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Instructional Design Strategies for Effective Blended Learning

Katherine Pang

Abstract - Faculty members and institutions of higher education are increasingly aware that students are seeking new ways to meet their educational requirements. This article emphasizes instructional design strategies that allow faculty and other providers of instruction to develop blended learning environments using e-learning technology authoring and delivery tools combined with face-to-face and collaborative interactive resources. Participants will learn techniques and strategies for designing and delivering blended learning that is grounded in constructivist and active learning pedagogy embedded in tested instructional design strategies.

Introduction

The use of technology is no longer a novelty in traditional United States university classroom environments. Many classrooms are equipped with projectors, computers, document readers, DVD players, and even smart boards. Professors may use a computer and projector to display a document for the class, launch a website to illustrate a point, or write notes projected for the class using a computer or document reader. In addition, professors use content/learning management systems to supplement in-class instruction and provide a place where students can access grades, documents, PowerPoint presentations, exams and quizzes, and perhaps engage in collaborative projects or supplement class discussions. In this rapid integration of technology in traditional classroom learning, questions arise as to how to effectively use the technology, how to develop curricula that is designed for a blended approach to learning, and how to enhance learner effectiveness in a blended learning environment.

Blended Learning

Blended learning has many definitions but is most commonly defined as learning that integrates live, or face-to-face, classroom learning with technology-driven instruction. According to Reid-Young (2003), the advantages of blended learning are derived from the ability to mix learning activities. Kerres and De Witt (2003) emphasized that blended learning should mix didactical methods with delivery formats. In this mix, pedagogical strategies are maximized when technology is integrated with other classroom based activities. Students in a blended learning environment have the opportunity to supplement their instruction through access to self-paced review of course materials posted in content/learning management systems as well as reinforce their classroom learning with access to audio, video, or other media-driven learning tools. It is the mix (Cross, 2003; Davies, 2003; Hulm, 2003; Thorne, 2003) as well as the diversity of learning tools and activities that are available through a blended learning environment that impact student learning effectiveness. For example, Graff (2003) explored the relationships between student's cognitive styles and the perceived sense of classroom community in a blended learning environment and found that blended learning environments must be structured to meet the individual needs of the students.

One popular use of a blended design is for purposes of reinforcement. Many professors use technology to supplement their live, in-class lectures and activities thereby building on the foundational skills presented in-class. For example, Ziob and Mosher (2006) used a blended instructional design for the purpose of building on and enhancing the skills developed in the live learning environment. However, Dziuban, Hartman, and Moskal (2004) argued that blended learning is not the same as traditional distance education, where courses are offered entirely online, nor is it merely a supplement to live courses but rather it is a type of learning that requires a concern with course design specifically originated for an integrated learning environment. A hybrid learning environment is, therefore, a genre that requires significant attention to course design and instructional strategy.

Instructional Strategy

Many faculty members have little or no exposure to instructional design or curriculum development. Faculty members are predominantly subject matter experts, to use technology vernacular; yet the invasion of learning/content management systems and the consumer/student demand for alternative means of learning have thrust faculty members into a world for which they have received little or no training. The notion that familiarity with how to upload course documents or a Syllabus into a learning/content management system, set-up and maintain a gradebook, use a chat feature, set-up a discussion board, or post announcements is considered sufficient to create a meaningful blended learning environment is an unfortunate conception in academia. Since few would disagree that technology has impacted traditional models of delivering instruction and convention has emphasized the professor as the disseminator of information, the need to explore instructional strategies that are easily adaptable by faculty and adaptive to a blended learning environment is critical if the goal is to develop and present a meaningful blended learning environment to students.

In an effort to present a novel way of approaching instructional design for a blended learning environment, this researcher developed a model for learning based on four categories: (1) instructional design as a process; (2) pedagogy as a drive; (3) technology as a strategy; and (4) meaningful student application as a goal (see Figure 1).

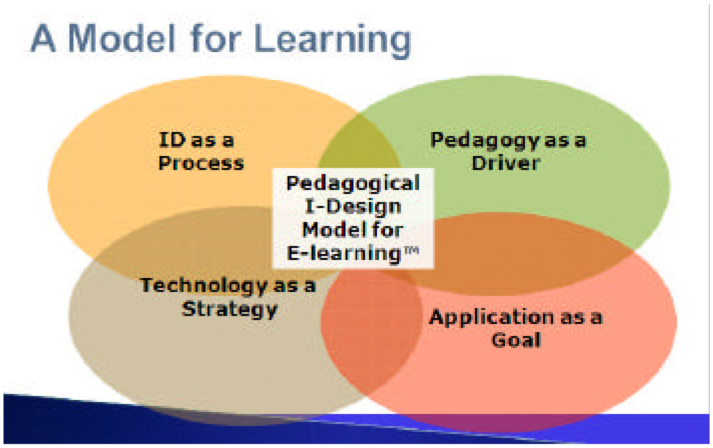

Figure 1

Instructional Design as a Process

First, instructional design as a process must be approached from the perspective that most faculty members are not designing at all or are designing backward. For example, faculty members who have a cursory familiarity with the learning/content management system will "design" based on the functionality of the technology. For example, a syllabus or course documents will be uploaded into the system or a discussion established simply because of the functionality with little or no consideration as to the strategy of instruction or the pedagogy that is driving the use of the technology. For example, why is a discussion board in use? What is the purpose of the discussion as it relates to student learning? How will the discussion be used as a component of the overall instructional strategy; not just for purposes of a graded activity? The process approach to instructional design requires that it be systematic, aligned with student needs and goals, grounded in constructivist learning and instructional theory that is schema-based, and functionally navigable by the student. The instruction, therefore, should be based on the three goals driving the development of the curriculum: (a) promotion of a deep understanding of the importance of self-regulation, self-facilitation, and responsibility for a student's own learning outcomes and successes; (b) development of an awareness of the identified components of metacognition, through constructivist active learning methods that facilitate student participation and interaction; and (c) connection of the first goal of self-regulation, self-facilitation, and responsibility with the second goal of an awareness of the identified components of metacognition and shared semantics with the third goal of applied learning in the context of the cognate subjects. The faculty role is multi-faceted in this environment in that educating is not just "teaching" in the traditional sense. It is a process, a methodology of communication, of sharing knowledge, of transferring information, of mentorship, of facilitating, of leading, of listening, of learning, of growing and developing, of challenging – it is fluid and difficult to label and capture.

Within a web-based environment, "prompts that encourage cognitive strategy use" can be very beneficial (Kauffman, 2004, p. 149). In recognizing the positive influence of cognitive constructs, Martinez and Bunderson (2000) expanded the application of cognitive strategies to study how individual learning differences impacted the learning experience. Von Glasersfeld (1995) believed that knowledge flows from active learning which is an iterative process and advocated that a constructivist ideology is not aligned with behaviorist stimulus-response beliefs. Johnson and Aragon (2002) emphasized that future studies should empirically test the effectiveness of different instructional techniques for maximizing learning opportunities and achievement in online learning. They suggested that the learning environment comprise elements in behavioral, cognitive, and social learning theory. According to Huitt (2003), the emphasis of the constructivist approach is that "an individual learner must actively build knowledge and skills (e.g., Bruner, 1990) and that information exists within these built constructs rather than in the external environment" (p. 386). In assessing the learning environment, Tam (2000) evaluated constructivism and instructional design to propose that instructional design methodologies must not only include constructivist perspectives, but also create a powerful learning environment. Tam advocated that web-based constructivist learning environments must include knowledge and intelligence (i.e., expert input). These factors are important for guiding and structuring the learning processes as well as stimulating cognitive potential. Colon, Taylor, and Willis (2000) further explored the constructivist instructional design model and created a multimedia instructional design package for teaching qualitative research. Colon et al.'s design resulted in the identification of two specific trends in education (a) critical theory and constructivism can be used as a basis for instructional strategies in instructional design, and (b) instructional design models do not need to be linear, but can be approached in a "spiral" fashion. In the first trend, the belief is that there can be both descriptive and normative bases for inquiry (i.e., critical theory), as well as learner-based constructions of knowledge in the learning environment. With the second trend, instructional design models can progress from standard linear models to models that allow for many levels. In understanding the need to build effective, interactive e-learning, Moreno and Mayer (2000) argued that personalized messages within a multimedia learning lesson promoted deep learning. They hypothesized that personalized messages facilitated deep learning by actively engaging students and reducing cognitive load based on an interactive method of teaching. From these studies we can glean that there are many approaches to instructional design for learning that are delivered through technology. It is also important to consider that in developing instructional objectives it is necessary that the objectives reflect not only the operational aspects of the instruction (the techniques and processes) but also how the learners will learn and integrate that learning in the learning environment. The instructional objectives and outcomes need to be clear and concise so that learners employing various styles can make meaning from them. In preparing for the transfer of learning, integration is the key element. The educator needs to determine what strategies should be utilized, what the key heuristics are that will facilitate the transfer of learning processes, and what transfer strategies will be most useful and effective in the learners' application of the instructional content to the learners' learning environment.

Pedagogy as Driver

Second, pedagogy must drive the instructional design process. Based on the supporting research and current literature (Kottler & Gallavan, 2008), there is a significant gap in developing the metacognitive skills that will move a student towards metacognitive expertise and academic achievement in not only emphasizing self-facilitation and self-regulation but also in including those components of metacognitive expertise (Pang, 2008). Topics such as engagement, motivation, awareness, self-confidence, and efficacy should provide the strategic frame for a fresh, new approach to blended instruction. The instruction should: (a) inherently demonstrate an understanding of student-centered, preferred learning styles, (b) develop positive self-concepts in the context of Socratic-based inquiry discussions, (c) assist students in identifying areas of weakness, and (d) clarify and promote a shared understanding of words such as "success," "effective," and "communicate." It is generally understood that many communities and cultures have shared semantics that are not shared beyond those boundaries and therefore misunderstood in other contexts. Therefore, these methods that have at their root the goal of promoting a deep understanding of the importance of self-regulation, self-facilitation, and student responsibility for a student's learning outcomes and successes must ensure that the student's "understanding" is based in shared semantics and mutual understanding. In addition, the instruction must emphasize kinesthetic learning that a student can apply contextually to make the necessary associations and connections that generate deep learning. Therefore, the learning opportunities must be targeted towards the different types of learners and their learning styles. The instructional pedagogy must also facilitate learning through a variety of modalities, both technology-based and non-technology-based, to allow for a systematic exposure to various learning activities which require customization as a component of the pedagogy driving the instructional design. The emphasis is on the learner's learning style, modes of thinking, and the context of the learning.

Researchers (Boyle, Duffy, & Dunleavy, 2003; Candy, 1991) have defined self-directed learners as those who assume responsibility and take charge of their learning. Research has also demonstrated a correlation between self-regulated, self-directed, and self-facilitated learners with metacognitive expertise and academic success (Pang, 2008). In order to use an effective pedagogy to drive the instructional design process in a blended learning environment, there must be a belief that a goal of education is not only the dissemination and transmission of information but the movement of the learner from novice to expert which requires the development of an inquiry-based, active-constructivist learning environment. For example, constructivist principles have for many years provided a methodology for recent pedagogical and instructional design movements. These pedagogical reform efforts reflect the view that "the acquisition of knowledge is not a simple straightforward matter of 'transmission,' 'internalization,' or 'accumulation' but rather a matter of the learners' active engagement in assembling, extending, restoring, interpreting, or in broadest terms, constructing knowledge out of raw materials of experience and provided information" (Salomon & Perkins, 1998, p. 115). If the student is viewed as an active sense-maker who must interact with and apply knowledge to be successful, then the pedagogy driving the instruction will move from direct instruction to more interactive, active learning. Direct instruction can be visualized as a drill team practicing for a football game where the team will draw on rote routines to dazzle the crowd and active learning as the third string quarterback placed in the game with 20 seconds and a tie score.

Researchers (i.e., Dean, 2006; Douglas, Burton & Reese-Durham, 2008) have also found that direct instruction, when compared to more robust methods of instruction, have fallen significantly short in developing strong cognitive abilities and academic skills. In addition, research has shown that a learner's knowledge about his or her own thinking, metacognition, impacts learning outcomes, and manifests in learners' efforts towards learning (Flavell 1992; Hartman, 2001). In addition, for learners to be effective they must understand and apply knowledge in increasingly ascending levels of complexity. This cognitive need demands that instructional strategies and techniques employ scaffolding principles. These drivers produce a pedagogy that embraces a belief that learners must develop metacognitive expertise as the result of many factors combining to provide a depth and breadth in metacognitive ability that equates to what researchers have found in the study of expertise (e.g., Ericsson, 2000). Although, Osguthorpe and Graham (2003) suggested that blended learning environments can vary widely depending upon goals, such as the richness of the pedagogy, access, collaborative and social factors, as well as cost effectiveness, and ease of revision; overall, there needs to be more than a replication of content and a depository mentality. Those using technology to deliver a blended learning environment must identify the constructs of the pedagogy that will ultimately design the instruction and create the meaningful learning environment. According to Aycock, Garnham, and Kaleta (2002), if the components of the live and online learning environments are not well blended, there can be an impact on the student's cognitive load that will impact the effectiveness of the student's learning experience.

Technology as a Strategy

Technology is the tool that is used strategically to deliver the instructional content. The focus is, therefore, on the instructional uses of the technology rather than the technology. According to Papert (1993), the emphasis must be on 'constructionism' where technology is viewed as the playground and learning is exploratory and inquiry-based. In research where constructionist models of learning were utilized, learning is driven through exploration of the 'learning world,' created by the components of the technology as an integrated whole. Many researchers agree, therefore, that the technology is not the focal point but rather how the technology is used to create a meaningful learning environment (Bryceson, 2001; Torrisi-Steele, 2002). If educators view technology as a tool that can be utilized to address different learning styles through the use of different components, such as collaboration, media, and discussion and develop well-defined pedagogical-driven instructional strategies as to when and how to use these components, then technology will facilitate scaffolding in learning which according to Burn and Leach (2004) is important in developing sound pedagogy. This view of technology and its use by students is recursive where students are engaged in a self-directed learning process in which they construct meaning through exploration and experimentation.

The Papert view of constructionism is not dissimilar to cognitive constructivist models where the student makes sense of the learning environment through interaction and development. In this pedagogical frame a student in a blended learning environment is constructing meaning based on his/her interaction with both the live and technology-driven learning environments by creation, which is active, rather than reception, which is passive. In this way technology, as a tool and medium, is aligned to various learning styles so as to engage students and support learning (Chen, Toh & Ismail, 2005). In addition, the components of the technology tools allow educators to create a variety of learning objects that promote learning through exploration and activity (i.e., "learning by doing" or "learning by seeing," Pittman, Rutz, & Elkins, 2006). As Chen, et al. (2005) found, the interaction with the variety of learning objects also contributed to the students' understanding of the content.

Application as the Goal

Finally, based on the novel model described in this paper, application is the goal for the use of a blended learning environment that uses technology as a tool driven by a pedagogical strategy that is most relevant to the students and the context of the content. To create a blended learning environment that stimulates meaningful learning it is important to balance and combine components from both learning environments and the relevant psychological and learning constructs that are relevant to the learners. For example, combining practical problem-solving methods (sensing/active) with fundamental understanding (intuitive/ reflective); providing logical inference, pattern recognition, generalization with observation of surroundings, empirical experimentation, and attention to details; encouraging both sensing and intuitive/reflective activities; using pictures, schematics, graphs before, during and after the presentation of verbal material (sensing/visual); providing opportunities to participate in active learning activities and exercises; and providing open-ended problems that require analysis and synthesis (intuitive/reflective/global).

So what are some of the macro questions that an educator faces in designing courses for a blended learning environment? One question stems from notions of social constructivism and inquires as to whether the learning engages the student in the zone of proximal development (Vygotsky, 1978) so as to build on the components of interaction and collaboration. According to Hakkarainen, Lipponen, and Jarvela (2002) when instruction is designed with a collaborative component, students develop critical thinking skills because of the need to interact with differing viewpoints. Further, Gabriel (2004) found that blended learning methods facilitated web-based collaboration. Another questions stems from whether the development of the instructional content is formed from the perspective of what instructional content is most intriguing and significant to the students. This question is not an attempt to shift the selection of the learning content to the student but rather to ensure that the educator understands that students will learn more meaningfully if they can construct relevance from the content and construct a connection for understanding the content. This requires that educators contextualize the content in ways that make sense to the students so that students can extract important concepts and develop a deeper sense of the importance of the instructional content. Related to this second question is a third question that inquires as to whether the instructional content fosters a sufficient grasp of concepts, principles, or skills that students can apply and transfer to new problems and situations, thereby moving forward along the novice-expert continuum.

Conclusion

Verstegen, Barnard, and Pilot (2008) in two empirical studies noted that "novice designers were not inclined to use a systematic approach to the design of instructional products" (p. 352). They also found that design was usually based on the components, or what has been labeled in this paper as functionality, of the operational systems, or what this paper has termed technology. Citing to other research by Verstegen, Veldhuis, Staalstra, and Hendriks (2001), they wrote "the instructors did not use the available tool to make lesson scenarios based on learning goals" (p. 352). Further research by Hoogveld, Paas, Jochems, and van Merriënboer (2001) found that the designs of teachers who had been trained in applying a specific instructional design model were rated significantly better than the designs of teachers who had received the same amount of training to improve their own experience-based design method. Additionally, Van Berlo (2005) found that studying design guidelines indeed helped novice designers to execute a better task analysis" (Verstegen, et al., 2008, p. 356) which drove greater success.

As discussed in this paper, it is not surprising but rather a cause for action that educators develop an understanding of instructional design so that they can adequately use pedagogy to drive instructional design so that the use of technology represents what students actually do when learning - or rather what they should do in the learning environment. In many design/development scenarios this requires the educator to be more realistic about student abilities and preferences as well as more flexible in the use of various pedagogical models that facilitate meaningful learning in a blended environment. The educator must also recognize that as a subject matter expert, he/she is prone to demonstrate domain expertise and less focused on instructional design, learning pedagogy, or curricula strategy. Part of the concern arises from the simple fact that educators with advanced degrees usually receive little or no exposure to the information necessary to develop these skill sets. However, if an educator is willing to engage in experimentation, accept a novice perspective, which requires an understanding of students' learning styles, modes of thinking, and the context of the learning, and the educator is willing 'to get it mostly right,' then the educator can begin to think about pedagogy driving instructional design and instructional design as a systematic process to develop meaningful blended learning.

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Video Streaming Potential in Education and Training - Who Says it Works and Why

Daniel S. Keenan

Abstract - It is no longer necessary, required, or even desired to educate or train people in traditional classrooms. As the economy tightens and as technology evolves into a more dynamic and stimulating option, the choice to migrate to video streaming is a logical progression. Streaming media can be found in the news and entertainment web sites that have enjoyed great success and growth, yet some institutions that have the obligation to teach or train have yet to include video streaming in their teaching practices. Video streaming is very affordable, however has not reached the application status it deserves. Studies have shown that video streaming is just as effective, and in some cases more effective, than face-to-face (Boster, Meyer, Roberto & Inge, 2002). The points presented highlight the reasons to embrace the video streaming technology, who is using it, why, and how it aids the decision making process of executives who are obligated to make informed decisions about how they plan to achieve their educational goals while being fiscally responsible. Employee and student training and education is paramount if a future is to be realized. Video streaming is a means to make the future a reality.

Introduction

The online content networks such as America On Line (AOL), Google, MSN, and Yahoo are growing by a factor of 10 from 13 million households in 2005 to an expected 131 million by 2010 (Burns, 2006). It is logical to assume that the media that is linked to those networks will increase also. Video streaming media is largely responsible for the growth of the internet industry as it is found in YouTube and in most internet sites, especially those associated with the news media and entertainment. The growth of high speed internet for households is expected to grow from 194 million in 2005 to 413 million in 2010 because of the high demand for online video (Burns, 2006).

The computer age is here and students are more familiar with it, and all that is embedded within it, than the World Book Encyclopedia. Seventy-five percent of the student population whose ages range from 18-24 have all used video streaming in one way or another and are therefore familiar with its processes and procedures (Figure 1) (Wright, 2007). It is a natural and wise choice to teach students using methods that they are comfortable and familiar with as it reduces stress and anxiety (Hsu & Huang, 2006; Cretchley, 2007). A student's level of confidence in his computer skills has a direct affect in his motivation for learning in a technology-rich environment and it empowers his learning (Cretchley, 2007). It is significant to note that students who do not exhibit strong levels of computer self-efficacy show strong levels of apprehension in using technology, but that the feeling usually subsides after a semester of using a system or software (Cretchley, 2007).

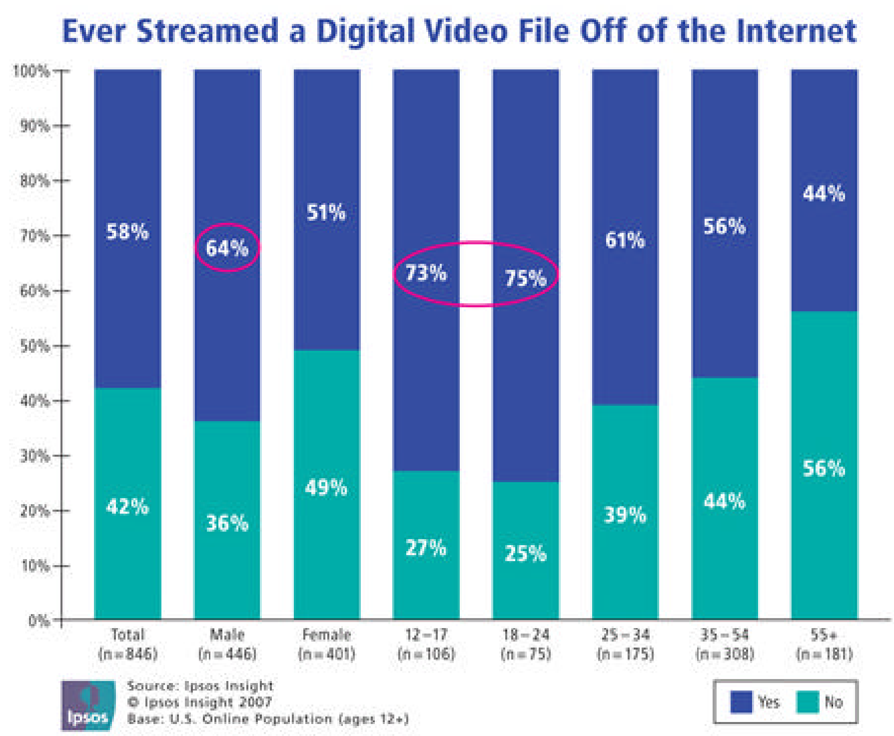

Figure 1

People who have video streamed

The reason why video streaming is so important to education today is because of the comfort and preference the student population have exhibited towards the technology-mediated virtual learning environment (TVLE). It is because of the level of student self motivation through learner control of the medium, student self-satisfaction, and the research showing that students who engage in TVLE outperform their peers who are in a traditional face-to-face classroom environment (Chou & Liu, 2005). It is interesting to find that users of video streaming in business tend to show a higher educational level and posses higher income (Wright, 2007).

Face-to-face instruction, though preferred, is not necessary to acquire information from a learning objective (King & Boehlje, 2000). King and Boehlje (2000) and Fill and Ottewell (2006) supported the evidence that the blended use of face-to-face and video streaming is a preferred method of delivery. It is also suggested that the more seasoned lecturers were less apt to change their teaching methods and did not trust or wish to try video streamed activities (Shephard, 2003). Shephard (2003) also contended that the video streaming method was enthusiastically viewed by the younger students. This could be directly attributed to the culture and electronic environment that the students, since the 1990s, have been raised in and therefore very comfortable with.

King and Boehlje (2000) showed that face-to-face classroom training was no longer required nor was it always the most desired agency of learning. The cost savings for educational institutions may be substantial, depending on the level of professional dedication the institution has to distance education, i.e. video streaming (Cecil, 2002; Shephard, 2003).

What is Video Streaming

Video streaming or streaming media (video and sound) involve constant electronic signals (streaming) sent in compressed form from the source over the Internet and displayed to the viewer through the use of a player, i.e., Windows Media, Flash, or RealPlayer (Rayburn, 2007). Video streaming uses the web, allowing access to a source in real time from a studio or video library without the delay of having to download a large file before experiencing the media. Rather, the media is sent through a perpetual and unbroken video and sound signal that is played when it arrives (Darrel, 2001). Rayburn (2007) explains that the user's player, which must be compatible with the signal being sent from the source will uncompress (decode) the data signal sending the video data to the monitor and speakers (CODEC programs).

A live video-streamed broadcast uses a special multicast Web server that allows users at different locations to view the media at the same time (Dan Rayburn, personal communication, September 16, 2008). The rate at which the signal can be sent and received depends on the systems being used (Microsoft uses Advanced Streaming Format [ASF]) and the data rates of the connection, but generally ranges up to 128 Kbps with an ISDN connection (Dan Rayburn, personal communication, September 16, 2008).

Video streaming impact and importance, Marine Corps Case Study

The U. S. Marine Corps prefers the pen and paper method of teaching and assessment, because as a grass roots and traditional military fighting force, it does not fully trust electronic technology. This distrust has foundation, as electronics tend to fail when they are exposed to the elements, which is where Marines will most often find themselves. There is expectancy by the Corps however, that recreation centers that are provided for off duty Marines could double as academic centers. They would have an atmosphere that would have the climate controlled thereby making them compatible for relaxation, leisure, and learning. This kind of climate will accommodate computers and internet connectivity. No permanent base or naval vessel is void of this capability and there are very few expeditionary camps were without satellite and internet connectivity that are available to the off duty Marine in some way or capacity.

> "The purpose of all training is to develop forces that can win in combat. Training is the key to combat effectiveness and therefore is the main effort of a peacetime military. However, training should not stop with the commencement of war; training must continue during war to adapt to the lessons of combat" (Navy, 1997, p. 78).

The Marine Corps has a history and mission of projecting American force where it is directed and the ability to be successful in the accomplishment of the Corps objectives depends on training her Marines effectively and efficiently. Force planning, as defined in the Marine Corps Warfighting Publication, MCDP1 (1997) is planning that is associated with the creation and maintenance of military capabilities. Force planning involves every part of military management and organization but has its roots deeply embedded in training, education, and doctrine (Navy, 1997).

To be efficient in training and education the Corps must change the way training occurs, at least in part. The Corps no longer has the luxury of transporting Marines to distant locations from a theatre of operation for training because Marines are engaged in tasks supporting the war effort. Often times the command can not afford to let a Marine leave for training who is performing an important job, even though the command and the Marine knows that the training and knowledge will contribute to the unit's efficiency of mission accomplishment. The economy is such that the Corps has to look at more efficient ways to train as money is becoming scarce and decisions have to be made on how to best spend the shrinking dollar. E-Learning is an applicable option with video streaming as a modern delivery means through Blackboard Learning System (Bb) (Fritz, 2006). The learning curves are steep, teaching paradigms need to change, and investment in technology has to be made in order to keep pace with the speed at which the e-world operates.

The Marine is a computer perceptive and technologically smart person. The educational level of the United States population between the ages of 18-24 in 2003 is higher than it has ever been. Organizations to include colleges, businesses, and the Marine Corps mirror this fact. It was determined that in 2007 the average graduation rate from high school was 74.4%. Of those students who were nineteen years old or less and dropped out in 2005, 45% took the General Educational Development test (GED) and passed (Statistics, 2007).

Because of these facts, the Marine Corps has just recently begun consideration of video streaming possibilities as a means of training career Marines (beyond the Military Occupational Specialty [entry level] schools).

Civilian business and educational institutions

In 2005, every public school had on average 154 instructional computers, with 94% of the instructional classrooms having access to the internet. In 2003, it was found that 56.1% of the total workforce population used computers at work. The range went as high as 66.2% for those between the ages of 25-29 (Statistics, 2007). These statistics for 2003 to 2005 were presented to make the reader aware of the level of the technologically smart generation of learners who were entering the workforce and the Corps. It was the opinion of Garland and Noyes (2004) that the lack of computer experience did not make the learner any less capable. In effect, the terms of experience could be defined in any number of ways; it depended on the user's exposure to technology and personal use, but with the ever increasing simplicity of point and click, learning speed and sequence became easier and quicker. In practical terms, computer experience was a poor predictor of attitude and success (Dambrot, Watkins-Malek, Silling, Marshall, & Garver, 1985).

The educational video streaming process is used throughout industry to train human resources. When and where personnel train has been recognized by education and psychology experts as being an important and motivating factor for student success (Chou & Liu, 2005). Educational institutions use streaming media to teach students at a distance (globally) as well as in the dormitory. Old Dominion University has a broad array of educational concentrations ranging from courses on the bachelor level to the doctorate level in subjects such as math, psychology, statistics, engineering, education, medical sciences, and more. The University of Minnesota video streams math, science, and engineering courses; Auburn streams music courses on a masters level; The Harvard Extension School streams classes in environmental sciences (Fill & Ottewill, 2006) and the University of Phoenix Medical College uses video streaming to broadcast complicated and detailed surgery procedures. Some other medical schools streaming video medical courses and procedures are Georgetown University Medical Center, Mt. Sinai School of Medicine, St. George's University Medical School, University of Pennsylvania, University of Vermont College of Medicine (Fritz, 2006), Cornell University School of Medicine (Fritz, 2005), and many more.

The medical profession has such confidence in the technology that it is used to consult other doctors during operations (Kane, 2008), as well as broadcast recorded surgeries and conferences to doctors and health care professionals around the world by using nothing more than desktop computers equipped with the standard streaming-enabled software, hardware, and operating systems (Gandsas, 2002). Gandsas (2002) was able to broadcast with such clarity that students, faculty, and clients "easily identified all anatomic structures in full color motion, clearly followed all steps of the surgical procedure, and successfully asked questions and made comments by using the e-mail/chat module while viewing the surgery. With minimal financial investment, we have created an interactive virtual classroom with the potential to attract a global audience" (p. 377).

Huang, Qiu, Fu, Shimizu, and Okamura (2008) transmitted video streamed surgical procedures to four sites in China and Japan. The transmission could be switched between any combination of the four sites on demand to facilitate question and answers using a video streamed face-to-face technique. The remote sites heard the "voices synchronously transmitted with the images. Every participant could offer comments and raise questions at any time while the live surgery was continuously shown on the screen" (p. 483).

e-Learning environment

The use of e-Learning grew from a 4.9 billion dollar industry in 2004 to an impressive 6.04 billion in 2007 and is expected to continue growing 11% every year, involving over 80 % of all companies in the United States (Britt, 2004). The economics of saving time, money, and resources is the driving factor behind this education and training migration from the traditional classroom to the e-Learning platform (Britt, 2004). The flexibility that asynchronous and synchronous learning permits through Bb, who has 85% of all of the colleges and universities in the US (D. Palmer, personal communication, May 21, 2008), is an added benefit not available before 1997 (Britt, 2004). E-Learning enthusiasts struggle with balancing the excitement of e-Learning with an effective physical and social setting, knowing that the environment in which the learner learns can impede the process of learning, therefore, is integral to the learner's behavior, motivation, comfort, and ability to concentrate (Halverson & Collins, 2006, Rotter, 1954, Merriam, Caffarella, & Baumgartner, 2007, Zifferblatt, 1972, Bibeau, 2001. Research clearly supports that humans are influenced by the environment but falls short of stating how exactly we can best interact with it and use it effectively to learn.

Hsu and Huang (2006) concluded that the use and familiarity of computers was the most significant factor in student self-efficacy when the use of computers was required. Improving the students' perception of the three learning motivations (interest, trend, and employment) and the environment of their home elevated their confidence.

The researchers also determined that students, on average, were "dissatisfied with their school learning environments" (p. 263). Learning environments do play a role in the learning process.

Video streaming is not a vision of the future, but rather, it is the action of today. Businesses, hospitals, universities, and departments within the government (College of Continuing Education [MCCDEC Quantico], USDA) use video streaming in one way or another (D. Chinault, personal communication, March 15, 2008). Two-way web conferencing and the ability to transmit information from one remote site to another is common practice. Kane (2008) believed that video streaming may soon become one of the most popular internet technologies because of its Video on Demand (VOD) web accessibility, video archive library potential, virtual classrooms, and chat capability. Students who received instruction in a course with VOD showed dramatic improvement in the attainment of the goals of the learning objectives (Boster et al, 2002, as cited in Reed, 2003).

Learning environments that are low in stress such as homes, libraries, Barnes & Noble stores, etc., favor reflection and analytic thinking because the thalamus, hippocampus, and the cortex portions of the brain (memory and higher level thinking) are not used as the electronic pathways that a high stress environment would use. Because of this neurobiology, the brain is allowed to synthesize information on a higher level and exercise creativity (Weiss, 2000). The novelty of computers and computer based learning is itself a motivator for some learners and as Robert Aitken has found, it played a role in learning, especially as intrinsic motivation (Aitken as cited in Weiss, 2000). If a student could be shown how the job he is learning is important, and necessary for "survival" (job success or actual survival on the battlefield) the material would be more easily learned (Weiss, 2000).

Learning biology

The biology of learning as presented by Leamnson (2001) was a matter of "brain change rather than brain use" (p. 78). Teaching is a process of motivation, stimulation, and encouragement: to help the learner focus on the change in behavior that is required after learning has taken place. "Computers and technology, and the access they afford, constitute a new way of studying" (Leamnson, 2001, p. 78). Technology has a permanent place in education. The precept that "learning can never be improved by technology is certainly and demonstrably wrong" (p.78).

Robert Sylwester studied the cycles of attention pointing out that the human brain has a cycle that runs between 90-110 minutes (Sylwester as cited by Weiss, (2000); Leamnson, 2001). Trainers need to recognize and appreciate this cycle and manage their courses to front load the bulk of the content to be learned and use practical exercises on the tail end. Video streamed classes, when managed properly, could obey the tenets presented by these researchers. Brown (1996) and Hara and Kling (2000) support the e-Learning requirements suggesting that learners using the social tools (chats, discussion boards) embedded within the e-Learning social design either through Bb or the video streaming format have a very positive effect on student satisfaction resulting in student success.

Technology is not the panacea of all of the educational problems, but it offers alternatives when time and money are a factor. Technology is utilized the best when it is augmented with the interpersonal human flavor, i.e. blended learning and strategies. Educational technology has to be placed into the hands of a trained facilitator (Leamnson, 2001; Reed, 2003). Neal Postman has said, "[t]echnological change is not additive; it is ecological. A new technology does not merely add something; it changes everything" (Postman, 1992, as cited in Leamnson, 2001, p. 77). Training instructors in the video streaming method will be a necessity, but the return on the investment will far exceed expenditures and expectations.

Definition of Terms

Asynchronous - operation without the use of fixed time intervals (opposed to synchronous).

Distance Learning - The acquisition of knowledge and skills through electronic or digitized means encompassing all methods that technology can support from one site to another.

Efficacy - capacity for producing a desired result or effect; effectiveness

e-world - the electronic dependent and technology driven world.

Synchronous - existing or occurring at the same time (opposed to asynchronous)

Video streaming - The animation of a video as it is being sent to a browser in real time (Darrel, 2001).

VOD (Video on Demand) – describes video content which may be viewed by the end user from beginning to end, at any time (Rayburn, 2007).

Summary and Overview

Video streaming had been considered a solution to a variety of problems, all of which apply to the needs of the Marine Corps training and education mission. Some of the problems the Marine Corps had to face were the growing costs of training, i.e. travel, Temporary Additional Duty (TAD) costs, lodging, and lost time from the parent command, etc. Considerations were how to place the Marine in the learning environment without the costs associated with it, how to deliver the instruction, and where to find the costs for the video streaming equipment (Klass, 2003). Bandwidth was a consideration but it was not the focus of this dissertation; the reason being that it could be easily overcome with the expansion of the existing system to allow greater bandwidth, the use of Compressors/DECompressors (CODECS) such as the latest CODEC's Media Player, RealPlayer, QuickTime player, and the modification of existing firewalls (Rayburn, 2007).

The brain is ready for the video streamed method of delivering a lesson and is, in fact, systematically designed for it. The dopamine system activates the feeling of pleasure as a reward for survival. This system is directly linked to emotion, and learning that may accompany it (Barry, 2001).

> As we move from slower paced media messages such as those in print to faster media messages characterized by triple cutting on the moment, the dopamine system and enhanced emotional memory reinforce the pleasure of the new pace with immediate gratification and reward. The delayed gratification associated with abstract thinking and complex analysis works less dramatically, working through the cognitive pathway first, only later adding emotional satisfaction to the task. The mesolimbic dopamine system is part of our emotional learning system… (Barry, 2001, p. 113).

The Marine Corps, as any corporation, considers the bottom line, cost. Unlike corporations however, the Marine Corps does not make a profit but relies on Congress to allocate funds so the mission of the Corps can be advanced. With money being hard to come by and not being immune to the economic crunch, it has to make every dollar count. Unlike corporations, the United States relies on the effectiveness of her Corps to project American naval power in the defense of her borders and interest. The United States Marine Corps wants to make the Marine on the battlefield successful and understands that training and education is at the core of every rifleman.

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Developing USAF Leadership Skills via Distance Education and Simulation

Bob Shook and Adam Nelson

Abstract - Vangent and the US Air Force have developed a master's degree curriculum in Applied Leadership, delivered via self-paced distance education. The instructional design optimizes learning and provides for real world application and authentic assessment, within substantial situational constraints. Qualitative simulations put learners in realistic leadership situations they will face on the job. As in the real world, learners can seek information and consult others before acting or making decisions, and can confirm and reinforce their understanding of approaches, theories, and other supporting knowledge. Both situational performance and supporting knowledge are assessed and elaborative feedback supports and enhances learning.

Keywords: instructional design, distance education, simulation, military, leadership

Introduction

Working with the U.S. Air Force, Vangent has created a curriculum in Applied Leadership to develop the next generation of effective officers. Designed with the goal of becoming a distance learning master's degree program when accreditation is granted, the Applied Leadership program is a series of courses that are delivered via the Blackboard Academic Suite™. Courses were designed to be application-oriented and relevant to company grade officers (CGOs) in all specialties, wherever they may be stationed around the world.

The entire Applied Leadership program is composed of six courses:

- Lieutenant Development ~ 108 hours
- Expeditionary Leadership ~ 108 hours
- Flight Commander ~ 108 hours
- Squadron Officer School (SOS) ~ 200 hours.
- Advanced Officership ~ 216 hours
- 21st Century Warfare ~ 324 hours

Phase One (first four) courses have been completed and are currently being implemented. The remaining courses are slated for the second phase of development.

Performance Objectives

The Applied Leadership program is designed to develop applicable skills rather than theoretical expertise. In addition, to meet the needs of the target audience, our mission was to create exercises providing structure and learning goals around activities the officers have to do as part of their normal duties, or assignments that provide benefit to their superiors, their unit, or the Air Force as a whole. Theoretical knowledge is an important component supporting development of applicable skills, but real-world performance is the bottom line.

The terminal performance objectives and the enabling knowledge objectives were developed based on the Air Force's *Institutional Competency List (ICL)*; a comprehensive set of skills and capabilities that the Air Force has determined all officers must develop. Vangent used the objectives to guide the selection and creation of content materials and to design experiential learning experiences, in order to prepare CGOs to develop the defined ICL competencies through on-the-job experiences.

Instructional Approach

In order to meet the needs of our audience with the technology used by the Air Force to provide remote access to courseware for airmen all around the world, Vangent employed a customized instructional design model we refer to as the **A^3 ("A-three") Instructional Design Model.** The model's name stems from the fact that in the A^3 model a course is composed of "units," each a series of "Acquire," "Apply," and "Assess" modules. Each unit primarily addresses one competency (referred to as the "focus" competency) and weaves in knowledge and skills addressing several related ("support") competencies. In each unit, several Acquire modules lead into one or more Apply exercises, followed by a single scenario-based Assess simulation module.

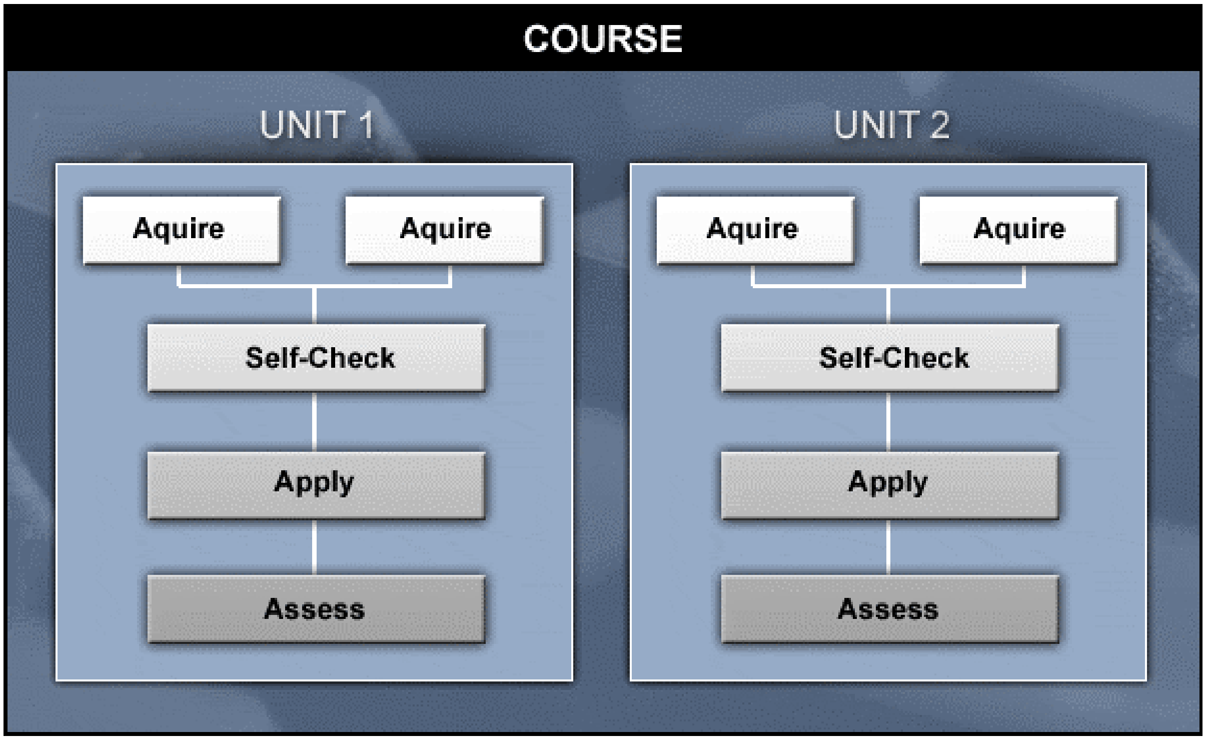

Figure 1: A^3 ("A-Three") Instructional Design Model

- **Acquire –** Acquire modules introduce a topic and present information delving deeper into that subject. The content of an Acquire module introduces, transitions, and synthesizes material presented in a series of textbook chapters, and finally wraps up the entire topic and ensures that it is relevant to learners.
- **Self-Check** assessments follow Acquire modules to ensure understanding of material presented. Questions about material presented in the readings reinforce key points and correct misconceptions.
- **Apply –** Apply exercises transfer learning to each learner's workplace and experience base. Exercises were designed to yield information and products that are of value to each learner or their command, to provide immediate value to the Air Force from each officer's efforts in the Applied Leadership program.
- **Assess –** Where the A^3 instructional design model is innovative is in the use of immersive simulation (AKA "serious games") to master and assess soft skills. Each Assess module is an in-depth, realistic scenario in which Air Force officers could actually find themselves. In fact, the ideas for the scenarios came from real world stories related by experienced officers. Assess exercises are the pay-off for each unit of instruction. They enable learners to apply what they've learned in the unit in-context, in real world situations, and to be assessed demonstrating the defined ICL competencies as well as answering questions to prove their understanding of underlying concepts.

These "Assess" scenario-based simulation exercises are crucial to the success of the Applied Leadership program, because the target population includes 42,000 active duty CGOs, dispersed all over the world, in different time zones, and with workloads that vary dramatically. It would not be possible to have remote instructors deliver the curriculum to the entire audience or to evaluate all the assignments.

Leadership Simulations

Simulation is a widely accepted instructional and assessment approach, employed in many instances for application and assessment of knowledge and skills. In most instances, however, simulation is used for mastering and evaluating complex procedural or psychomotor skills, such as using software systems, operating machinery or vehicles, or flying aircraft. In the Applied Leadership curriculum on the other hand, simulation is used to practice, hone, and evaluate "soft" leadership skills in very complex situations.

Skills employed in the simulations involve many leadership competencies, including:

- Improving listening skills in support of successful mission accomplishment
- Self-assessing to evaluate both strengths and developmental needs
- Developing flexibility to meet the alternating role as leader/follower
- Honing speaking and writing skills to communicate clearly and concisely
- Applying the principles behind the warrior ethos
- Applying inter-cultural skills to establish and grow productive relationships with indigenous people and

members of foreign militaries, governments, and other organizations
- Developing subordinates as individuals and as a team while also meeting mission requirements
- Establishing the trust between leaders and followers that is essential in military operations in peacetime or during war
- Finding a mentor and being a mentor
- Establishing processes that will help to make effective decisions
- Building teams and being a member of a team

The Challenge

The Vangent design team was immediately challenged by the difficulty in creating scenario-based simulations that would do justice to the curriculum's leadership skills. To meet this challenge, the team identified goals for the successful design of the simulations:

Engaging: For an audience familiar with computer and video games, any one simulation would have to be an immersive experience that would maintain the learner's attention over a 30- to 60-minute period.

Challenging: Air Force pilots speak about the "Golden BB", a one-in-a-million round that finds your plane even if you have flown through massive anti-aircraft fire without any real damage. The simulations would need to be challenging enough that the learner would not be able to Golden BB their way through a simulation by taking educated guesses at the correct answers.

Believable: The scenarios developed for the simulations would need to be grounded in fact. We did not want any learners to say to themselves, "That would never happen."

Traceable: Learners would need to demonstrate the targeted competencies, applying the information, theories, and models learned in the preceding Acquire modules.

Insightful: Any decisions the learners made in a scenario would require meaningful feedback that explained why the decision was or was not a good one.

Meeting the Challenge

To successfully meet these goals, the Vangent design team developed a high-level design model that could be implemented across all 12 scenario-based simulations. The design included the following components:

Interesting and realistic stories combined with quality graphics: Early in the design process the design team realized that the simulations would succeed or fail based on the quality of the storyline developed for each simulation. Consequently, the team broke into groups, and using the key points culled from the Acquire readings, developed storylines for each simulation that could tie together as many of the key points as possible. To ensure realism and believability, each team included retired Air Force officers who were crucial in keeping the stories real and ensuring that actions, argot, and dialogue would be "Air Force blue."

To avoid the complexities of making the simulation a first-person experience (e.g., would there need to be a male and female version of each simulation?) the team created a fictional protagonist within each simulation. The learner's role is to provide guidance and counsel to the protagonist by offering advice at crucial decision points.

For example, in the simulation on global, regional, and cultural awareness, the team developed a storyline that focused on a Captain assisting the people of a fictional African nation with a reconstruction effort after a devastating earthquake.

To successfully complete this simulation, the learner must help the Captain carefully work through issues of understanding and responding to different cultural norms while still accomplishing the mission. The storyline has the Captain meeting and interacting with a variety of individuals, from military officers, politicians, and tribal leaders to street vendors and shopkeepers.

In addition, the team decided that these sophisticated storylines deserved quality visuals; consequently our lead graphic artist created a look that emulates a graphic novel. Figure 2 is the artist's line drawing of one of the scenes from the culture storyline.

Figure 2: Artist's line drawing from the Culture simulation

Challenging interactions: Each storyline requires the learner to help the protagonist make decisions at crucial times. To be successful, the learner must apply the knowledge and skills acquired in the preceding Acquire modules. To avoid the Golden BB of the learner guessing the correct answer, much thought was put into writing the options so that the learner really had to carefully consider each possible choice before making a decision. In many instances, there was no 'wrong' decision, only right decisions, with some being more appropriate than others in that particular situation.

In addition, decisions had to be traceable back to the sub-competencies identified in the ICL. To ensure this, each design team was required to be able to trace back from a scene from the simulation to a key point in the readings and ultimately one or more of the ICL competencies.

For example, one of the simulations focuses on a new Flight Commander who must develop subordinates as individuals and as a team while also meeting mission requirements. Figure 3 displays the possible decisions the learner can suggest to the Flight Commander. While all three decisions may appear to be reasonable, the best decision will be apparent only to the learner who has conscientiously completed the unit's Acquire module.

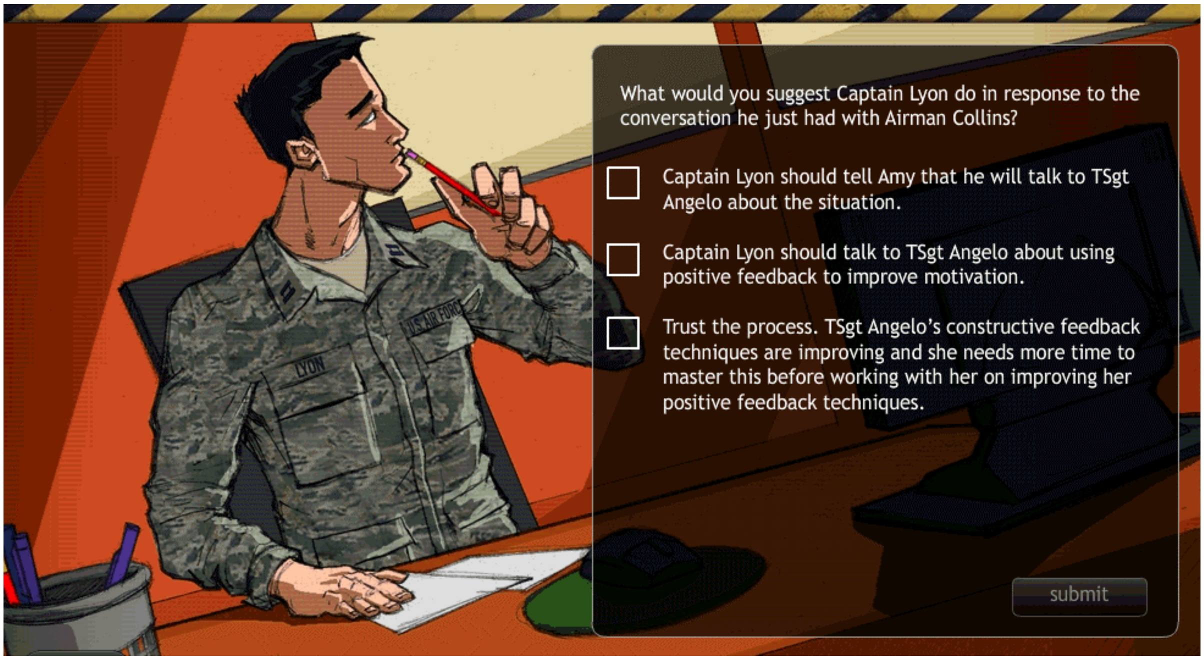

Figure 3: Sample decision point

Designers were given the flexibility to assign a point value (using a scale from -3 to +3) to each decision. This meant that one decision point might have three decisions scores of +1, +2, and +3, while another decision point might have three decisions scores of -3, 0, and +3. In addition, every point was tagged to a unit sub-competency.

Once a learner makes a decision, he or she is not provided traditional feedback, but instead the storyline continues based on the decision made. For example, if the learner selected the second choice in Figure 2, the storyline progresses to a conversation between the Flight Commander and TSgt Angelo that not only continues to drive the storyline, but provides an example of how a new Flight Commander might counsel an NCO (Figure 4).

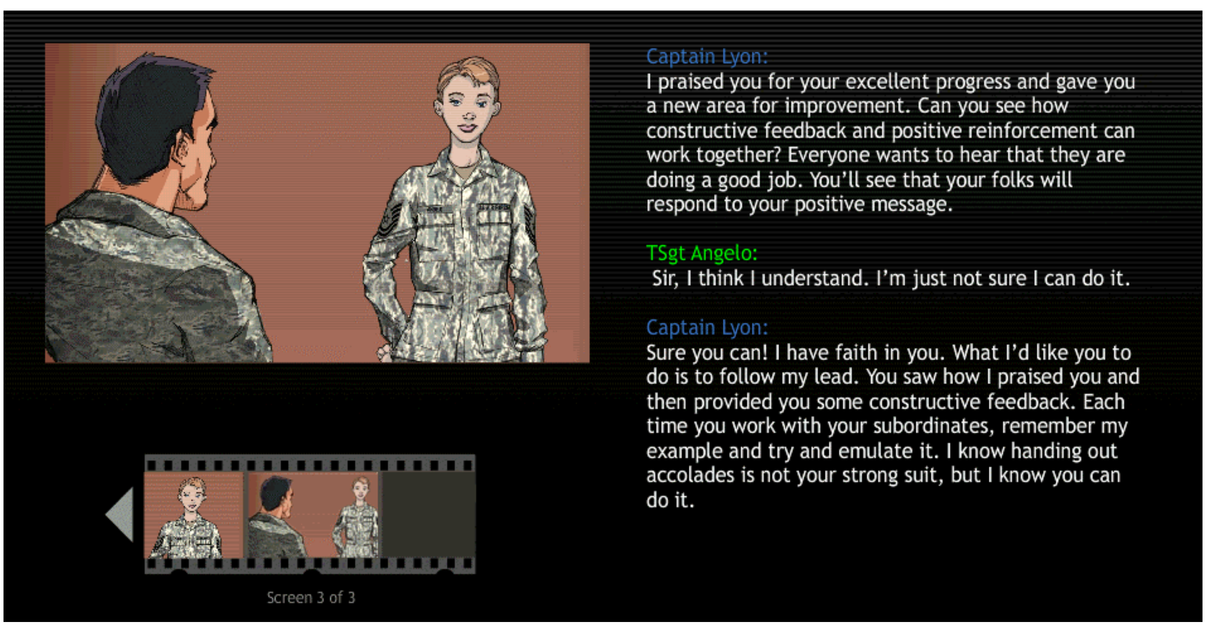

Figure 4: Sample storyline

If the learner had made another decision, the storyline would have branched in a different direction.

In addition to decision points encountered throughout the simulation, the team decided that the addition of scored knowledge check questions based on content encountered in the Acquire module would provide an additional challenge to the learner. Note that these questions are directly linked to the storyline. (Figure 5).

assigned to specific sub-competencies in the ICL, and the total points for the simulation can rise or fall based on the selections the learners make. Points for the knowledge

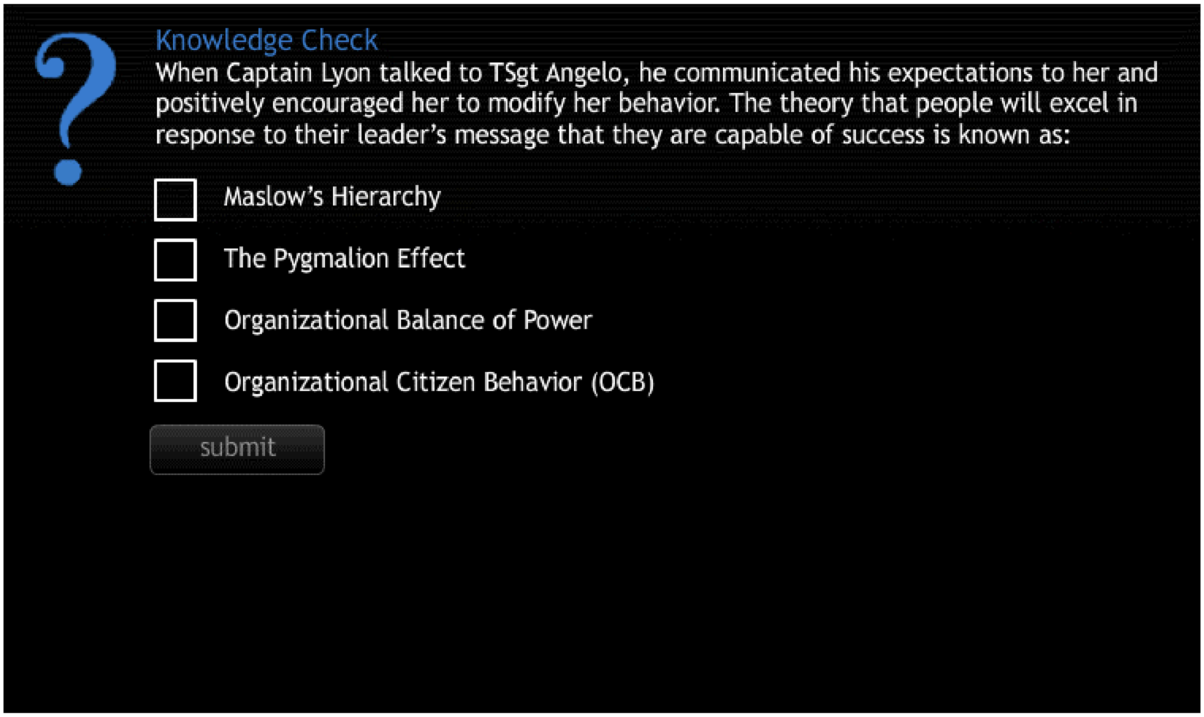

Figure 5: Sample knowledge check question

Meaningful feedback: Insight is provided periodically throughout each simulation at appropriate times in the form of Interim Performance Reports that provide scores for the decisions made, as well as a customized analysis of the learners' decisions so that they can reflect on their performance (Figure 6). Points from each decision are checks are also included in the total score. Learners must obtain a minimum score by the end of the simulation to obtain a passing score. If they do not pass the simulation, learners have the opportunity to complete it again. Since the storyline branches based on decisions made, learners may experience different versions of the simulation each time they go through it.

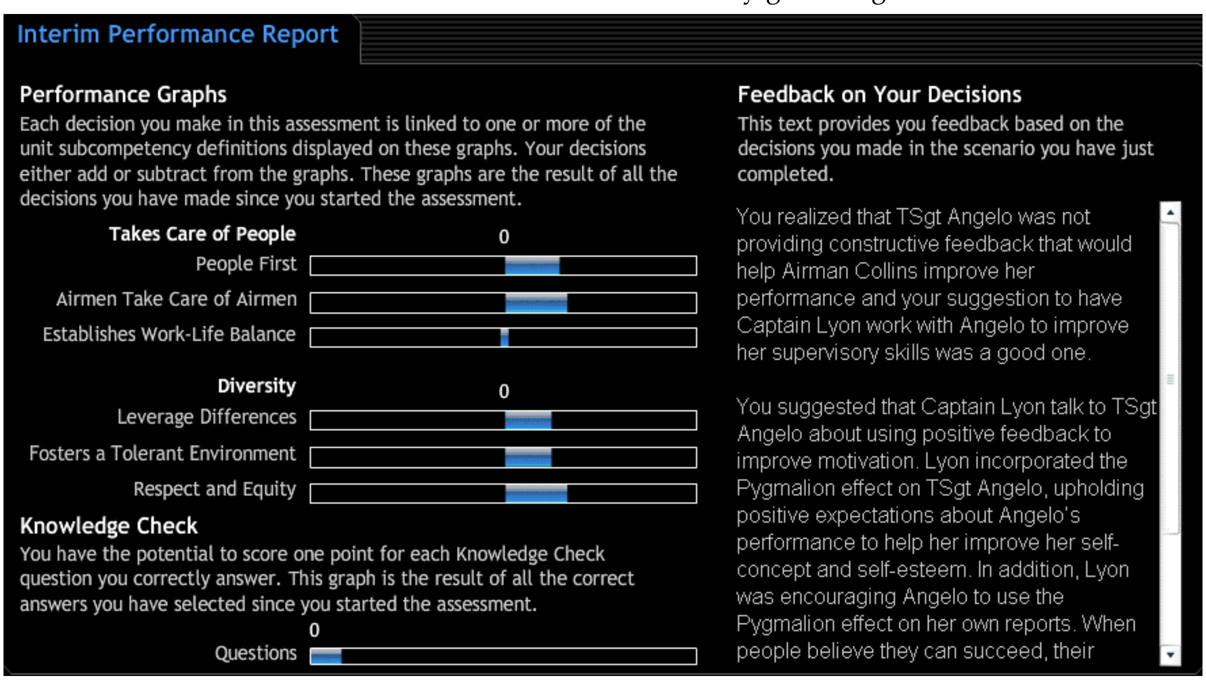

Figure 6: Sample Interim Performance Report

Conclusion

The "Assess" simulation exercises are an integral and indispensable element of the U.S. Air Force's Applied Leadership program. They provide an automated tool for assessment of each learner's understanding of the material presented in the courses as well as each person's level of skill in relation to the defined ICL competencies. Without the simulations, it would not be feasible to develop the skills of so many people, so broadly dispersed, and with such variable availability for study.

Vangent found that the effort required to design the simulation elements was significantly greater than what we typically experience for this type of simulation. This was due to the uniqueness of the Air Force environment, culture, jargon, acronyms, etc. While this understanding was helpful for writing material to introduce and make relevant the assigned readings of the Acquire modules and to design the Apply exercises, it was absolutely indispensable to designing relevant workplace exercises and writing the detailed immersive scenarios of the Assess modules. The authors, both senior design team leaders working on this effort, have no military experience ourselves. To address this weakness, we assembled a design team that included a number of recently retired Air Force and other services' officers.

The use of simulation in the U.S. Air Force Applied Leadership program is innovative in that:

- The simulations enable learners to practice mission-critical leadership skills in a risk free setting before applying newly acquired skills on the job
- The skills applied in the scenarios are designed to translate directly to real-world performance
- The scenarios are both relevant to a very diverse and widely dispersed population, as well as being flexible enough to be tailored to each learner's individual situation and needs
- The simulations evaluate learners' comprehension and ability to transfer and apply knowledge gained from assigned readings
- The simulations assess both comprehension and performance without significant human intervention
- The scenarios meet all these needs and requirements within technical constraints, so that they can be accessed remotely anywhere on Earth through limited bandwidth
- The entire program was designed to meet the rigorous standards of the U.S. Air Force and to meet accreditation body requirements

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MST-READI: Practical Guidance for Military Medical Simulation Training Evaluation Research

Dawn Riddle and Roger Chapman

Abstract - Training effectiveness evaluation research is not keeping up with the rapid pace of medical simulation technology development and acquisition. Currently the military acquisition community is calling for *empirical* demonstration that simulators provide an effective means for training medical personnel. Military and civilian organizations are charged with evaluating simulation based training, frequently without access to trained evaluation researchers or easy to use guidance for selecting among the myriad approaches to training effectiveness evaluation. The goal of this paper is to illustrate challenges to training evaluation in the military and present an overview of a training evaluation research guidance tool, the Medical Simulation TRaining REseArch DesIgner (MST-READI), to aid researchers in developing a research protocol, or evaluation plan, for assessing the 'READI'-ness of the training system to support effective training, taking into account relevant aspects of the evaluation environment, training system characteristics, and evaluation science.

Keywords: medical simulation, training effectiveness, Army, training evaluation methodology

Introduction

Within the military, simulation based curricula are being used to train medical personnel across all echelons of care from first responders on the battlefield to combat support hospital staff to surgeons in the Continental United States (CONUS). The use of medical simulation is rapidly gaining momentum due to rapid advances of enabling technologies, and demand for improved outcomes and objectively assessed competencies. Much anecdotal evidence suggests training is effective, however the military acquisition community is calling for *empirical* demonstration that simulators provide an effective means for training medical personnel. Military as well as civilian organizations are frequently charged with evaluating simulation based training without access to trained researchers or guidance in selecting among the myriad approaches to training effectiveness evaluation. The military medical simulation community is faced with a daunting task in that there are a growing number of medical training simulations, an overwhelming number of approaches to training evaluation, and limited support for empirically sound evaluation research.

Background

Medical Simulation Training

Simulation provides an alternative and/ or supplement to traditional medical training and evaluation practices. Traditionally, student training and skills practice has focused on rehearsal using cadavers or anesthetized animals and residency "training by opportunity." It is becoming more difficult to meet training requirements relying on the traditional model alone. Procedures are becoming more complex, the physiology of cadavers and animals is obviously different from that of a live human patient, and ethical concerns exist regarding the use of animals. In addition, patient contact is constrained due to limitations placed on residency hours, and exposure to procedures is dictated by existing patient pools.

Simulation provides a means to circumvent many of these obstacles for training and assessment. Medical simulations provide virtual models along with realistic visual and tactile feedback. These characteristics afford the training of cognitive skills required for effective decision making and execution of procedures, as well as psychomotor skills (e.g., cutting, grasping, suturing and navigation) required for manipulating tools during procedures, and direct manipulation of the patient (e.g., palpation, checking for a pulse).

Training Effectiveness Evaluation (TEE)

Although the major goal of training is to enhance skills, increase knowledge, change behaviors and even attitudes through an instructional medium, organizations may have many, varied reasons for developing and implementing a new simulation based training system. Medical simulation may be implemented with additional goals of reducing instructor contact hours, minimizing training costs, increasing training safety, shortening time to proficiency, and presenting critical training opportunities not typically available in clinical rotations. Training effectiveness research is key to determining if, and how, a training system is meeting its prescribed goal(s).

Perhaps the most well known and commonly used model for assessing training effectiveness is Kirkpatrick's 4-level model of Training Effectiveness Evaluation (1959): Level 1 assesses *Reaction:* How do participants react to the training? Level 2 emphasizes *Learning:* How do participant knowledge, skills, and attitudes change as a result of the training? Level 3 focuses on *Behavior:* Does participant learning during training lead to behavior changes on the job? Level 4 targets *Results*: What organizational benefits resulted from the training?

The American Society for Training and Development's 2002 state of the industry report indicated the majority of TEEs conducted by organizations (78%) did so by obtaining user *reaction* feedback (e.g., post training surveys and focus groups). Thirty-two percent examined skill acquisition or *learning* (e.g. completed pre- / post- test to determine if skills improved significantly as a direct result of the training), while only 9% completed transfer studies investigating longer term changes in *behavior* (e.g., evaluating performance back on the job to determine if trained skills transferred to the operational environment) and 7% examined the organization level *results* or impact of the training (e.g., evaluating changes in department or unit level performance). As one might imagine, moving from Level 1, evaluating effectiveness based on user feedback, to Level 4, detecting organizational impact, leads to increased complexity and a multitude of challenges including increased threats to validity to be encountered by the evaluator.

After systematic review of the *medical* simulation based training domain, several authors (Bradly, 2006; Scalese, Obeso, & Issenberg, 2008; Issenberg, McGaghie, Petrusa, Lee Gordon, Scalese, 2005) conclude that the field of medical simulation training needs not only more research surrounding each of the levels of evaluation described above, but more rigorous research in order to advance the field of simulation based medical education. Although many experimental studies report face, construct, and content validity of various medical simulators, research is lacking regarding the key question of predictive validity, that is, does simulation performance predict future performance (Scalese, Obeso, & Issenberg, 2008).

The current paper 1) identifies specific challenges affecting evaluation research of medical simulation in military settings, and 2) describes the development of a proposed solution to those challenges, an evaluation research guidance tool, the Medical Simulation TRaining REseArch DesIgner (MST-READI). MST-READI is intended to aid researchers in developing a research protocol, or evaluation plan, for assessing the 'READI'-ness of the medical simulation program to support effective training, taking into account not only evaluation science, but also relevant aspects of the training evaluation environment, and training system characteristics.

Challenges to TEE in Military Environments

Work by Boldovici, et al. (2002) and Salas, Milham & Bowers (2003) identify core misperceptions surrounding the conduct of valid training evaluation research in the military:

- Training evaluation research has to have a control group. It's too difficult to conduct controlled studies in military training.
- If subject matter experts say it works, empirical research is not needed.
- Close is good enough - even if power is insufficient to detect a significant effect, study results will be close enough.
- To determine training effectiveness we have to evaluate training transfer. To assess training transfer effectively, we need to conduct large-scale, multi-echelon field trials.
- Training on high fidelity simulators involves training on close approximations of the real work environment; therefore training will transfer to the operational environment.

These misperceptions allude to the challenges associated with the complexity of training evaluation. Planning and executing evaluation research affording valid inferences about the effectiveness of the training system under investigation requires significant attention to both logistical issues presented by the training evaluation context, such as overcoming the myths surrounding evaluation research, as well as sound scientific practices.

Although the literature offers a wealth of relevant guidance including principles for designing pedagogically sound training simulations, models of training effectiveness evaluation, principles for conducting valid evaluation research, and even lessons learned from the field, understanding what principles and guidance to apply under which circumstances can be quite challenging, even for individuals trained in evaluation. Military medical simulation products are often evaluated by the product developer and / or in the case of R & D efforts, by the military sponsor. There does not appear to be any practical guidance for these evaluators that integrates the training and evaluation research literatures with practical considerations in a manner that allows evaluation researchers to more easily determine training evaluation approaches that suit their evolving set of research conditions.

TEE Guidance from the Literature

Effective Training System Design. In addition to theoretical models of training effectiveness evaluation (e.g., Kirkpatrick, TIER), relevant guidance for conducting training effectiveness evaluations can be found by looking at scientifically based principles found in the literature as well as practical lessons learned from training research in the military. In this section we describe previous research involving principles and tools for assessing pedagogically sound training, general principles for training evaluation research, and finally literature specifically addressing training and evaluation of *medical simulation based* training.

As alluded to by the models described in the section above, effective training begins with well designed training systems. Hays, Stout, and Ryan-Jones (2005) present a tool for quantitatively evaluating the quality of web- and computer-based instructional technologies. They identified a series of relevant training product evaluation criteria, addressing instructional features (Content, Activities, Performance Assessment, and Feedback) as well as interface design (Navigation and operation, Content presentation, and Installation and registration). For each criterion, anchored Likert scales capture quality ratings. Additional detailed discussions of evaluation criterion are also provided for users interested in conducting more in-depth evaluations.

Evaluation Research Guidance. A primer of sorts has been developed by the US Army Research Institute (ARI; Boldovici, Bessemer, & Bolton, 2002) examining the elements of training evaluation. The authors identify characteristics of field research and performance assessment associated with the ability to make valid inferences about the impact of training, training capabilities, and trainee proficiency. Boldovoci, et al., emphasize the dangers of ignoring threats to validity, leading to the potential for invalid inferences of the effectiveness of the training system under study. The primer provides readers with 18 basic rules for design and analysis of scientifically sound training evaluations allowing for valid inferences concerning the effectiveness of the training being evaluated (e.g., when possible, randomly assign participants to training conditions; specify the risk the evaluation customer is willing to take of erroneously detecting no differences between the compared groups' scores). Further, they list 18 rules for the proper use of performance ratings (e.g., be specific in instructions to raters, provide scoring aids or templates) in yielding valid training evaluations. Finally, Boldovoci, et al. describe a number of alternate evaluation research designs along with examples of use and considerations when implementing each design.

Practical Guidance

Practice-based Lessons Learned. In addition to scientifically, theoretically- and empirically-based guidance for evaluating training, within the literature we can find practical guidance from training research in military settings. Boldovoci, et al., advises that the success of training evaluations and the efficiency of the evaluation administration can be improved through a priori preparation. They suggest evaluators should: 1) have an understanding of how and where the target training audience trains, as well as how units are likely to incorporate the new training into their courses, 2) be familiar with schedules for new training and with extant data streams, and 3) understand and be able to use multiple evaluation methods, singly or jointly, to achieve evaluation objectives.

Furthermore, Wampler, Dyer, Livingston, Blackenbeckler, Centric, & Dlubac (2006) report lessons learned from 8 years of military training research involving digital systems, interactive courseware, training simulations, new dismounted soldier systems, and institutional training courses. They group lessons learned into the following categories: instructional system design, and live training, virtual and constructive training, and interactive courseware. Example lessons from each category include:

Instructional System Design (ISD) Lessons

- Involve trainers in the design stages of new equipment
- Plan for and use a mix of instructional media and techniques
- Allow sufficient time for AARs and conduct AARs at all levels

Live Training Lessons

- Follow a proven sequence to maximize success for the soldier to learn
- Allow soldiers time to practice new skills
- Train tasks within the context in which they will be executed and relate to commonly understood practices and information when possible

Virtual and Constructive Training Lessons

- Realize and accommodate strengths and limitations of using virtual environments to train Soldiers
- Be aware of distractions or potential sensory overload in virtual environments

Interactive Courseware Lessons

- Test interactive courseware install sets under conditions similar to those used by the intended target audience
- Determine the details needed for user performance records

Factors Influencing Medical Simulation Effectiveness

Factors Effecting Effectiveness. As we have argued, enhancing the rigor of medical simulation based training evaluation includes following principles of effective instructional system design as well as principles of valid training evaluation. Howell and Higgins (2004) present a medical simulation based educational framework for training medical military personnel (combat medics, physicians, and other soldiers) to increase personnel readiness. The educational framework employs a key set of principles of learning science that have been demonstrated to enhance learning. Components of the framework include: simulations, modification of existing curriculum to incorporate simulation-based training, problem-centered learning, critical skills focus, varied and contrasting examples, demonstration, practice opportunities, reflection, feedback, assessment, skills refreshment, and reusable education training materials

Issenberg, McGaghie, Petrusa, Lee Gordon, Scalese (2005) conducted a review of the literature between 1969 and 2003 examining the features and uses of high-fidelity medical simulations that lead to effective learning. Based on the available research they concluded that high-fidelity medical simulations facilitate learning under the right conditions. Important features of medical simulation and it's use: *providing feedback* (47%), *repetitive practice* (39%) *curriculum integration* (25%), *range of difficulty level* (14%), *multiple learning strategies* (10%), *capture clinical variation* (10%) *controlled environment* (9%), *individualized learning* (9%), *defined outcomes* (6%), *and simulator validity* (3%).

MST-READI

To respond to the need for more scientifically rigorous evaluation of medical simulation training, and more direct support for evaluators of medical simulation training particularly in military settings, we are developing the Medical Simulation TRaining REseArch DesIgner (MST-READI), an evaluation research tool intended to aid researchers in assessing the 'READI'-ness of a training system to support effective training.

The goal of MST-READI is to leverage and integrate *training* & *evaluation sciences* (models, principles and empirical evidence), with *practice-based lessons learned* (opportunities and challenges of conducting research in military environments), and existing *research on medical simulation effectiveness* (factors leading to medical training simulation effectiveness) into an integrated methodology for providing guidance in the planning, design, and conduct of scientifically sound medical simulation based training evaluation research.

MST-READI will assist evaluators in applying good science to the medical simulation training evaluation at hand. In an iterative fashion, the methodology will step users through relevant questions and issues related to designing and conducting evaluation of training systems at any level of training system maturity from early design through development and finally to assessment of the mature product.

A number of factors, in addition to the principles of training and evaluation, and practical lessons learned from experienced evaluators, influence the selection of valid approaches to training evaluation research including characteristics of the simulation and the evaluation context. Given the myriad contextual factors and simulation characteristics for a given evaluation, the methodology will yield a constellation of *training evaluation conditions*. These conditions may change or become more salient over time - as more information about the training context and the simulation become available - and will influence decisions regarding evaluation approach, details of the research protocol, appropriateness of data collection procedures, and selection and implementation of analytic methods.

MST-READI will support evaluators though the *training evaluation research process* for a given medical simulation product or simulation-based curriculum within a specific training evaluation context (see Figure 1).

Figure 1. MST-READI methodology integrating Science and Practice with Training Evaluation Conditions to guide the research process.

Initially information defining the training evaluation research context and the characteristics of the training simulation is integrated with principles of training and training evaluation to determine a research approach and detailed protocol allowing for valid inferences regarding the effectiveness of the training simulation. The training evaluation conditions and specific research protocol, along with principles of evaluation and practical considerations influence aspects of data collection and interpreting the analysis results.

It is important to note that information regarding the *training evaluation conditions* is critical to decision making throughout the research process; new information can influence and cause modifications to decisions and activities at any stage of the research process.

As shown in Figure 2 the research process can be applied at any level of system maturity to assess various questions of training effectiveness throughout a spiral development system design process. The composition of the research process icons in the figure are identical because the methodology does not change, however the icons are different colors indicating the training evaluation conditions processed by the methodology and the resulting research design guidance can vary widely.

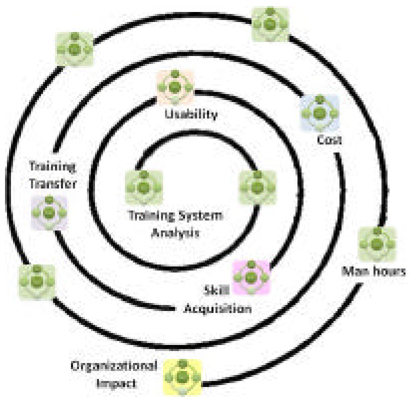

Figure 2. Training evaluation at various levels of simulation maturity.

The intent of developing this methodology is to make decisions related to designing training evaluation easier and more efficient for evaluators. Given the complexity of evaluation of medical simulation in military settings, the wealth of relevant knowledge, variations in information presentation medium, and the need for varying levels of support, rather than providing tedious documentation with multi-dimensional decision trees, the methodology will be instantiated in a software application, the Medical Simulation Training REseArch DesIgner (MST-READI) interactive toolkit (see Figure 3).

The amount and level of specificity of information known and input by the user will influence the levels of support available through MST-READI ranging from detailed, step by step research design and administration guidance for evaluators requesting maximal support to browsable databases including general research designs and administration considerations.

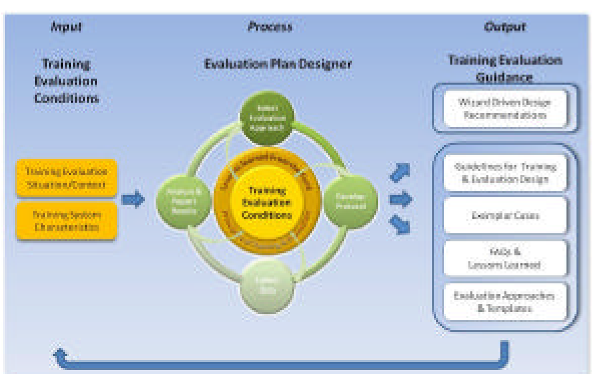

Figure 3. MST-READI Conceptual Overview.

Evaluator support will be available in multiple forms:

- *Wizard Driven Design Recommendations*. Users can invoke a Design Wizard to input training system and evaluation situation information. Questions will then be tailored at each stage based on the users' responses to previous questions. If enough information about the training system and evaluation context is known, detailed design recommendations will be presented.

The following guidance will be presented to users based on user input and also through browsable/ searchable databases.

- *Guidelines for Training and Evaluation Design.* The MST-READI methodology integrating good science with practical application issues will incorporate principles of effective training system design and training evaluation. A tailored set of these principles can be presented to the user based on evaluator input, and / or the full list may be browsed.
- *Exemplar Cases.* Examples depicting appropriate research designs given specific evaluation situations.
- *Frequently asked questions (FAQs) and Lessons Learned*. Practical concerns and lessons learned. Things you didn't know you needed to know.
- *Evaluation Approaches & Templates*. Approaches appropriate across the various phases of training system design, development and evaluation. Tool for evaluation of Training Design. High level primer or tutorial on common research design and their advantages and disadvantages. Templates for surveys, e.g., usability

If you have collected data in military field settings you are well aware that "things change" … just as your research protocol begins to take shape, conflicting information may be obtained, obstacles may present themselves, the evaluation situation may change. Given the dynamic nature of the evaluation situation, it is anticipated that the development of an evaluation plan using MST-READI will be an iterative process... as more information is obtained, more questions become answered, and different solutions will emerge.

MST-READI will offer methods and tools to support evaluation along the continuum of training effectiveness evaluation – i.e., support evaluation during training system design and development as well as evaluation of mature training systems.

Conclusions

The MST-READI interactive toolkit implementing the Medical Simulation Training Evaluation Methodology is designed to assist evaluators in designing, conducting, and interpreting training evaluations leading to: *1) enhanced validity of the inferences made from training evaluation research; 2) faster, more cost effective, and tailored training evaluation design process; 3) much needed support for novice (as well as expert) training evaluators.*

In addition, MST-READI minimizes the tendency to apply a "cookie cutter" approach – one evaluation design approach fits all – by reducing the time, effort, and cost associated with considering and designing new approaches, while at the same time enhancing the efficacy of the research.

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Book Review

Good Video Games + Good Learning = More Complex Problem-solving?

By Shalin Hai-Jew
JIID

Good Video Games + Good Learning: Collected Essays on Video Games, Learning and Literacy
By James Paul Gee
New York: Peter Lang
2007
194 pp. softcover

"Good learning principles are built into their very designs." – James Paul Gee

As a social linguist, Dr. James Paul Gee came to gaming in his 50s and found himself a surprise convert in *Good Video Games + Good Learning*, a collection of essays.

Starting learners off with books may be premature. If books are about people's live work worlds, then handing them to learners is like "giving them the manual to a game without the game. The manual is boring and makes no sense all by itself. It is hard to read until you have played the game for a while; then it becomes easy to read, because now you have an image, action, experience, or dialogue to associate with each word in the manual, not just 'dictionary definitions'" (p. 3). It may work better to begin with the experience for the building of situated meanings and the acquisition of language via a work context.

Gee uses an approachable and folksy tone in his short, pithy pieces. He sees good (real-time strategy) games as those able to help learners learn effectively, while bad ones may "disable" a learner (p. 5). Games must be good at getting themselves learned by individuals during the game play. Effective games are good for "the soul."

He writes: "If people are to nurture their souls, they need to feel a sense of control, meaningfulness, even expertise in the face of risk and complexity. They want and need to feel like heroes in their own life stories and to feel that their stories make sense. They need to feel that they matter and that they have mattered in other people's stories. If the body feeds on food, the soul feeds on agency and meaningfulness" (p. 10).

This author takes on various contemporary debates about computer games. He suggests that violent video games may be cathartic instead of reinforcing. If people play a range of computer games, they may expand their senses of the world to a full spectrum instead of experiencing limited worldviews (p. 16).

Games need to allow space for reflecting on moral dimensions. Video games as "good thinking tools": "Their deepest pleasures are cognitive. The 'drug' the video game industry discovered was learning—humans love it when it's done right" (p. 17). He suggests that the contents of a game may set up "the basic themes, metaphors, and emotional valences of the game, beyond the emotions of the challenge, frustration, competition, and accomplishment that are determined by game play" (p. 19). While subtexts in games are important, the gameplay itself has value independent of the content.

This author sees gaming as a social enterprise (p. 20) around which people share experiences and communicate. They are a new form of culture, with embedded meanings. He suggests that there must be more sophistication in how people consume games, with reflection, strategy, and their own choice of what to focus on (p. 21). Games reflect how the human mind works, and the best ones integrate effective learning principles to enhance learning (p. 22); they offer helpful simulations which may affect decision-making and role play (p. 24).

This author offers a list of games that he finds particularly engaging and those that are less effectual. Gee strives to look at the potentiality of games of the future with proper innovations and technology advancements to promote learning, problem-solving, inter-communications, and human interactivity.

Gee suggests some basic points in game design. First, learners should co-design games as part of the gameplay. Games should be customizable to fit players' learning and playing style as well as areas of interest. They should allow players to create identities that encourage a "deep investment" in the game. Based on cognitive research, learners benefit when they can be active and engaged in knowledge building. The sequence of problems that learners encounter should be designed strategically in the proper developmental order, with new challenges that are "pleasantly frustrating," just at the outer edges of learner capabilities. Information should be provided to learners at their moments of need and not prior, given the poor human capabilities of using verbal information when given these out of context or in large quantities. (pp. 30 – 38)

Virtual systems should be as simple as "fish tanks," with a few critical variables and their interactions displayed. Games should also be like "sand boxes" where people may experiment without undue pressures or risks. Skills should be built up within a virtual context and a larger strategy instead of as discrete skills practiced again and again. The larger context of a game needs to give the learning meaning. And lastly, the learning should be experiential, not abstract or general (pp. 38 – 40).

This author notes that learning is not infinitely variable, and the observed patterns and principles of learning should be integrated into game design (p. 47). Prior to the learning, though, games have to attract a loyal following of players: "What has to come before is *motivation for an extended engagement* with the game. Without a commitment to an extended engagement, no deep learning of a complex domain can happen (diSessa 2000, as cited in Gee, 2007, p. 48).

Gee suggests that "affinity spaces" be created as interaction spaces built around activities and actions and social affiliation—a vital context for learning (p. 87). These spaces would be democratic and encourage learning by all, with sharing of learning in every direction (pp. 102 – 103).

This professor believes that games may help head off the so-called "fourth grade slump," where "many children, especially poorer children, pass early reading tests, but cannot read well to learn academic content later on in school) that the goal of early reading instruction has to be more forward looking than simple decoding and literal comprehension (American Educator 2003b; Chall, Jacobs, & Baldwin 1990; Snow, Burns, & Griffin 1998). The goal has to be that children learn to read early on in such a way that this learning creates a successful trajectory throughout the school years and beyond. Such a trajectory is based, more than anything else, on the child's being able to handle ever increasingly complex language, especially in the content areas (e.g., science and math), as school progresses. Children need to get ready for these increasing language demands as early as possible" (pp. 104 – 105).

Based on his own son's experiences, he finds that children may be motivated by games to use higher-level language than they would otherwise in a regular course of studies.

He suggests that interactive games help people collaborate and team around distributed knowledge, from specialist, intensive knowledge, to general, common, or "extensive" knowledge (p. 127). Games may help move from book learning to applied problem-solving, he suggests (pp. 143 – 144). They may help provide a sense of ownership of the learning (pp. 157 – 158). Games, if designed and played well, may encourage intentionality in how people formulate goals, engage the world, and pursue their aims (p. 171).

References

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Making More Challenging Computer Games With AI

By Shalin Hai-Jew
JIID

Biologically Inspired Artificial Intelligence for Computer Games
By Darryl Charles, Colin Fyfe, Daniel Livingstone, and Stephen McGlinchey
Hershey: Medical Information Science Reference (IGI Global)
2008
262 pp. hardcover

Digital gaming may enhance e-learning experiences; games may even form the central body of the learning as in immersive or simulation types of learning experiences. Darryl Charles, Colin Fyfe, Daniel Livingstone, and Stephen McGlinchey's *Biologically Inspired Artificial Intelligence for Computer Games* provides an overview of some of the types of artificial intelligence (AI) and machine learning that may be used to enhance the playability of computer games.

The concept is to create worthy opponents in gaming situations, both in the form of avatars and nonplayer characters as well as the larger gaming environment. A game that adapts and "learns" from repeated playing becomes more challenging. For the first time in history, we are able to create intelligent games, even though games have been designed and played for millennia. The authors note that it's not always win-or-lose for the human player. Games need to be believable in an experienced way.

These four authors have backgrounds in artificial neural networks. They offer case studies—some theoretical, and some applied.

Artificial intelligence refers to any programming that mimics human intelligence—the ability to reason; to form strategies using informational analysis; the demonstration of understanding; the grasping of facts, relationships, and meanings; the ability to perceive visually, auditorially, textually, and with other sensory abilities; and the maintenance of a working and a long-term memory.

The "golden age" of video games is set at 1979 – 1983, with many of the residual developments of that time updated through to the present. The authors summarize the various foundational game types early on—from racing games to platform ones.

The range of AI addressed here include artificial life, genetic algorithms, artificial immune systems, and ant colony optimization. These include flocking mechanisms in which avatars move as individual entities and as crowds, with emergent behaviors.

The different designs addressed model some of the ways the human brain has been found to function, such as with parallel processing and "the learning mechanisms." These include non-linear problem solving and the accumulative power of information. Mirroring the machine intelligence would be the human player development through essentially unsupervised learning. Both human and machine are co-evolving in terms of strategies and skillsets, with the play retraining the game.

"Because the occurrence of an unlikely event has more information than that of a likely event, it has a higher information content. Hence, a data set with high variance is liable to contain more information than one with small variance," the authors observe (2008, p. 51).

The authors note that the ideas here may apply to "planning in an uncertain world with incomplete information learning, opponent modeling, and spatial and temporal reasoning" (Buro, as cited in Charles, Fyfe, Livingstone, & McGlinchey, 2008, p. 141).

Much of this text is truly written for developers and those who actually code the games and the underlying modeling structures. The authors probe esoteric concepts, such as 10-dimensional hide-and-seek and multi-object problems. They look at how types of interactivity and effects are modeled on the back end. They are as likely to break out into various genetic algorithms as they are to offer scientific theories from the biological realm.

For the non-computer scientist, *Biologically Inspired Artificial Intelligence for Computer Games* offers rich insights about what happens on the back end. This may be helpful to understand some of the far edges of what is possible but only if the reader is willing to work around plenty of complex lingo, concepts, and design practices.

References

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A Short Guide for Professional Contributors

The *Journal of Interactive Instruction Development* (JIID) is a professional quarterly online publication devoted to enhancing the quality, effectiveness, and productivity of interactive systems design. The *JIID* is intended to be a practical publication. It will showcase successful programs and, where appropriate, provide information about efforts that were not successful. The *JIID* strives to be instructive without being academic, precise without being pedantic, and thorough without being boring.

Our readers

Our readers share an interest in technology based learning. They come from diverse backgrounds and fields of expertise, but most are managers and senior level professionals in training, education, and government. Their primary job is to solve problems. The *JIID* attempts to give them information that will allow them to recommend appropriate solutions to problems faced by their organizations and to manage the people who do the hands-on work of developing interactive instruction.

Our interests

We are particularly interested in case studies about strategies or techniques that work; training program design; evaluating existing design tools and templates; and adapting design to differing hardware systems and components.

While we do not automatically reject reports of empirical studies, review articles, theoretical articles, or methodological articles, these are usually not as important to our readers as the how-to information in case studies.

We also seek informed, thought-provoking commentary on issues related to interactive program design: how to achieve quality, what makes for better interactivity, and what universal truths may be found to guide design. We also are seeking knowledgeable individuals to review books of interest to our readers.

Anyone interested in providing either commentary or book reviews should contact the editor for information about length and manuscript style.

Submissions

The *JIID* encourages authors to query us with an abstract, information about why the article would interest our readers, and a projected date by which the article could be ready. Queries about the suitability of proposed articles, including an abstract of no more than 100 words in the message text, should be e-mailed directly to **IID@lti.org**.

Overall considerations

Manuscripts should be written with a scholarly regard for objectivity. We do not wish to receive manuscripts advertising a particular company or product. With submissions, authors warrant that articles have not been published previously. Naturally, originality of the author's material is presumed.

Each article should include an abstract not to exceed 100 words. Identification of the author and email contact information, not to exceed 40 words per author, should be included with submissions.

Style matters

The *JIID* has adopted the *Publication Manual of the American Psychological Association, Fifth Edition* as its style guide. Be sure to follow this 2001 version of APA in the matters of font choices, double spacing the manuscript, preparing an abstract, and citations of electronic and print sources.

For more information

Detailed information to help authors prepare manuscripts for *JIID* is available. The detailed guidelines cover such items as headings, trademark identifications, and use of graphic elements. To get a copy of those detailed guidelines, send an email to **IID@lti.org**.