	**3**	**4**
36. When I work as part of a team, I treat all my team members as equals.	**1**	**2**	**3**	**4**

Teamwork Scoring Key

Scales	**Items**
Coordination (n=5)	6,11,17,23, 32
Decision Making (n=6)	3,7,12,18,24,28
Leadership (n=7)	1,4,8,13,19,25,29
Interpersonal Skills (n=6)	5,9,14,20,33,36
Adaptability (n=5)	15, 21, 26, 30, 34
Communication (n=7)	2, 10, 16, 22, 27, 31, 35

Creativity Questionnaire
Appendix E

Service Number: _____

Directions: This set of questions is to help us understand your level of creativity in different situations. Read each statement below and bubble in one answer per question. Do not spend too much time on each question.

ELABORATION SUBSCALE

1) When something unfair happens to you, can you figure out all of the reasons behind that event?

❍ I don't.

❍ Sometimes, I do.

❍ Usually, I do.

2) When something strange occurs, what do you usually do?

❍ I do not look for the possible reasons.

❍ I look for some possible reasons.

❍ I look for all of the possible reasons.

3) When you get interested in something, how much attention do you pay to the details?

❍ I do not pay much attention to the details.

❍ I pay attention to some of the details.

❍ I pay attention to all of the details.

4) When you listen to a song, how much attention do you pay to what the song says?

❍ I never pay attention.

❍ Sometimes, I pay attention.

❍ I pay a lot of attention.

5) When you look at a piece of art work, do you think about what the artist is trying to say?

❍ I do not.

❍ I do at times.

❍ I always do this.

6) After you have seen a movie that has affected you, what do you usually do?

❍ I move on to my next activity.

❍ I think about some aspects of the movie.

❍ I think about many aspects of the movie.

7) When you write a letter, what do you usually include?

❍ I include some general information about myself.

❍ I include some general information and a few additional description.

❍ I include some general information and many additional description.

ELABORATION SUBSCALE (continued)

7) When you read a book, do you create pictures of the characters in your mind?

❍ I do not create pictures.

❍ I create some pictures.

❍ I create many pictures.

9) How much complexity do you enjoy in what you do?

❍ I enjoy doing things that are straightforward.

❍ I enjoy a little complexity in what I do.

❍ I enjoy a lot of complexity in what I do.

10) How involved do you get in the details of what you are doing?

❍ I do not get involved with the details.

❍ I get involved with a few of the details.

❍ I get involved with many of the details.

FLEXIBILITY SUBSCALE

11) Would you ever be interested in a job which would require you to make up stories in front of audiences?

❍ I would not be interested.

❍ I might be interested.

❍ I would be interested.

12) When you need to communicate with someone who speaks English poorly, how easy is it for you to come up with simpler ways to communicate with that person?

❍ It usually is difficult for me.

❍ It sometimes is easy for me.

❍ It often is easy for me.

13) How much do you enjoy making new things out of existing objects?

❍ I usually do not enjoy making new things.

❍ I sometimes enjoy making new things.

❍ I often enjoy making new things.

14) What do you do with people who are difficult to convince?

❍ I have trouble coming up with convincing arguments.

❍ I try to come up with few alternative arguments to convince them.

❍ I come up with a variety of arguments to convince them.

15) How do you approach a complex task?

❍ I come up with a single approach.

❍ I may be able to come up with few approaches.

❍ I will be able to come up with a variety of approaches.

16) Which kind of job you like the most?

❍ I like a job in which almost everything is done based on rules or instructions.

❍ I like a job in which some of the work is done based on rules

❍ or instruction.

❍ I like a job which is not based on rules or instructions.

17) What kind of job interests you?

❍ A job which requires you to follow instruction.

❍ A job which requires some talent.

❍ A job which requires a lot of talent.

FLEXIBILITY SUBSCALE **(continued)**

18)If you were invited to a meeting to discuss problems in your community, how difficult it would be for you to come up with a long list of problems?

❍ It would be very difficult.

❍ It would somewhat difficult.

❍ It would not be difficult at all.

19)If you were asked to help the city council to come up with many ideas, how would you do?

❍ It would be difficult for me to generate ideas beyond those the City Council has considered already.

❍ I would be able to generate a few ideas beyond those which had been considered already.

❍ I would be able to generate a variety of ideas for the City Council.

20) Would you be able to help a first grade teacher generate many alternative ways for teaching numbers in such a way that children would become interested in learning numbers.

- ❍ No, I would not be able to do that.
- ❍ I might be able to generate a few alternative ways.
- ❍ Yes, I would be able to generate many alternative ways.

21)How easy would it be for you to help a school with very limited resources, to come up with interesting ideas for new sports and games?

- ❍ It would be very difficult.
- ❍ I would be able to come up with few ideas.
- ❍ I would be able to come up with many ideas.

22) How easily do words come to you when you express yourself?

- ❍ Words do not come easily.
- ❍ Sometimes, words come easily.
- ❍ Often, words come easily.

23) How well do you express yourself?

- ❍ I do not express myself well.
- ❍ Occasionally, I express myself well.
- ❍ Often, I express myself well.

FLUENCY SUBSCALE

24) How well do you express your ideas?
- ❍ I have difficulty expressing my ideas well.
- ❍ I am able to express some of my well.
- ❍ I am able to express all of my ideas well.

25) If a group of people were to ask you to give an unprepared speech, how well do you do?
- ❍ I would not do well.
- ❍ I am not sure how well I would do.
- ❍ I would do well.

26) How easy is it for you to come up with words to describe something?
- ❍ It is difficult for me.
- ❍ It is not very easy for me.
- ❍ It is easy for me.

27) How comfortable would you be in a job which requires you to come up with many ideas?
- ❍ I would not be comfortable.
- ❍ I might be comfortable.
- ❍ I would be very comfortable.

28) How easy would it be for you to come up with many alternative words to express the same idea?
- ❍ It would be quite difficult for me.
- ❍ It would not that easy for me.
- ❍ It would be quite easy for me.

29)If you had to participate in a contest in which you were asked to come up with as many words as possible which began with the letter "J", how would you do?
- ❍ I would do poorly.

❍ I would do okay.

❍ I would do very well.

30) If you were asked to participate in a contest of naming things that belong in a given category (class) like food or plants, how well would you do?

❍ I would do poorly.

❍ I would do well.

❍ I would do quite well.

FLUENCY SUBSCALE (continued)

31)How many sentences could you come up if they all would have to begin with the same word?

❍ I could come up with only a few sentences.

❍ I could come up with several sentences.

❍ I could come up with many sentences.

32)Would you be able to come up with a number of possible uses for things other than their common use?

❍ It would be very difficult for me.

❍ I might be able to come up with a few possible uses.

❍ I would be able to come up with a number of possible uses.

33) How easy would it be for you to tell many new stories?

❍ It would be difficult for me.

❍ It would not be that easy for me.

❍ It would be easy for me.

34) Which of the following would you prefer to do?

❍ Reading a poem.

❍ Learning a poem.

❍ Discussing a poem.

35) If you were asked to write a newspaper article about your community, which of the following choices would you prefer?

- ❍ I would copy other articles.
- ❍ I would add to other articles
- ❍ I would write my own article.

36) Which of the following do you enjoy the most?

- ❍ I enjoy reading famous books.
- ❍ I enjoy reading famous books and writing some of my own.
- ❍ I enjoy writing my own books.

37) How easy would it be for you to write many synonyms for the word "fast"?

- ❍ It would be very difficult for me.
- ❍ It would be somewhat difficult for me.
- ❍ It would be easy for me.

FLUENCY SUBSCALE (continued)

38) Let us suppose that we lost all of the possible ways to heat food, how easy would it be for you to come up with a list of other ways to heat food?

- ❍ It would be very difficult for me.
- ❍ It would be somewhat difficult for me.
- ❍ It would be easy for me.

39) If you had to give a speech, how would you present it?

- ❍ I would read my prepared notes verbatim.
- ❍ I would read mostly from my notes.
- ❍ I would glance occasionally at my notes.

40) When you are faced with an extremely difficult problem, what do you usually do?

❍ I usually ask for the answer.

❍ I usually look up for the answer.

❍ I usually make up my own answer.

ORIGINALITY SUBSCALE

41) If You were making something, and you discovered suddenly that you were missing an important part, what would you do?

❍ I would stop.

❍ I would try to find the missing parts, and if I could not find them, I would stop.

❍ I would try to find the missing parts, and if I could not find them, I would make some substitute.

42) When you are in a public place, do you ever try to guess what people who are far away from you are discussing?

❍ I am never interested in guessing what other people discuss.

❍ Sometimes I like to guess what other people discuss.

❍ I always like to guess what other people are discussing.

43) Do you enjoy solving difficult problems?

❍ I do not enjoy solving difficult problems.

❍ I rarely enjoy solving difficult problems.

❍ I often enjoy solving difficult problems.

44) When you are faced with a new kind of problem, what do you usually do?

❍ I have someone else do it for me.

❍ I try to do it with someone else's help.

❍ I try to get more information so that I can solve it on my own.

45) What would you do if you were solving a difficult problem?

❍ I would ask a teacher or someone else to help me.

❍ I would read a book on that subject.

❍ I would try a number of different ways to come up with my own answer.

46) When you have an unusual problem, how do you usually solve it?

❍ I often seek help.

❍ Before I seek help, I spend a short period of time trying to solve the problem on my own.

❍ I spend a lot of time trying to solve a problem on my own.

ORIGINALITY SUBSCALE **(continued)**

47) Do people think that you ask tough questions?

❍ No, they don't.

❍ Sometimes, they do.

❍ Often, they do.

48) Do people think that you come up with unique ideas?

❍ No, they don't.

❍ Sometimes, they do.

❍ Often, they do.

49) Do you find that you usually like to try new things?

❍ I do not usually try new things.

❍ I sometimes try new things.

❍ I often try new things.

50) When you encounter a complex problem what do you do?

❍ I try to avoid it.

❍ I spend a short period of time trying to solve it until I get frustrated.

❍ I spend a lot of time trying to solve it.

51) Do you enjoy new experiences?

❍ I do not enjoy new experiences.

❍ I sometimes enjoy new experiences.

❍ I usually enjoy new experiences.

52) How much do you depend on others when you find yourself in an impossible situation?

❍ I often depend on others.

❍ I sometimes depend on others.

❍ I usually prefer to depend on myself.

53) How confident are you when you do something on you own?

❍ I do not have much confidence.

❍ I have some confidence.

❍ I have a lot of confidence.

ORIGINALITY SUBSCALE **(continued)**

54) Do you enjoy scientific experimentation?

❍ I do not enjoy experimentation.

❍ I enjoy experimentation to some extent.

❍ I enjoy experimentation a lot.

55) How good would you be at designing new toys for children?

❍ I would not be very good at this.

❍ I might be able to come up with a few ideas.

❍ I would be able to come up with many ideas.

56) If you were a substitute teacher for a Kindergarten class without a teaching plan, how well would you do?

- ❍ I would fail.
- ❍ I would have a hard time.
- ❍ I would do well.

Appendix F

Table 34: Student's Retention Measure (N=52)

Student number	Communications	Coordinate/Organize	Recognized maritime picture (RMP)	Search plan	Identify and classify contacts	Contact	Visual identification (VID)	Maintain surprise/Emissions Control (EMCON)	Best weapons	Battle damage assessment (BDA)	STUDENT TOTAL
101	1										1
104	1	1	1		1	1			1		6
105	1		1								2
106	1	1									2
107	1	1	1								3
108	1	1	1	1	1	1		1			7
109	1										1
110											
111			1		1	1	1		1		5
112	1										1
113											
114											
115	1	1	1	1	1	1		1	1		8
116	1	1	1		1		1	1	1		7
117	1	1			1						3
118	1	1	1	1	1	1					6
119	1	1	1	1	1	1					6

120									1		1
121	1	1	1		1	1	1	1			7
122	1	1			1						3
124											
125	1	1									2
126	1	1									2
127	1	1									2
129		1	1	1	1				1		5
130											
131	1	1			1				1	1	5
132	1	1	1								3
134											
135											
136											
138	1	1									2
139				1	1						2
141	1										1
142											
144	1	1			1				1		4
145	1	1									2
147	1	1	1		1						4
148	1										1
149		1	1								2
159	1	1	1		1	1	1				6
160											
161											
162	1	1									2
163	1	1									2
164	1	1									2
165	1										1
166											
167	1	1									2
168	1	1									2
169	1										1
170	1				1						2
TOTALS	35	28	15	6	17	8	4	4	8	1	126

Appendix G

Table: 35- Retention Individual Raters Score

Stud. No.	Rater 1	Rater 2	Consensus
101	1	1	1
104	5	6	6
105	1	1	1
106	1	1	1
107	2	3	3
108	7	6	7
109	1	1	1
110	0	0	0
111	4	5	5
112	1	1	1
113	0	0	0
114	0	0	0
115	8	8	8
116	7	7	7
117	3	2	3
118	6	6	6
119	6	6	6
120	1	1	1
121	7	7	7
122	3	3	3
124	0	0	0
125	2	2	2
126	2	2	2
127	2	2	2
129	2	2	2
130	0	0	0
131	5	4	5
132	3	3	3
134	0	0	0
135	0	0	0
136	0	0	0
138	2	2	2
139	2	2	2
141	1	1	2
142	0	0	0
144	4	4	4
145	2	2	2
147	3	4	4
148	1	1	1

149	2	2	2
159	6	6	6
160	0	0	0
161	0	0	0
162	2	2	2
163	2	2	2
164	2	2	2
165	1	1	1
166	0	0	0
167	2	2	2
168	2	2	2
169	1	1	1
170	2	2	2

Appendix H

Table 36: Student's Transfer Measure (N=52)

Student number	Increase scenario fidelity	Improve Link modeling	Improve tactical aircraft employment	Improve reporting procedures	Add ability to organize assets other than own ship	Improve gunfire simulation	Improve environmental modeling	Improve missile attack coordination	Improve optical sight	Improve bridge/CIC coordination	TOTAL
101											
104	1			1							2
105											
106											
107	1										1
108	1	1	1		1		1	1			6
109											
110	1					1			1		3
111											
112	1										1
113	1			1							2
114	1										1
115		1									1
116			1								1

117										
118	1	1								2
119										
120	1		1							2
121										
122										
124	1		1							2
125										
126		1			1					2
127	1	1		1						3
129						1	1			2
130										
131										
132										
134										
135										
136	1									1
138										
139	1									1
141								1		1
142		1								1
144				1						1
145	1									1
147										
148	1		1							2
149	1	1	1							3
159	1				1					2
160										
161										
162	1									1
163										
164				1						1
165										
166	1									1
167										
168										
169				1						1
170	1				1					2
	20	7	6	6	4	2	2	2	1	50

Appendix I

Table 37: Transfer Individual Raters Score

Stud. No.	Rater 1	Rater 2	Consensus
101	1	2	2
104	0	0	0
105	0	0	0
106	0	0	0
107	1	1	1
108	6	5	6
109	0	0	0
110	3	3	3
111	0	0	0
112	1	1	1
113	2	2	2
114	1	1	1
115	1	1	1
116	1	1	1
117	0	0	0
118	2	1	2
119	0	0	0
120	1	1	1
121	0	0	0
122	0	0	0
124	1	1	1
125	0	0	0
126	1	1	1
127	2	3	3
129	1	1	1
130	0	0	0
131	0	0	0
132	0	0	0
134	0	0	0
135	0	0	0
136	1	1	1
138	1	1	1
139	1	1	1
141	1	1	1

142	1	1	1
144	1	1	1
145	1	1	1
147	0	0	0
148	2	2	2
149	3	2	2
159	1	1	1
160	1	1	1
161	0	0	0
162	1	1	1
163	0	0	0
164	0	0	0
165	1	1	1
166	1	1	1
167	0	0	0
168	0	0	0
169	1	1	1
170	2	2	2