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Factors affecting training effectiveness in synchronous, dispersed virtual environments

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MBA PROFESSIONAL REPORT

FACTORS AFFECTING TRAINING EFFECTIVENESS IN SYNCHRONOUS, DISPERSED VIRTUAL ENVIRONMENTS

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June 2014

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The U.S. Navy is investigating the feasibility of incorporating distance learning technology to its technical training programs. Specifically, a distance learning model with instruction provided through 3-D virtual worlds could provide effective training at a significant cost savings as compared to traditional training models. Students learn differently in a virtual environment than they do with face-to-face instruction, however, and for the Navy to successfully incorporate training through virtual worlds, it must accommodate the learning challenges specific to the medium. For students in training, monitoring of student perceptions about the virtual environment would serve as the best available barometer of the effectiveness of the training design and could provide early warnings of students who have difficulty learning in the virtual environment. Some students may be better suited to this type of training than others, and measurable personality factors may be helpful in predicting which students would be most likely to succeed in the virtual environment.

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FACTORS AFFECTING TRAINING EFFECTIVENESS IN SYNCHRONOUS, DISPERSED VIRTUAL ENVIRONMENTS

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Submitted in partial fulfillment of the requirements for the degree of

MASTER OF BUSINESS ADMINISTRATION

from the

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June 2014

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ABSTRACT

The U.S. Navy is investigating the feasibility of incorporating distance learning technology to its technical training programs. Specifically, a distance learning model with instruction provided through 3-D virtual worlds could provide effective training at a significant cost savings as compared to traditional training models. Students learn differently in a virtual environment than they do with face-to-face instruction, however, and for the Navy to successfully incorporate training through virtual worlds, it must accommodate the learning challenges specific to the medium. For students in training, monitoring of student perceptions about the virtual environment would serve as the best available barometer of the effectiveness of the training design and could provide early warnings of students who have difficulty learning in the virtual environment. Some students may be better suited to this type of training than others, and measurable personality factors may be helpful in predicting which students would be most likely to succeed in the virtual environment.

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LIST OF ACRONYMS AND ABBREVIATIONS

CAI	computer aided instruction
CSE	core self-evaluation
CSES	Core Self-Evaluation Scale
TAM	technology acceptance model
TRA	theory of reasoned action
VLE	virtual learning environment

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EXECUTIVE SUMMARY

Distance learning technologies offer significant promise to reduce the costs of Navy training through 1) the physical consolidation of training hardware and expertise and 2) the distribution of that training to a broad dispersion of fleet locations using high speed networks and virtual world technology. Students learn differently through virtual interaction than they do in face-to-face communication, though, and understanding the difference is critical to achieving the desired training outcomes.

Disambiguation. Because the research relevant to this topic comes from a wide variety of scientific disciplines, much of the literature attaches different meanings to the same words. To prevent confusion or the comparison of contextually incompatible studies, it is necessary to clarify a few key definitions:

- A **Virtual Learning Environment** (VLE) is a three-dimensional representation of reality used as a medium for instruction.
- VLE can be either **Proximate** (student and instructor in the same room) or **Dispersed** (student and instructor separated by geographical distance) (Johansen, 1992). This report concerns only dispersed VLE.
- VLE can be either **Synchronous** (students and instructors use the system simultaneously in real time) or **Asynchronous (**Johansen, 1992)**.** This report concerns only synchronous VLE.
- The pedagogies of VLE used in military training can be either **Objectivist** (classroom) or **Constructivist** (simulator) (Benbunan-Fich, 2002). This report concerns both objectivist and constructivist VLE.
- The use of VLE by the student can be either **Mandatory** or **Volitional**. This report concerns only mandatory use environments.
- **Communication Richness**, sometimes called interactivity, is the effectiveness and fidelity with which the VLE permits communication between two physically separated users (Daft & Lengel, 1986).
- **Learner Control,** sometimes called interactivity, is the degree to which students can modify the content, form, pace, or path of instruction to suit their individual needs (Milheim & Martin, 1991). It is often cited as a selling point for VLE, but it is much more important in asynchronous environments than in synchronous environments. It introduces its own complications, and may be intentionally restricted by training course design.

Findings

The Technology Acceptance Model (TAM; Davis, 1989) is a widely accepted concept in information systems research concerning the volitional adoption of IT systems. As a psychological model, it presents an ideal framework for connecting learning outcomes to the antecedent variables of student personality factors and student perceptions. Through the mediating processes of cognitive attitude and cognitive engagement, the same pathways that lead to technology acceptance can lead to desirable learning outcomes in a technology-mediated learning environment.

Student Personality

The personality factors chosen as predictors of success in learning through VLE are the student’s core self-evaluation, goal orientation, and regulatory focus. These factors were selected based on their experimentally validated acceptance within academic psychology and the ease with which they can be identified in a student through established methods.

Core self-evaluation is a comprehensive measure of the student’s self-perceptions (Judge, Erez, & Bono, 1998). It comprises the student’s beliefs about their capability, emotional control, self-worth, and their ability to control their own fate. Predictably, students who are confident about their ability to control themselves and the world around them are more likely to succeed in academic endeavors than those who lack confidence. Presumably, this observation extends to the ability to learn in VLE.

Goal orientation is essentially a way of looking at motivation in achievement settings (Dweck & Leggett, 1988). In a learning environment, it concerns whether a student would rather make the best possible grade or learn the most from the course, given the choice. For students preoccupied with grades (performance), it matters whether they are more interested in receiving good grades and accolades or in avoiding bad grades and ridicule—in other words, to use a sports analogy, the degree to which they “want the ball.” Students who fight for good grades or strive for mastery of the course material both tend to achieve the desired learning outcomes, while students preoccupied with avoiding bad grades will generally not perform as well.

Regulatory focus is complimentary to goal orientation in that it concerns motivation and the achievement of goals. Regulatory focus theory holds that the drive to achieve a goal will generally come from one of two systems of motivation: the desire to acquire a good thing, or the desire to avoid a bad thing (Higgins, 1997). Where goal orientation looks at an individual's reasons for choosing a certain goals, regulatory focus provides detailed insight into the individual's process for achieving the goal. In the context of this report, regulatory focus can provide additional insight to a student's mechanisms for goal achievement, but is unlikely to independently predict performance in the VLE.

Student Perceptions

Where personality factors are helpful in predicting successful learning outcomes, the student's perceptions about the learning environment are also helpful in gauging progress and understanding performance. Rather than looking at qualities intrinsic to the student, the students' perceptions reveal the qualities of the learning environment *as perceived by the student*. The student's perspective is the best available indicator of how well the environment is actually working. For example, if the students perceived that the hardware is malfunctioning while it is actually performing as designed, their learning would still be negatively impacted, which would suggest that the design should be modified.

Perceived system performance concerns the way a student feels about the training hardware. Based on preconceived notions and their own experience, students will make judgments about the system's usefulness, ease-of-use, technical reliability, and communication richness:

Perceived usefulness and perceived ease of use are well-established contributors to technology acceptance. Perceived usefulness is the degree to which the user feels the system is helpful or beneficial in the achievement of their overall goals, and perceived ease of use is the degree to which the user feels that using the system is effort-free (Davis, 1989). Considered together, these two factors address the extent to which a user feels that the system is more helpful than it is inconvenient.

Technical reliability refers to the degree to which the system performs as designed. Again, perception matters more than reality here—a student can easily become convinced that bugs or connectivity issues are unfairly hampering their progress, which can introduce lingering biases that inhibit learning and motivation.

Communication richness refers to the effectiveness and fidelity with which physically separated users can communicate (Daft & Lengel, 1986), and it naturally affects the students' sense of immersion or isolation in the environment, which then affects learning. Student-to-student interaction is important when the students are physically isolated, because students need one another as a frame of reference to gauge their own performance (Conner, 2003).

Perceived quality of execution concerns the students' perceptions of the instructors: their attitudes, their interactivity, and their technological competence:

Instructor attitudes toward the technology will affect the students' attitudes, and therefore, their ability to learn. Instructors have many reasons to dislike the idea of VLE: it is time-consuming compared to traditional instruction (Hiltz, 1993), time and energy devoted to mastering the technology could be devoted to mastering the course material, and instructors may perceive it to be an inferior mode of instruction chosen for cost savings. If students perceive that their instructors dislike the VLE, they are likely to adopt the same attitudes, necessarily affecting satisfaction and motivation.

The instructors' interactivity refers to their teaching style. Specifically, it concerns the degree to which the instructor is deliberately, personally interactive with the student through the medium of VLE. Keeping students engaged is more challenging in the virtual world than it is in person, and the physical separation can make it difficult to identify gaps in understanding. Instructors can partially compensate by practicing immediacy behaviors, such as calling students by name or asking probing questions (Curtis & Mazzone, 2013).

The instructor's technological competence refers to their proficiency in operating the virtual environment. Technical problems are distracting and irritating to students, and can contribute to the impression that VLEs are an inferior mode of instruction (Piccoli, Ahmad, & Ives, 2001). Students become impatient while instructors troubleshoot problems with operations or connectivity. Perceptions that an instructor lacks competence in operating the learning environment will undermine that instructor's overall credibility as a technical expert.

Recommendations

Despite the challenges inherent to this method of instruction, the barriers to practical adoption of VLE for Navy training are falling as network technology evolves. In the near future it may be possible to distribute advanced training worldwide from a single facility, including to students aboard deployed ships, entirely through the virtual medium. To stay ahead of the technological curve and fully capitalize on new technology as it becomes available, the Navy should begin sincerely developing the necessary methods and infrastructure immediately.

The most practical format for conversion of existing training programs to VLE is a synchronous environment with restrictive learner control. Unfortunately, this limited approach runs the risk of introducing all of the undesirable qualities of distance learning while barely scratching the surface of the VLE's potential as a teaching tool. As the Navy's confidence in virtual world technologies grows, it should explore the learning potential of asynchronous environments with high degrees of learner control. A course taught in this format would have little resemblance to anything in practice today.

While the VLE offers promise of significant cost savings, there has never been a shortage of ways to make training cheaper. The problem with cheaper training is that it regularly proves to be inferior, in spite of promises to the contrary. Instead of promising sufficient training at a net cost savings, VLE should be developed as a way to make training *better*— in terms of expediency, availability, and most importantly, effectiveness.

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I. INTRODUCTION

A. PROBLEM STATEMENT

The U.S. Navy faces a constrained budget environment now and for the foreseeable future. In spite of stark budget realities, the highly technical skills of today's sailors and the highly sophisticated systems they operate continue to demand high quality training. Delivering this training across a variety of fleet locations requires the establishment of instructional facilities featuring expensive simulators and a proficient instructional staff, which strains the Navy's funding as well as its manpower.

As instructional technology evolves, the Navy should capitalize on new developments in its effort to provide the most effective training achievable at the lowest practicable cost to the taxpayer. Distance learning techniques employing the emerging technology of 3-D virtual world instruction offer significant promise to reduce the costs of training. The consolidation of simulator hardware and instructional staff in a few large facilities could capture significant efficiencies in manning and simulator hardware. Electronically delivering this training capability across high speed data networks could eliminate the need for travel and temporary lodging of trainees. As common network technology continues to progress in speed and bandwidth, distributed virtual training becomes feasible across ever-greater geographical distances.

In any attempt to achieve learning outcomes, it is important to consider the cognitive implications of the learning environment. Students learn differently through virtual interaction than they do with face-to-face communication. If we expect to be successful in delivering quality training through virtual worlds, we must ensure that we understand these differences and design our training programs to accommodate them.

B. RESEARCH QUESTION

The purpose of this report is to further the Navy's understanding of trainee learning in dispersed virtual environments. In keeping with that purpose, I have sought to answer the question, "What common psychological models are most useful in framing the way a student perceives the virtual world as a learning environment?" Furthermore, it is important to identify the individual factors that affect the student's likelihood of achieving desirable learning outcomes—whether they are intrinsic personality factors of the student, ingrained biases or beliefs, or factors specific to the execution of the training program. To that end, this report seeks to answer the question, "What perceptions or personality factors are most relevant to the student's ability to learn in the virtual environment?"

C. APPROACH

This report draws from prominent research in fields including (but not limited to) education, industrial and organizational psychology, information systems, and business management. It also draws from lesser-known, niche research on virtual world technology. In identifying established psychological models relevant to the research questions, it was necessary to omit many viable candidates in the interest of parsimony. The models I reference in this report are what I consider to be the *most* relevant research of everything investigated, as well as the most appealing starting points for future research in this area.

D. ORGANIZATION

This report begins with an executive summary and this introduction. The executive summary should address most of the concerns of decision-makers in business or government who would be interested in this research. This introduction is followed by a background chapter that illuminates the context of this research within the Navy's training needs, and clarifies the vocabulary of virtual learning technology as necessary to synchronize the rest of the report. Following the background chapter is a brief explanation of the research method, followed by a detailed literature review.

The literature review chapter contains the bulk of the research findings. It is essentially composed of three parts. The first part concerns the establishment of a conceptual framework for learning in the virtual environment, including the learning outcomes and the cognitive processes that mediate the learning process. The second and third parts concern the student's intrinsic personality factors and the perceptions that affect the greater theoretical framework for learning.

Following the literature review is a concluding discussion chapter. This provides a high-level overview of the conceptual framework developed in this report, as well as a convenient table of the most important research contributing to the findings. It concludes with recommendations for the implementation of virtual world technology in the Navy training context as well as recommendations for future research.

E. SUMMARY

The Navy stands to achieve cost savings in training if it sincerely adopts virtual world technology, but an initiative of this scope will face significant pitfalls on its way to success. Some of the most critical challenges in this approach are those related to the way students learn in virtual environments. Acknowledging that learning is indeed different in the virtual environment is the first important step. From there, we need to develop an understanding of the differences.

In conducting the research for this report, I have attempted to plumb the literature from fields like psychology and education to find the most relevant concepts and models for understanding student learning in the virtual environment. I've pared down my findings to those most directly relevant to the Navy training establishment, and I have built a road map for further research in this niche application of distance learning technology. Finally, I've summarized my findings and provided recommendations for concept implementation and for future research in this area.

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II. BACKGROUND

A. NAVY TRAINING

The United States Navy trains its operators of ships and aircraft using a wide variety of methods and technologies. Operators will attend many lectures in traditional classroom environments throughout their careers, from introductory basic training to advanced and sustainment training conducted in the spaces of deployed ships. Depending on their specialty, operators and their supervisors may also refine their skills in simulators, for which the interface can range from little more than a desktop computer to an immersive 3-D virtual reality environment. Typically, simulator training as well as traditional classroom lectures are conducted within large shore-based “schoolhouses” located on major Navy bases.

In some cases, individuals or teams from moored ships will utilize schoolhouse facilities in preparations for deployment. More commonly, trainees may be assigned to schoolhouse facilities for periods ranging from several days to several months while they develop new skills or become proficient with new systems. Such an assignment may occur in between basic training and initial detail to a deployable asset, or it may involve a temporary absence from an existing assignment. Temporary assignments requiring absence from a permanent station will incur travel and lodging costs. In some situations, the time required for travel becomes prohibitive, necessitating the construction of remote satellite schoolhouses such as the Naval Submarine Training Center Pacific Detachment Guam, which incur still greater costs in staff and simulator hardware.

Advances in distance learning techniques and the rapid progress of information technology are beginning to offer new options to the Navy as it seeks to reduce expenses amid force-wide budget reductions. The effectiveness of distance learning in classroom environments has been repeatedly demonstrated in academic studies (Russell, 1999). Applying the same techniques to simulator training, especially for those simulators using a simple desktop computer as an interface, may allow the Navy to concentrate its simulator hardware and staffs at a small number of land-based facilities while providing training to students dispersed over great distances using existing network infrastructure. Such an approach fully realized could result in significant cost savings and personnel efficiencies for the Navy.

B. THE VIRTUAL LEARNING ENVIRONMENT

As advances in graphics processing and network technology have increased the utility and appeal of 3-D virtual worlds, academic institutions and training organizations have begun to sincerely investigate this technology for its potential to support and improve the learning process (Li, D'Souza, & Du, 2011). Curtis and Mazzone (2013) identified three main elements to virtual worlds: people, environments, and goals. People—who interact with one another through representative avatars—are what distinguish virtual worlds from solitary three-dimensional simulations. The environments are the virtual spaces that the participants’ avatars occupy and explore. The third element, goals, implies that the people inhabiting a virtual world are there for a common or related purpose. If that purpose is to teach and/or to learn, the virtual world then becomes a virtual learning environment (VLE).

A VLE is defined as a relatively open, computer-based environment allowing interactions and encounters with other learners, and providing access to a wide range of learning resources (Wilson, 1996; Piccoli, Ahmad, & Ives, 2001). While the original proposal of the VLE concept did not specify the use of 3-D virtual worlds as the learning environment, for the remainder of this report, VLE shall be considered an application of 3-D virtual world technology. VLEs are similar to the Computer Aided Instruction (CAI) concept in that learners can individually select paths and activities or independently access material in a three-dimensional representative setting (Piccoli et al., 2001). VLEs are distinguished from CAI in their reliance on communication; CAI is a solitary experience, but VLEs capitalize on the growing capabilities of network infrastructure to encourage interaction between students and instructors, as well as other students (Wilson, 1996).

The VLE concept shows great potential for educational applications. Advocates suggest that properly employed, VLE can transcend geographical boundaries and distances, encourage interactivity and engagement, and facilitate superior communication and knowledge retention as compared to the traditional classroom (Hackbarth, 1996; Kiser, 1999; Massy & Zemsky, 1995). Compared to traditional learning models, VLE offer advantages in convenience and flexibility (Kiser, 1999).

VLE have not been universally accepted as a positive development. Studies have shown that students using VLE may feel frustration, anxiety and confusion (Hara & Kling, 2000). The detached nature of virtual interaction can lead to feelings of isolation (Brown, 1996), and the students' interest in subject matter suffers as well (Maki, Maki, Patterson, & Whittaker, 2000). VLE require that instructors master a new teaching style as well as an entirely novel approach to learning, and are resultantly labor-intensive (Piccoli et al., 2001). Instructors used to traditional classroom teaching have shown skepticism and resistance to virtual world technology (Curtis & Mazzone, 2013).

C. CHARACTERIZATION OF VLE APPLICATIONS

1. Location, Mode, and Pedagogy

Johansen (1992) developed a typology for classifying collaborative applications of information technology based on the *time* and *place* of interaction between users (Figure 1). The *place* axis refers to whether the collaborators are in the same location (proximate) or are separated (dispersed). The *time* axis categorizes the users' interactions based on whether they occur at the same time (synchronous) or at different times (asynchronous). Chat and videoconferencing are examples of synchronous interaction, while email and discussion boards are examples of asynchronous interaction (Bernard, Abrami, Borokhovski, Wade, Tamim, Surkes, & Bethel, 2009).

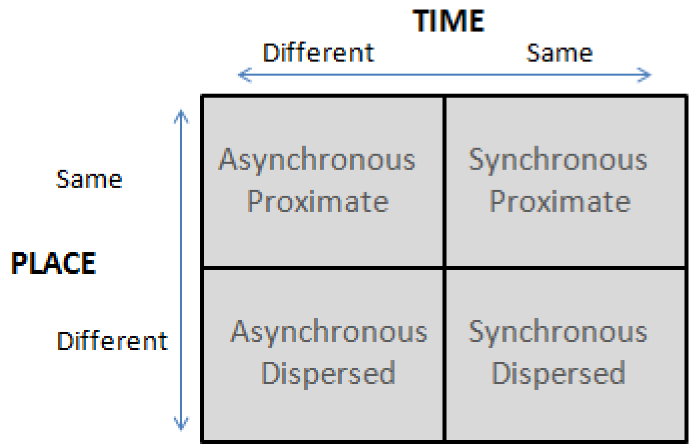

Figure 1. Typology of dispersion (after Johansen, 1992).

Synchronous interaction has many advantages over asynchronous interaction in distance learning. Park and Bonk (2007) point out that synchronous environments promote efficient and rich communication including tones of voice, facial expressions, and emotional states. Other researchers cite the timely correction of misconceptions (Finkelstein, 2006), the students' ability to engage spontaneously (Beuschel, Gaiser, & Draheim, 2003; Fish, Kraut, & Chalfonte, 1990) and the instructors' ability to give personal, real-time attention to students (Finkelstein, 2006; Munzer, 2003). Synchronous learning environments have more in common with the traditional classroom than asynchronous learning environments, so synchronous interaction is the most practical mode for courses adapted from traditional classrooms to the VLE. While the Navy should explore the possibilities of asynchronous learning environments in the future, it is reasonable to assume that in the short term most "virtualization" projects will fall under the synchronous mode of interaction.

Benbunan-Fich (2002) adapted Johansen's matrix to the use of IT in educational and training applications, replacing *time* and *place* with *mode* and *location* respectively, and adding a third axis, *pedagogy* (Figure 2). This third axis divides approaches to learning and teaching into two camps based on the philosophical positions of objectivism and constructivism. The *objectivist* position assumes that learning is composed of cognitive processes that represent reality to the learner (Jonassen, 1991), emphasizing a one-way transmission of concepts from teacher to student (Benbunan-Fich, 2002). A practical manifestation of the objectivist model is the traditional classroom lecture. The *constructivist* position, on the other hand, assumes that effective learning occurs when the student reflects on his experiences (Piaget, 1977). Constructivists maintain that learning comes from the thoughts of the learner as opposed to his environment (Kettanurak, Ramamurthy, & Haseman, 2001), and are principally concerned with natural, untutored concept formation (Forman, 1980). Science students learning through the conduct of collaborative laboratory experiments are an example of the constructivist model applied; Navy operators learning through simulators or on-the-job training are another example.

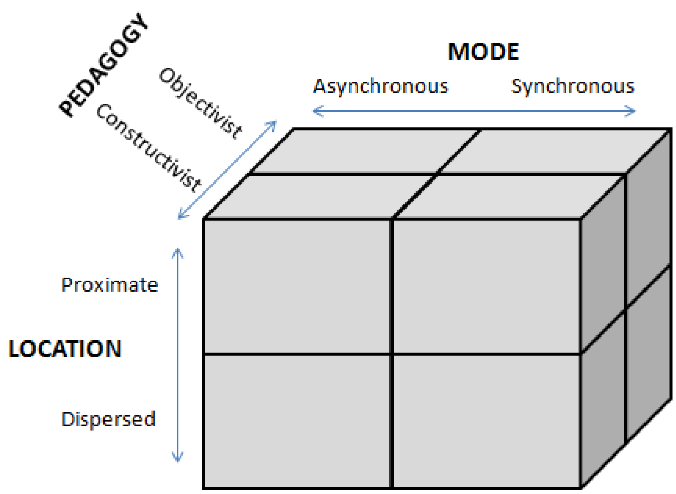

Figure 2. Tridimensional model (after Benbunan-Fich, 2002).

Any study of learning with information technology should be specific about the *location*, *mode*, and *pedagogy* of the learning environment of concern. Models based on observations of students using an asynchronous virtual laboratory will have limited relevance to students in a synchronous virtual lecture hall, for example. This review is concerned principally with those applications most likely to be of immediate utility to the U.S. Department of Defense.

The Navy's objective in developing VLE for training applications is to reduce travel, housing and facility expenses by consolidating training hardware and personnel to a central location, which can reach sailors in a wide variety of locations through existing network infrastructure. This will most likely involve the conversion of existing training programs, which rely on both objectivist and constructivist pedagogies, to a synchronous, dispersed VLE. Consequently, the framework proposed in this report will consider both pedagogies but will be constrained to dispersed applications with synchronous modes of interaction (Figure 3). Where relatable, findings from studies of asynchronous and proximate learning environments will be applied to make inferences about learning in the synchronous, dispersed environment.

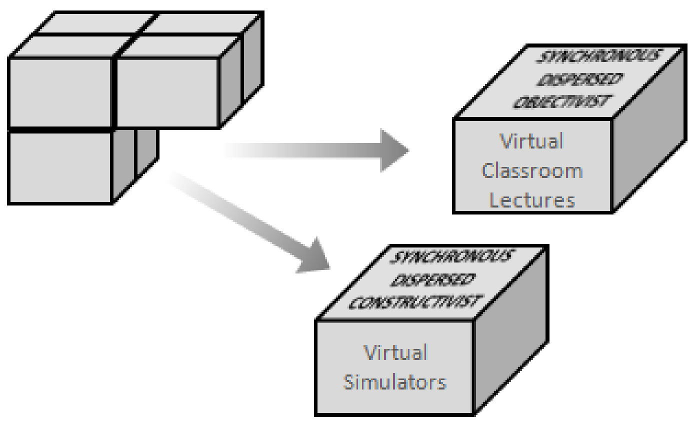

Figure 3. VLE applications relevant to Navy training

2. Learner Control

Most of the studies concerning the effectiveness of distance learning, technology-mediated learning, and the educational uses of virtual worlds place a great deal of emphasis on learner control. Learner control is the degree of discretion that students have over the pace, sequence, and content of instruction (Milheim & Martin, 1991). Some studies of technology-mediated learning apply the term "interactivity" to this definition (e.g., Steuer, 1992; Weller, 1988); this report will assign a different meaning to that term, discussed in chapter IV(E). Applications with high degrees of learner control allow the students to "make their own decisions regarding some aspects of the 'path,' 'flow,' or 'events' of instruction" (Williams, 1996, p. 957).

Research has shown that high degrees of learner control can lead to better student academic performance and satisfaction than traditional instructor-led models of learning (Merrill, 1994). High learner control adds complexity to course design; however, as students will have different capabilities for making appropriate educational decisions and taking advantage of increased discretion (Reeves, 1993). For example, many students in environments with high learner control will overestimate their own abilities (Lee & Wong, 1989), leading them to skip over important areas of instruction (Lepper, 1985). Students with high maturity and motivation have demonstrated success in this kind of environment, but less mature or motivated students have shown difficulty in achieving desired learning outcomes (Leidner & Jarvenpaa, 1995; Hiltz, 1993). To compensate for this effect, learning applications with high degrees of learner control must include resources and feedback mechanisms to assist students in gauging their own progress and instructional needs (Milheim & Martin 1991; Steinberg 1989).

Given the complications it introduces and the responsibility it shifts to the student, it is reasonable to assume that Navy course designers will seek to constrain learner control in training applications for the immediate future. While it is one of the most distinguishing and appealing features of VLE (Piccoli et al., 2001), learner control is mostly significant to asynchronous environments, and is unlikely to be a prominent feature of synchronous training applications adapted directly from existing courses. Consequently, the theoretical framework proposed in this report assumes that learner control is not significantly expanded from traditional learning environments.

3. Volition

As opposed to learner control, which concerns a student's degree of discretion in how to go about achieving learning objectives within the learning environment, volition is concerned with a student's freedom as to whether or not to use the provided learning environment at all, and is highly significant to models of technology acceptance (Koh, Prybutok, Ryan, & Wu, 2010). A volitional use environment is one in which the user perceives the system to be available for use as a matter of personal discretion (Teo, 2009). A mandatory use environment, on the other hand, is one in which use of the system is perceived to be required in order for the user to perform their job or required tasks (Sukkar & Hasan, 2005; Brown, Massey, Montoya-Weiss, & Burkman, 2002, p. 283). For the purposes of this report, the learning environments under consideration are assumed to be mandatory use environments.

III. METHOD

A. PURPOSE

The purpose of this report is to advance the understanding of trainee learning in dispersed virtual environments, to the greater end of contributing to the Navy's incorporation of distance learning with sophisticated network technology to its training regimen. The report draws from salient literature in the fields of education, psychology, and information technology. It does not concern any one particular study or experiment; instead it pieces together the results of many related studies to create a framework of learning in the virtual environment. It may serve as a foundation for controlled studies or as a starting point for a more focused literature review

B. SETTING

While this report does not entail a controlled experimental study, it does concern the learning of student s in a very specific training environment that is inviting for scientific investigation. In the prototypical application of virtual learning environments for Navy training, students will be junior enlistees in their early twenties, in classes of ten to twenty students. They will experience classroom instruction as a whole unit under a single instructor, and will train in simulators with two students and two instructors (one to manage the simulator, one to train the students) at a time. This format of instruction is in keeping with the structure of existing training programs; the difference will be a geographical separation between the students and the instructors as well as the physical hardware supporting the simulators.

C. SELECTION

The psychological models and theories referenced in this report were chosen primarily for their parsimony and contextual relevance. Potentially useful models were omitted if they were too similar or redundant to selected models or were overly complicated. The underlying framework of this report is built on a model which comes from information systems research rather than education, because it is more contextually relevant than prevailing learning theories. Theories from education, psychology, and management research were then incorporated into the overall picture, selected based on utility and their acceptance within their respective fields.

D. FRAMEWORK

The theoretical framework of this report was essentially developed by identifying the dependent variables, learning outcomes, and then searching for the most important antecedent variables that would likely affect learning outcomes in the virtual environment. These antecedents fell under two broad categories: student personality factors, which came from psychological research, and student perceptions, which came primarily from education and information systems research. In connecting the antecedents to learning outcomes, I identified cognitive processes that mediated the relationships, and these were incorporated into the overall framework.

IV. LITERATURE REVIEW

A. TECHNOLOGY ACCEPTANCE MODEL

Researchers generally agree that the success in implementing new, behavior-altering technology will depend in part on the users' attitudes and opinions regarding the technology (Davis, Bagozzi, & Warshaw, 1989; Zoltan & Chapanis, 1982). The Technology Acceptance Model (TAM; Davis, 1989) provides useful framework for understanding attitudes and acceptance behavior of technology users (Figure 4). Based on the Theory of Reasoned Action (TRA; Ajzen & Fishbein, 1980), TAM asserts that usage behavior will be determined by the users' behavioral intentions. Behavioral intentions to use technology, in turn, are determined by the users' perceptions about the technology, as mediated by their attitudes. Specifically, Davis (1989, p. 320) found that the two most important factors affecting behavioral intentions were perceived usefulness, defined as "the degree to which a person believes that using a particular system would enhance his or her job performance," and perceived ease of use, defined as "the degree to which a person believes that using a particular system would be free of effort."

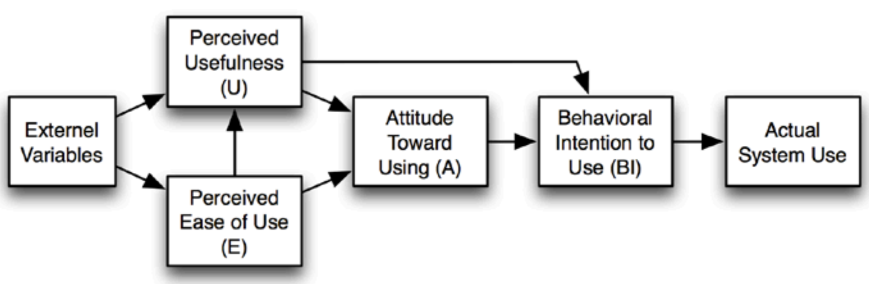

Figure 4. Technology Acceptance Model (after Davis, 1989).

Due to its simplicity, parsimony, applicability, and understandability, TAM has received a great deal of research attention and has undergone extensive modification (Chau, 1996; Teo, 2009; Sun & Cheng, 2009). By applying a variety of domain-specific external variables or antecedents, researchers have applied TAM theory to a wide variety of situations where empirical research could help to understand user behavior (Straub, 2009; Venkatesh, 2000; Venkatesh & Davis, 2000). Despite its numerous modifications and adaptations over the decades since it was conceived, studies using TAM theory usually return to perceived usefulness and perceived ease of use as the dominant predictors of technology adoption (e.g., Adams, Nelson, & Todd, 1992; Davis et al., 1989; Gefen & Straub, 1997; Igbaria, Zinatelli, Cragg, & Cavaye, 1997; Szajna, 1996; Taylor & Todd, 1995; Teo, Lim, & Lai, 1999; Venkatesh, Morris, Davis, & Davis, 2003).

The original conception of TAM assumes that the individual's use of a given information system is under their volitional control (Yen, Wu, Cheng, & Huang, 2010). This poses a problem in extending TAM to mandatory use environments, as behavioral intention to use becomes irrelevant when users are required to use the system (Brown et al., 2002; Koh et al., 2010). Researchers have generally approached this paradox in one of two ways (Nah et al, 2004). One approach is to use the same model for mandatory and volitional environments, applying "voluntariness" as a moderating variable to the relationship between behavioral intention and its determinants (e.g., Venkatesh & Davis, 2000; Venkatesh & Bala, 2008). The other approach is to focus on the attitude construct, as either a predictor of outcomes or a moderating variable to the predictors (Koh et al., 2010). This paper takes the latter approach, viewing attitude as a moderating cognitive process.

B. LEARNING OUTCOMES

The overall purpose of this report is to build understanding of the contributing factors to student success in a virtual learning environment as applied to Navy training. It is necessary, then, to select a factor or set of factors that can be measured to evaluate learning effectiveness. In most empirical studies of distance learning environments, exam performance is measured to compare learning outcomes in the distance environment with those achieved in the traditional face-to-face model (e.g. Alavi 1994; Alavi, Wheeler, & Valacich, 1995; Storck & Sproull 1995; Webster & Hackley 1997; Hiltz & Wellman 1997). While it may well be the most important indicator of learning effectiveness, exam performance should not be considered the only learning outcome worth measuring. Student satisfaction in using the VLE should be considered as well (Zhu, 2012).

Studies have found that students may be less satisfied with VLE than traditional learning environments, but exhibit comparable test scores in both cases (Piccoli et al., 2001). Training designers should, however, resist the temptation to write off student satisfaction as an unimportant parameter, as it can have long-term repercussions for the student as well as the overall training program (Guuawardena, Nola, Wilson, Lopez-Islas, Ramirez-Angel, & Megchun-Alpizar, 2001). Satisfaction has been widely used as an indicator of the effectiveness of learning environments in both academic (Alavi 1994; Alavi et al. 1995) and business contexts (Wolfram 1994). This report will consider student satisfaction along with exam performance as a key learning outcome in the Navy training context.

C. MEDIATING COGNITIVE PROCESSES

1. Cognitive Engagement

Learning is most effective when students are actively involved (Leidner & Jarvenpaa, 1993; Alavi et al., 1995). Cognitive engagement is defined as "the quality of students' psychological engagement in academic tasks, including their interest, ownership, and strategies for learning" (Davis, Summers, & Miller, 2012, p. 22). As opposed to behavioral engagement, which concerns how hard a student works or the *quantity* of effort they devote to a learning task, cognitive engagement is concerned with the *quality* of the student's efforts in terms of curiosity, focus, and interest (Webster & Hackley, 1997; Webster & Ho, 1997; Pintrich, 2003, p. 105). A student who is cognitively engaged does not just do the required work, but does it in the interest of understanding and mastery (Fredericks, Blumenfeld, & Paris, 2004; Greene, Miller, Crowson, Duke, & Akey, 2004).

Courses designed to be engaging are more effective than those designed for passive learning (Adelson, 1992; Hsi & Agogino, 1993). Numerous studies have found cognitive engagement to be a predictor of student academic achievement (e.g., Greene et al., 2004; Greene, DeBacker, Ravindran, & Krows, 1999; Greene & Miller, 1996;

Graham & Golan, 1991; Kardash & Amlund, 1991; Nolen, 1988; Pintrich & Garcia, 1991). Webster and Hackley (1997) also identified a positive relationship between cognitive engagement and student attitudes toward the use of multimedia technology in distance learning.

2. Cognitive Attitude

Attitude is defined as an individual's positive or negative feelings about performing a certain behavior (Ajzen & Fishbein, 1975, p. 216). In most studies of technology acceptance, attitude is a uni-dimensional construct influenced by an individual's beliefs about the object or system (Yang & Yoo, 2004). Other literature has shown that the individual's beliefs are actually only half of the attitude construct, the other being the individual's feelings about the object or system (Petty, Wegener, & Fabrigar, 1998). These feelings, or the degree to which an individual likes or dislikes the object, are considered to be the affective dimension of attitude (McGuire, 1985). Beliefs, on the other hand, are the result of cognitive processes, and are therefore considered to be the cognitive dimension of attitude (Bagozzi & Burnkrant, 1979; Bagozzi & Burnkrant, 1985).

Yang and Yoo (2004) showed that the cognitive and affective components work through different psychological mechanisms. Future TAM studies, they argued, should treat cognitive attitude and affective attitude as separate, independent constructs (Weiss & Cropanzano, 1996; Triandis, 1980). Cognitive attitude has been shown to mediate the influence of perceived usefulness and perceived ease of use on the usage of information systems (Yang & Yoo, 2004), as well as to influence the individual's affective attitude (Thompson & Hunt, 1996). Affective attitude, on the other hand, is more appropriately classified as a dependent variable (Yang & Yoo, 2004). For the purposes of this report, the like/dislike function of affective attitude is addressed through the dependent variable of learner satisfaction, while cognitive attitude is considered along with cognitive engagement as a mediating process to the antecedents of student learning outcomes.

D. STUDENT PERSONALITY FACTORS

1. Core Self Evaluation

Core self-evaluation (CSE) is defined as “the fundamental appraisal of one’s worthiness, effectiveness, and capability as a person” (Judge, Erez, Bono, & Thoresen, 2003, p. 304). While self-esteem is one of the most widely studied and durable concepts in psychology, significant overlap exists between self-esteem and other trait measures which have demonstrated predictive power. Aggregating data from related traits, concepts and contexts improves the predictive validity of personality variables (Buss, 1989). CSE, a product of industrial-organizational psychology, seeks to increase predictive power by aggregating four separate but related dimensions of personality into one integrated dispositional construct (Judge, 2009).

The four dimensions of CSE are locus of control, emotional stability, generalized self-efficacy, and self-esteem (Judge, Erez, & Bono, 1998). Locus of control refers to the degree to which an individual feels that their circumstances are under their control, and classified as either “internal” or “external.” For example, someone with an internal locus of control is likely to believe that the environment is under their control and they are responsible for their circumstances, while someone with an external locus of control believes that external forces control their circumstances. Emotional stability is effectively an inverted measure of the *neuroticism* personality trait, which describes an individual’s susceptibility to emotional upheaval, stress, and frustration (Judge et al., 1998).

Self-efficacy is defined as “beliefs in one’s capabilities to mobilize the motivation, cognitive resources, and courses of action needed to meet given situational demands" (Wood & Bandura , 1989, p. 408). While traditional definitions of self-efficacy are task-specific, Judge, Locke, and Durham (1997) expanded the concept to a global scale, defining *generalized self-efficacy* as “estimates of one's capabilities to mobilize the motivation, cognitive resources, and courses of action needed to exercise general control over events in one's life.” It is distinguished from locus of control in that self-efficacy is concerned with an individual’s control of their own actions, while locus of control concerns their control over outcomes (Judge et al., 1998). It is distinguished from self-esteem in that self-efficacy considers capability, while self-esteem considers one's overall value as a person (Harter, 1990).

While early research measured CSE by combining separate measurements of each of the four traits, Judge et al. (2003) have developed a combined 12-item measure termed the Core Self-Evaluation Scale (CSES), which evidence indicates is a better predictor than a composite of the four traits measured individually (Judge, 2009; Judge et al., 2003). The validity of CSE has been demonstrated in a variety of organizational constructs (e.g., Erez & Judge, 2001; Judge, 2009; Judge & Bono, 2001), and CSE's trait indicators have been repeatedly associated with learning and training (e.g., Stanhope, Pond, & Surface, 2013; Chen, Gully, & Eden, 2004; Rowold, 2007; Spector, 1982; Williams, Thayer, & Pond, 1991). In particular, Stanhope et al. (2013) found that CSE related directly and indirectly to affective, cognitive, and skill-based learning.

2. Goal Orientation

In achievement settings, an individual's disposition toward developing or validating their abilities is known as goal orientation (Vandewalle, 1997). Early research in goal orientation (Dweck, 1986; Dweck & Leggett, 1988) proposed that individuals had two major dispositions toward achieving goals—learning goal orientation, manifested as a drive to develop one's own competence by acquiring skills and knowledge, and performance goal orientation, manifested as a drive to demonstrate competence so as to gain approval and avoid negative judgments. Later researchers held that performance goal orientation should actually be subdivided into two separate predispositions: performance-prove goal orientation, an achievement drive based on desire to receive favorable judgments, and performance-avoid goal orientation, an achievement drive based on desire to avoid unfavorable judgments (Vandewalle, 1997).

Learning goal orientation and performance-prove goal orientation are similar in that they are both motivated by desire to eliminate a discrepancy between an existing state and a desired (goal) state (Elliot & Thrash, 2002); in other words, to achieve goals. Elliot and Harackiewicz (1996) called this commonality "approach" motivation. It is contrasted with "avoid" motivation, which has the sole disposition of performance-avoid goal orientation. Where learning goal orientation and performance-prove goal orientation differ is in their interpretation of skill malleability.

Individuals who are inclined toward learning goal orientation view their skills as malleable, or subject to improvement through learning and effort, and that success can best be achieved through exercise of their ability to improve their skills (Dweck, 1986; Elliot & Dweck, 1988). In contrast, individuals inclined to either performance goal orientation view skills as fixed attributes, which can't be changed (Brett & VandeWalle, 1999). For those with a performance-prove orientation, eliminating the discrepancy between the actual and desired state is not achieved by learning and improving, but by completing tasks and thereby demonstrating competence and capability in comparison to others (Dweck & Leggett, 1988; Elliot & Dweck, 1988).

While arriving by way of the differing motivational paths of task mastery and external perceptions of competence, both approach-based orientations incline individuals to achieve positive outcomes (Johnson, Shull, & Wallace, 2011). They encourage cognitive processes that facilitate task engagement, and encourage affective attitudes (Elliot & Thrash, 2002). Approach-based orientations were also positively related to job performance (Porath & Batemen, 2006), and adaptive response patterns in learning contexts (Payne, Youngcourt, & Beaubien, 2007). In contrast, performance-avoid oriented individuals are motivated by a desire to prevent unfavorable judgments of others, manifested as an aversion to challenging tasks or a lack of engagement and persistence in goal directed tasks (Elliot & Harackiewicz, 1996). In learning contexts, performance-avoid goal orientation has been linked to maladaptive responses like increase frustration or anxiety and decreased effort. These, in turn, lead to suboptimal learning outcomes (Schmidt & Ford, 2003).

a. Relationship with Self Efficacy

Research in self-efficacy indicates that individuals with high self-efficacy are more persistent and devote more effort to achieving their goals, encouraging achievement and desirable learning outcomes (Bandura, 1977; Pintrich, 2000). Elliot and Dweck (1988) found that individuals with high performance goal orientation and high self-efficacy demonstrated adaptive responses to negative feedback, but those with high performance goal orientation and low self-efficacy demonstrated maladaptive responses, suggesting that self-efficacy may moderate the impact of goal orientation on achievement. This research predates the division of performance goal orientation into the performance-prove and performance-avoid dimensions (Brusso, Orvis, Bauer, Tekleab, 2012).

The research is less conclusive with respect to the effects of self-efficacy in individuals with performance-avoid goal orientation. Dierdorff, Surface, and Brown (2010) found that trainees with high performance-avoid orientation and low self-efficacy exhibited substantially worse performance than those with high performance-avoid orientation and high learning self-efficacy. On the other hand, Bråten, Samuelstuen, and Strømsø (2004) found that high self-efficacy hindered self-regulation in business school students with performance-avoid goal orientation, and Brusso et al. (2012) found that while self-efficacy generally had positive impacts on performance, trainees exhibiting both high performance-avoid goal orientation and high self-efficacy had an especially hard time recovering from a performance-goal discrepancy. They speculated that the performance-avoid oriented trainees may deliberately reduce effort in order to avoid judgment that the failures were caused by incompetence, instead intimating that a lack of interest or effort is to blame (Brusso et al., 2012, p. 13). The takeaway is that while there is probably a relationship between self-efficacy and goal orientation, it is not fully understood, particularly for individuals with performance-avoid goal orientation.

b. Regulatory Focus

Johnson et al. (2011) proposed a model which synthesized Vandewalle's (1997) perspective on Goal Orientation with Regulatory Focus theory. In Regulatory Focus theory (Higgins, 1997), goals are ultimately based on one of two systems of motivation, promotion or prevention, which are, in turn, based on primal survival functions. For example, the promotion system is based the instinctive drive to acquire sustenance, and is manifested as a perception of either capturing or failing to capture a desirable outcome. The prevention system, on the other hand, is based on the instinct to obtain security and avoid danger, manifested as a perception of either escaping or failing to escape an undesirable outcome. An individual with a promotion focus seeks to achieve goals while maximizing gains and the individual with a prevention focus seeks to achieve goals while minimizing losses (Johnson et al., 2011; Higgins, 1997, 2000; Neubert, Kacmar, Carlson, Chonko, & Roberts, 2008; Wallace & Chen, 2006).

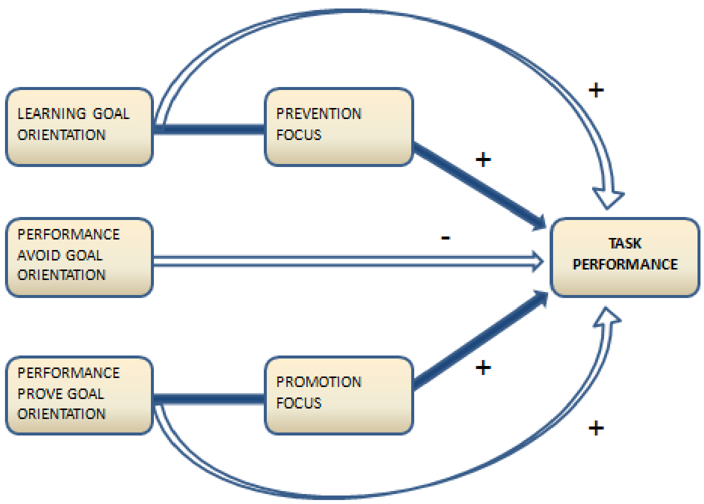

Figure 5. Hypothesized relationships between goal orientation, regulatory focus and task performance (after Johnson et al., 2011).

Johnson et al. (2011) contend that goal orientation and regulatory focus are two separate but related theoretical constructs. Specifically, they held that goal orientation, which focuses on the individual's reasons for choosing a certain goal, is an antecedent to regulatory focus, which is concerned with an individual's processes for achieving the goal. Importantly, they held that regulatory focus theory applied specifically to goals from the approach motivational construct, related through the discrepancy-reducing function of approach motivation. They proposed a model, which their study supported, in which promotion focus mediated the effect of performance-prove goal orientation, and prevention focus mediated the effect of learning goal orientation (Figure 5). The latter relationship was justified in that mastery of a task ultimately amounts to a reduction of errors committed in the performance of said task (Johnson et al., 2011, p. 755).

E. STUDENT PERCEPTIONS

1. Perceived System Performance

a. Usefulness and Ease of Use

In the original development of the TAM, Davis (1989, p. 320) found that the two most important factors affecting behavioral intentions were perceived usefulness and perceived ease of use. Perceived usefulness is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance." Perceived ease of use is defined as "the degree to which a person believes that using a particular system would be free of effort." Considered together, perceived usefulness and perceived ease of use capture the degree to which a user feels that the given technology is more helpful than it is inconvenient to use.

b. Technical Reliability

When a learning environment is designed to rely on technology for instruction and class communication, the reliability of that technology will be especially important to successful learning outcomes (Sandholtz, Ringstaff, & Dwyer, 1992). This is especially important in technology-mediated distance learning, where perceived usefulness and attitudes toward the technology and distance learning in particular are positively related to the quality of the technology (Webster & Hackley, 1997; Pituch & Lee, 2006). Students can quickly become frustrated if they perceive that problems with the technology, such as software bugs or connectivity issues, are artificially hampering their performance. Even if they are able to achieve the learning objectives, frustration with the technology can linger and permanently skew their affective reaction to the learning experience (Hiltz 1993; Webster & Hackley 1997).

In studies of information systems adoption across a variety of contexts, reliability and response time were repeatedly identified as core elements of system quality (Delone & McLean, 1992). For the technology applications of concern in this report, perceived technical performance is defined as the students' perceptions of overall information system quality, in terms of reliability and response time. Reliability, in this context, is the degree to which software performs as designed, free of bugs, crashes, or system errors.

Response time, on the other hand, concerns the flow of data between stations in the dispersed environment. While a slowdown in data rates can be a nuisance for users of asynchronous environments, it can absolutely shut down a synchronous VLE, since the entire learning model is predicated on real-time interaction (Benbunan-Fich, 2002).

c. Communication Richness

(1) Disambiguation. Interactivity is an important element of any investigation of dispersed learning environments. Unfortunately, researchers often mean different things when they use the word interactivity. For example, some use the word *interactivity* to describe effectively what this report refers to as Learner Control—the extent to which students can modify the content, form, pace, or path of the instruction to suit their individual needs (e.g., Steuer, 1992; Weller, 1988). Other studies refer to interactivity in terms of teaching styles, specifically, the degree to which instructors elicit feedback and inquiry from students. This report refers to that form of interaction as "instructor interactivity," and it is addressed in a later section of this report.

A third context of interactivity concerns the effectiveness with which a technology-mediated learning environment permits communication between dispersed users. Rogers (1986) proposed a continuum of interactivity which describes the degree to which technology facilitates communication resembling face-to-face interaction. Other researchers have referred to this dimension as "richness," as a great deal of information is communicated through nonverbal cues such as facial expressions, tones of voice, or body language (Daft & Lengel, 1986). In a study of synchronous and asynchronous dispersed learning environments, Burke and Chidambaram (1996) found that richer interaction environments elicited perceptions of greater social presence and communication effectiveness than the more restrictive environments.

(2) Student-Student Interactivity. Moore (1989) identified three types of student interaction in distance education: Student-student interaction, student-teacher interaction, and student-content interaction. Anderson (2003) found that students perceived student-teacher interaction to be of the most value out of the three, but that student-student interaction became especially important in environments based on

constructivist learning principles—such as Navy simulators. Regardless of how well the VLE design promotes interactivity, the degree to which a VLE is interactive ultimately depends on student behavior (Piccoli et al., 2001).

One consideration of interactivity that designers of virtual learning environments may find easy to overlook is the need for students to compare their experiences. According to social comparison theory, people tend to judge their own performance against comparative "referents" of similar experience and ability (Dakin & Arrowood, 1981, p. 91; Kulick & Ambrose, 1992; Ronen, 1986). Supervisors tend to underestimate the importance that their subordinates invest in their comparisons with one another (Greller, 1980). In classrooms, this kind of student-student interactivity is automatic and often transparent. In a dispersed environment, students who are used to judging their own performance based on that of nearby peers may suddenly be without their usual frame of reference, increasing personal uncertainty (Conner, 2003).

(3) Impact. While researchers of dispersed learning environments have explained its impact in a variety of ways, they are generally in agreement that social interactivity is important—to learning in general (Dillon & Gunawardena, 1995), and to technology-mediated learning in particular (Collis, 1995; Borbely, 1994; Latchem, Mitchell, & Atkinson, 1994). Social interactivity was shown to increase e-learning acceptance (Selim, 2007), improve attitudes (Kettanurak et al., 2001), and increase the achievement of learning outcomes (Berge, 2002; Roussou, 2004; Proske, Narciss, & Körndle, 2007). Using the TAM framework, Shen and Chuang (2009) demonstrated the significant role of interactivity in determining the perceived usefulness of dispersed work environment. Fortunately, the use of VLE's 3-D environment and voice-over-IP capabilities provide for greater richness of social interaction than what is available in traditional media for dispersed collaboration (Fetscherin & Lattermann, 2008).

2. Perceived Quality of Execution

Learning effectiveness in a technology-mediated environment is positively related to the instructor's attitude toward the technology, their competence in using it, and the interactivity of their teaching style (Webster & Hackley 1997). In other words, student perceptions are affected not just by the capabilities and limitations of the technology, but by the manner in which it is used. Collis (1995, p. 146) observed, “It is not the technology but the instructional implementation of the technology that determines its effects on learning.” Webster and Hackley’s observations suggest that the instructor’s behavior can significantly influence the students’ evaluations of their individual learning experiences (Piccoli et al., 2001).

a. Instructor Attitudes

Instructors have a variety of reasons to be disinclined toward using VLE. In addition to the burden of mastering entirely new tools and teaching styles, addressing student needs through the virtual environment is more time-consuming than in traditional face-to-face instruction (Hiltz, 1993). Feeling isolated due to the lack of face-to-face contact, students in VLE tend to seek more attention from an instructor than they would in a traditional environment (Hara & Kling, 2000). Additionally, being widely perceived as a medium borne of pure entertainment applications (video games), virtual worlds are likely to engender skepticism from veteran instructors in serious environments such as a Navy training program. If instructors perceive the VLE to be an innovation not for improving learning, but for reducing costs, then they are especially likely to oppose the initiative.

Because subordinate attitudes toward technology are subject to influence by social norms and supervisor attitudes, it follows that instructor attitudes will necessarily affect student attitudes. Webster and Hackley (1997) identified a relationship between instructor attitudes toward technology and student attitudes toward the same technology and distance learning in general. Dillon and Gunawardena (1995) proposed that instructors’ attitudes toward technology-mediated distance learning systems should be part of any evaluations of such systems. To the purpose of evaluating the factors which may affect student learning in VLE, this report proposes that the same end can be achieved by evaluating students’ *perceptions* of their instructors’ attitudes.

b. Instructor Technology Competence

The instructors' ability and confidence in using the technology will affect student learning outcomes in a variety of ways (Piccoli et al., 2001). Technical problems can become distractions in the learning environment (Gowan & Downs, 1994), and instructors who show little control over the instructional technology may be seen by students as less competent overall (Webster & Hackley, 1997). Students become impatient with technical problems (Leidner & Jarvenpaa, 1993), and may feel that their time is being wasted if classes or simulators do not start on time. Webster and Hackley (1997) also found that students' cognitive engagement, perceptions of technology usefulness, and attitudes toward distance learning were related to their instructors' control of the technology.

c. Instructor Interactivity

In student-teacher interaction, instructors should seek "to stimulate or at least maintain the students' interest in what is to be taught, to motivate the student to learn, to enhance and maintain the learner's interest, including self-direction and self-motivation" (Moore, 1989, p. 2). Distance learning environments require more concentration from the student than face-to-face communication (Kydd & Ferry, 1994), so students can easily become distracted by side activities (Isaacs, Morris, Rodriguez, & Tang, 1995) or one another (Gowan & Downs, 1994). To mitigate these challenges, a high degree of interaction is vital (Nahl, 1993). Instructor interactivity raises the perceived demand on the students' attention, encouraging active learning (Salomon, 1983). In addition to improved cognitive engagement, Webster and Hackley (1997) found that students' attitudes toward technology and attitudes toward distance learning were improved with more interactive teaching styles.

Instructors using VLE should develop teaching strategies, transfer educational practices to the virtual classroom and manipulate the virtual environment individually and collaboratively prior to teaching (Curtis & Mazzone, 2013). Some elements of instruction are more challenging to adapt to the virtual world than others—for example, identifying gaps in understanding is difficult for instructors using VLE (Curtis &

Mazzone, 2013). Instructors can help to compensate for technical communication barriers by asking probing questions, including open-ended ones which address the students' emotional state, as well as closed questions which can help assess their state of cognition. Although counterintuitive, some of the most important teaching practices are those which serve to increase the students' sense of interaction with instructors, such as immediacy behavior.

Immediacy behaviors are defined as the communication practices that "enhance closeness to and nonverbal interaction with another" (Mehrabian, 1969, p. 102). Research in education has shown that instructor immediacy behaviors in the classroom, such as addressing students by name, making eye-contact, adding humor, or giving praise are positively related to learning outcomes for students (Baringer & McCroskey, 2000; Allen and Lawless-Reljic, 2011; Swan, 2003). Instructor immediacy has been shown to increase student satisfaction, motivation, and perceived learning (Christophel, 1990; Gorham & Christophel, 1990; Gorham & Zakahi, 1990; Kelley & Gorham, 1988), as well as cognitive engagement and information recall (Allen & Lawless-Reljic, 2011; Kelley & Gorham, 1988; Richmond, Gorham, & McCroskey, 1987). Immediacy is important in any classroom, but especially in the virtual learning environment, as it contributes not just to students' learning outcomes, but also their feelings of immersion and engagement with the instruction (Curtis & Mazzone, 2013).

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V. DISCUSSION AND CONCLUSIONS

A. CONCEPTUAL FRAMEWORK

Factors contributing to the attainment of learning outcomes in synchronous, dispersed VLE can be categorized as student personality factors or student perceptions. These contributing factors are mediated by the cognitive processes of attitude and engagement (Figure 6). The identified factors and processes are organized for convenience in Table 1-1 with key associated literature.

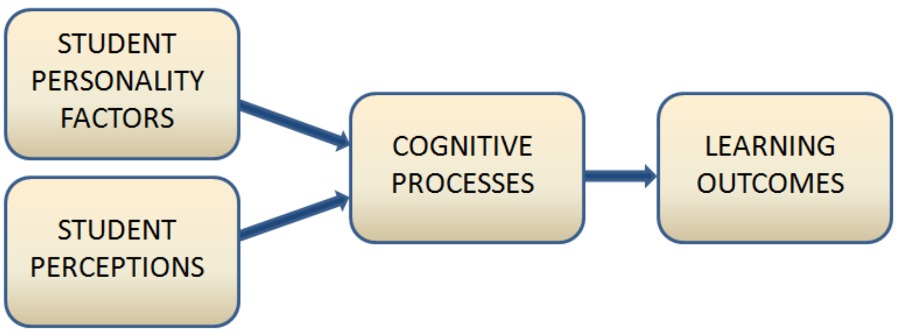

Figure 6. Overall conceptual framework of learning in synchronous, dispersed VLE with restrictive learner control

Factor	Principal Authors	Field of Study
Student Personality Factors		
Core Self-evaluation (CSE)	Judge et al., 1998	Industrial and Organizational Psychology
Goal Orientation	Dweck, 1986; Dweck & Leggett, 1988; Vandewalle, 1997	Educational Psychology
Regulatory Focus	Higgins, 1997; Johnson et al., 2011	Social Psychology; Industrial and Organizational Psychology
Student Perceptions: System		
Usefulness	Davis, 1989; Davis et al., 1989	Information Systems
Ease of Use	Davis, 1989; Davis et al., 1989	Information Systems
Technical Performance	Delone & McLean, 1992; Webster & Hackley, 1997	Information Systems
Communication Richness	Kettanurak et al., 2001; Daft and Lengel, 1986	Information Systems; Management
Student Perceptions: Instructors		
Attitudes	Webster & Hackley, 1997	Information Systems
Technology Competence	Piccoli et al., 2001; Webster & Hackley, 1997	Information Systems
Interactivity	Christophel, 1990; Kelley & Gorham, 1988; Baringer & McCroskey, 2000	Educational Psychology
Mediating Processes		
Cognitive Attitude	Bagozzi & Burnkrant, 1985; Yang & Yoo, 2004	Social Psychology, Information Systems
Cognitive Engagement	Davis, 2012	Educational Psychology

Table 1. Factors contributing to learning in synchronous, dispersed VLE with restrictive learner control, with key associated literature

B. IMPLICATIONS AND RECOMMENDATIONS

1. Future Training Design

The conceptual framework for trainee learning presented in this report is constructed from the perspective of a synchronous, dispersed environment with restricted learner control, and will require modification to apply to environments that are asynchronous or that exhibit high learner control. This report considers a synchronous, dispersed environment with restricted learner control to be the most plausible application of VLE to military training in the near term. Such an application would require the least modification of existing training programs and models.

Going forward, the Navy absolutely should explore the training possibilities of asynchronous, high-learner control environments. Some pedagogical design features of asynchronous distance learning have been linked to better learning outcomes than traditional teaching models (Bernard et al., 2009). Constraining VLE training to synchronous, restricted-control programs in order to shoehorn existing training models into the virtual environment may unintentionally suppress the VLE's most salient capabilities as a teaching tool. Restricted to this approach, we may introduce all of the undesirable qualities of training over distance without fully realizing the benefits.

Another avenue of training design worth exploring, especially relevant to this report, is consideration of individual trainee characteristics and suitability for training in the VLE. This report assumes that the Navy will pursue a universal approach to training, where all candidates qualified for a given occupation shall be considered trainable using any available model or technology. In fact, some perfectly capable operators may find the VLE to be an especially difficult learning environment, while still others may learn more effectively in VLE than in the traditional schoolhouse. This report is intended to lay the groundwork for tests designed to discern such students. In the future, the Navy may consider a dualistic approach to training where trainees are funneled into programs that best suit their individual learning styles.

2. Future Research

One of the objectives of this report is to organize a foundation for future studies of student or trainee characteristics which may predict their likelihood for success in a VLE. Proposed relationships are based on those identified in academic studies or are otherwise inferred from the literature. Future researchers may conduct studies to confirm the relationships proposed in this report, or may wish build a testable model based on some or all parts of the proposed conceptual framework.

There has been a great deal of media attention paid to distributed online environments, but limited empirical research on the topic, especially with respect to virtual worlds (Curtis & Mazzone, 2013). Academic studies of virtual learning environments tend to focus on the student, and there are relatively few studies concerned with teaching in virtual worlds (Sampson & Kallinois, 2012). Future studies of dispersed learning environments should consider the instructor's perspective: preparation, flexibility of course design, similarities and differences from traditional training models, and instructor satisfaction and burnout.

Finally, most academic research in distributed learning is focused on learning in the academic environment. There is comparatively little research on distributed learning in occupational or military training contexts. This is undoubtedly a factor of the relative ease of finding suitable study subjects in an academic environment, but it unnecessarily limits progress in identifying useful applications of emerging technology. Occupational and military training programs differ substantially from academic environments, and researchers could positively contribute by exploring these contexts in earnest. Simply reproducing the findings from prominent studies under occupational or military training conditions could lead to substantial progress in our understanding of learning.

C. CONCLUSION

In seeking the support of decision makers, the greatest obstacle that proponents of VLEs are likely to face is skepticism. The VLE's roots in the video gaming industry do not naturally lend to an air of credibility, especially in an atmosphere as grim and rigid as the military training environment. Some decision makers are likely to instinctively dismiss the VLE as a distracting gimmick. Proponents of VLE programs must carefully guard their programs' credibility as a training asset, and fight any urges to show off capabilities that lack immediate training benefits, such as avatar customization.

Arguments in favor of VLE should be presented from the standpoint of training benefit, not just cost savings. Tactical simulators also have roots in the video gaming industry, and they are now ubiquitous in military training programs—it is their demonstrable effectiveness as a training asset that has brought simulators into widespread acceptance. So it must be with VLE. While cost savings may appeal to the budgeter, it is effectiveness as a training asset that will ultimately determine if VLEs are a viable solution for the warfighter.

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