2010

Horizons in Learning Innovation through Technology:

Prospects for Air Force Education Benefits

HQ Air University A4/6I
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Disclaimer

Foreword

This report, "Horizons in Learning Innovation through Technology," is the result of a collaborative effort by educators from inside and outside Air University. This sight picture describes why innovation matters for educating Airmen with the capacity to learn faster and adapt more quickly to the changing demands of warfighting, where unforgiving circumstances require greater knowledge, critical-thinking skills, and performance. The document supports AU strategic initiatives by stimulating thinking and discussion about emerging innovations as they pertain to leveraging educational technologies to enhance professional military education and professional continuing education, and deliver cyberspace education for the 21st century.

The report identifies and describes seven horizons in learning innovation for helping shape competitive and adaptive learning systems and environments for Air Force education benefits:

- Challenge-centered instruction and assessment
- Blended and affective learning for lifelong learning and digital literacy
- Educational informatics and intelligent tutors
- Modular distributed learning and portal services via cloud computing
- Weak-tie networking and peer-based learning
- Linkage of learning, performance, and decision-support applications
- 3rd-space virtualization of learning environments

Each horizon offers prospects for leveraging benefits from the integration of learning and assessment sciences with technology. Air University has a long tradition of excellence in intellectual leadership for developing Airmen and joint/coalition partners to be prepared to fight and win future wars. In that tradition, Air University uses innovations through technology to transform learning systems and environments in an effort to keep them efficient, effective, relevant, and adaptable to tomorrow's challenges. Moreover, a culture of learning innovation as a vehicle for continuous improvement helps strengthen the core of our foundation, our Airmen, for the challenges of both current and future warfare.

I solicit your exploration and input on the seven horizons in learning innovation outlined in this report in support of AU's strategic plan and initiatives. I encourage recommendations on each horizon in learning innovation. Your inputs will contribute to our efforts in setting priorities and dedicating resources within AU to further explore and assess learning benefits and capabilities in shaping future Air Force education.

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Introduction

Sight Picture for Innovation through Technology. The United States Air Force is facing future learning environments requiring the need for educating Airmen with the capacity to learn faster and adapt more quickly to changing demands of war fighting where knowledge, critical-thinking skills, and performance are required in unforgiving circumstances. Learning innovations are needed to effectively blend learning environments across informal self-development efforts, formal schoolhouse programs, and operational experience. Future learning must not be limited to place but be readily accessible at the point of need. The learning innovations through technology described in this paper were identified on the basis of this sight picture.

What is Innovation through Technology? Innovation through technology, for Air Force education benefits, is seen as the competitive edge where "emerging" educational technology comes into being and is transformed into a concrete reality that produces learning and performance benefits for Airmen. EDUCAUSE defines educational technology as "the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources." Innovations can span instructional design, invention, development, and/or implementation of educational-technology products, services, processes, or business models for creating new value for the Air Force in a way that improves learning and performance. This annual report is generated to help anticipate and assess innovations that may be targeted for prototyping, testing, and use to help ensure the Air Force has a competitive and adaptive learning system capable of meeting future learning needs of Airmen.

Sustaining Versus Disruptive Innovation. Innovation through technology can be either sustaining or disruptive. **Sustaining innovation** involves incremental improvement of established educational technologies (e.g., improving how services share data across the local education enterprise). **Disruptive innovation** introduces new capabilities and benefits that can emerge without long lead times for analysis or benchmarking to help establish a pathway forward that can account for links to existing organizational culture values, demands, and cost structures. An example of a disruptive innovation with the potential to significantly impact education cost structures is cloud computing (e.g., providing campus services across a global network using Google or Microsoft Web apps). Disruptive innovation can also introduce the need for new knowledge and skills, making it very challenging for some educators to adopt and apply (e.g., mobile-learning apps, games for learning, immersive 3-D worlds).

Several factors can contribute to whether a disruptive innovation is successfully adopted and applied (Christensen, 1997, n.p.):

- Implementation progress is often separate from technology progress. Educators do not always know what they need or how to apply disruptive innovations. Many disruptive innovations in educational technology emerge from undercurrents associated with research on how people learn, advances in technology, and increased global networking.
- Innovation implementations typically require new resource plans and allocations, which can be extraordinarily difficult to predict and obtain, particularly if the technology is disruptive.
- Successful implementation and use of disruptive innovations is mostly a cultural challenge, not a technological one.
- Disruptive innovations often require very different capabilities (e.g., policy and cost-structure adaptations, new forms of service support, infrastructure integration).
- Failure and iterative learning are usually required with disruptive innovations; thus the importance of rapid prototyping within the culture of intended use.
- Disruptive innovations reward leaders; they are doing things that often do not make sense to the crowd.

Christensen offers the following strategies to successfully address disruptive innovations:

- Embed disruptive innovation prototyping in the organization and purposively seek out potential users (customers and users typically do not come and seek out innovation).
- Engage prototyping of disruptive innovations using small user groups and start with small wins.
- Plan to fail early and inexpensively: trial and error is critical.
- Understand that managers typically represent organizational values and cost structures that avoid risk taking and adoption of change; leaders are more likely to champion disruptive innovations.

Emergent Innovation Horizons for Competitive and Adaptive Learning Systems and Environments

Years of research in learning science, cognitive psychology, educational psychology, neuroscience, and other fields related to learning have helped to identify some of the most important learning principles that should be included in the design of competitive and adaptive learning systems and environments:[1]

- Learners interpret every learning experience through an existing mental model (Bransford, Franks, Vye, & Sherwood, 1989; Cognition and Technology Group at Vanderbilt, 1990).
- Acquiring and retaining new concepts and skills can be strengthened when connected to an existing mental model and integrated with current knowledge if learning is active and constructive rather than passive and assimilative (Resnick, 1987).
- Learning is dependent on beliefs, attitudes, affect, and style of learning based on cognitive, sensory, psychomotor, and social factors; tailoring instruction to individual styles can increase learning effectiveness (Cohen, 1987).
- Learning is enhanced by situating learning in an environment similar to that in which the knowledge will be used (Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991).

[1] The list of learning principles is an adaptation from the list offered by Dede and Fontana (1995).

- Learning is continuous and unbounded; people who treat every situation as an opportunity for growth learn more than those who limit their education to classroom settings (Dede & Fontana, 1995).

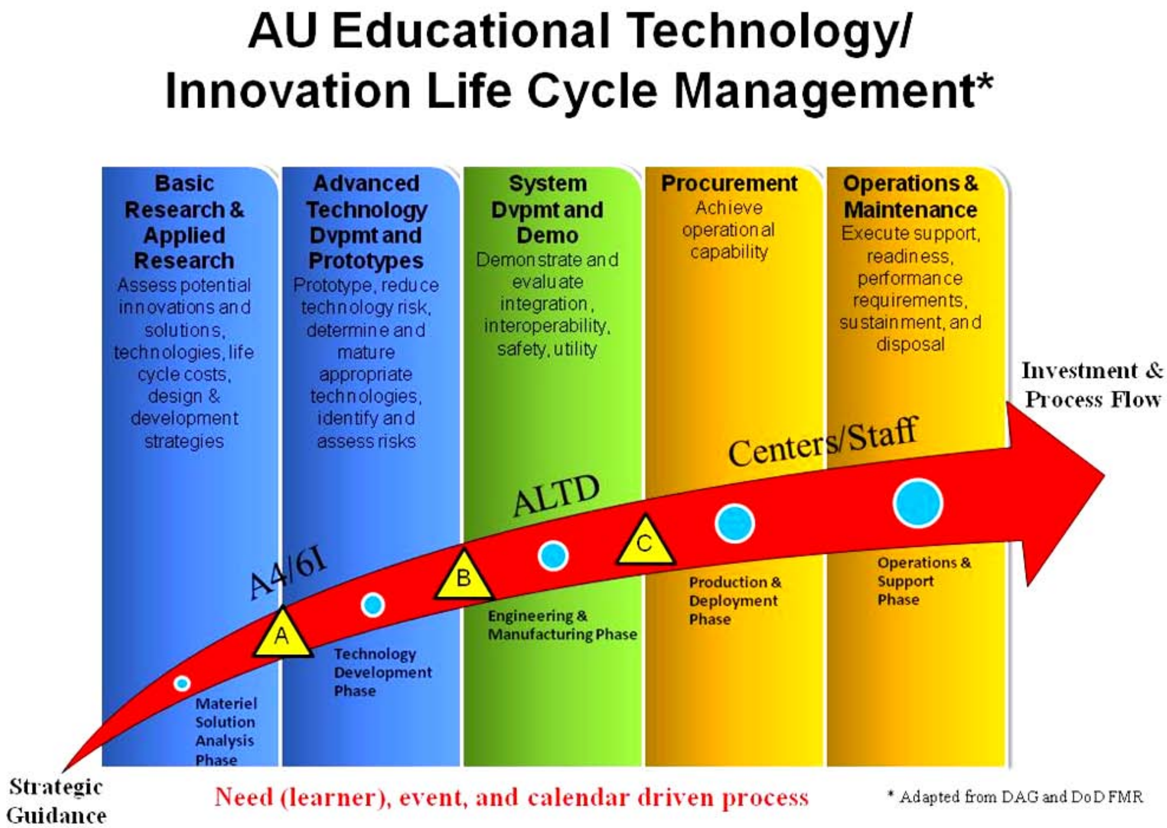

Figure 1

This annual report highlights a selection of sustaining and disruptive innovations through technology that are emerging on the horizon and have the greatest prospect for helping to ensure a competitive and adaptive learning system for Airmen. Innovations through technology, discussed in this paper, can either impact Air Force education in unintended or with more purposeful intents, depending on how well the disruptive innovations can be addressed by change management, rapid prototyping, and implementation. Successfully implementing disruptive innovations requires change management to help steward the identification, prototyping, testing, analysis, and suitability for enterprise implementation. Change management is also used to help foster a climate among educators and staff to assess and successfully apply learning innovations through technology in support of innovation lifecycle management (see Figure 1: "AU Educational Technology/Innovation Life Cycle Management").

Implementing changes to curriculum, instruction, or delivery methods from innovations through technology can be successfully facilitated using a Collaborative Design Build (CDB) approach wherein user-centered groups, involving educators, learners, designers, and builders, engage for collaborative design, rapid prototyping, and implementation of learning-technology innovations. This CDB approach can support corporate-level change management to help ensure a learning system stays competitive and adaptive using both sustaining and disruptive innovations. Increasingly, competitive and adaptive learning systems are learner-centered

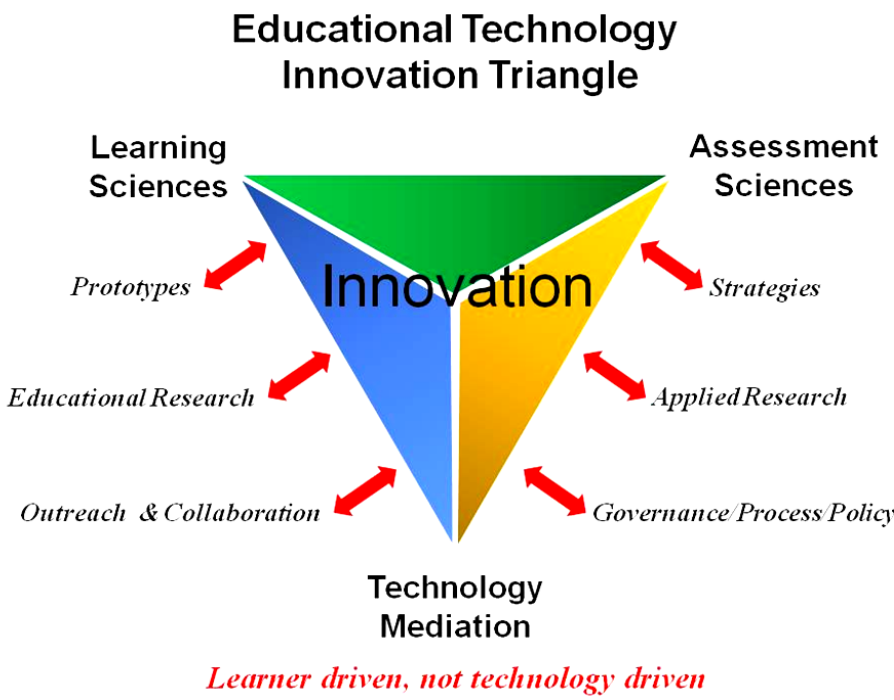

Figure 2

environments supported by multi-purpose, multi-functional devices and tools (many of which are disruptive innovations) that operate across local and global enterprises, with many or most services provided by mobile apps via cloud computing. This unprecedented and emerging interconnected global-learning environment can support synthetic reason, intelligent machines, augmented knowledge and culture, networked and mobile devices—all serving to interconnect and blend immersive 3-D worlds/virtual reality with physical environments and systems (Ito et al., 2008; Veltman, 2006). The CDB approach can also help to leverage the emerging interconnected global-learning environment for Air Force education benefits by offering the means to prototype and assess promising innovations through technology using an

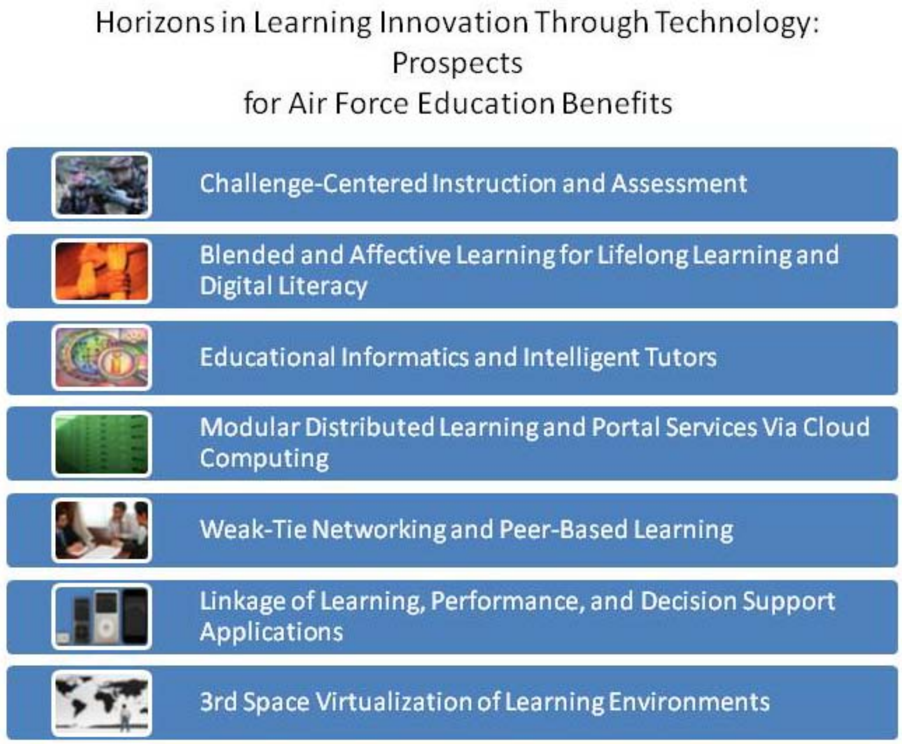

Figure 3

interdependent effort among educators geographically distributed across several organizations spanning the globe. A geographically distributed community, involving a heterogeneous mix of worldviews and skills, is inherently beneficial for learning-innovation work to design and build a competitive and adaptive Air Force learning system and environment. In this light, Air University educators formed and steward a global community of learning innovators, called the Global Learning Forum (GLF), to help identify, explore, and prototype emerging innovations through technology horizons showing prospects for Air Force education benefits. GLF members look for innovation prospects that can help leverage advances in learning and assessment sciences through the application of technology to integrate or fuse the three areas into the instructional design of the learner-driven educational technology (see Figure 2: Educational Technology Innovation Triangle).

Seven innovation horizons, briefly described below (with in-depth coverage provided in appendices), align extremely well with the above learning principles for use in helping to shape competitive and adaptive learning systems and environments for Air Force education benefits[2] (see Figure 3: Horizons in Learning Innovation Through Technology: Prospects for Air Force Education Benefits):

a. *Challenge-Centered Instruction and Assessment*. Challenge-centered instruction and assessment depends on the use of instructional theories and principles that place emphasis on using real-life challenges for development [Bransford, et. al., 1990, Bransford, Brown, & Cocking, (Eds.), 2000, and Brophy, 2003, Aug). Challenge-centered instruction uses real-life challenges to develop higher levels of critical thinking and problem solving skills associated with adaptive expertise. Bransford's [1990] research on an adaptive expertise development has been applied in a learning framework named, "Anchored Modular Inquiry." Bransford's learning framework has been applied and studied across several curriculum redesign projects involving Northwestern, MIT, Harvard, Vanderbilt, and University of Texas. Results, over the past several years, demonstrate significant gains in the development of adaptive expertise among their learners [Brophy, 2003]. With the use of Anchored Modular Inquiry in challenge-centered instruction and assessment, learners are introduced to authentic and open-ended problems and assisted with learning different adaptive learning strategies to better discern and value how situations are actually addressed or solved in the real world. Situations take the form of complex, real-world challenges. The learner is engaged experientially to think and adapt as an experienced practitioner; to adaptively apply skills and decision making strategies successfully to a challenge. In particular, the approach focuses on the development of metacognitive knowledge and skills to better discern the appropriateness and effectiveness of problem solving strategies in the context of real-world challenges. Assessment emphasis is placed on the value of developing enduring understanding. Gardner and Hatch [1989], define understanding as a "sufficient grasp of concepts, principle or skills so that one can bring them to bear on new problems and situations, deciding in which ways one's present competencies

[2] Several of the characteristics described in the horizons are directly adapted from the draft TRADOC Pamphlet 525-X-X, dated 18 May 2010, pp. 13-17. Extracts from the TRADOC document are indicated by italicized text within brackets.

can suffice and in which ways one may require new skills or knowledge." **[***Traditionally, students complete individual learning activities such as reading, self-paced technology-delivered instruction, or research outside the classroom and solve problems in the classroom. Engaging learners in collaborative, problem-solving exercises relevant to their work environments provides an opportunity to develop critical 21st-century competencies such as initiative, critical thinking, teamwork, and collaboration, along with specific knowledge content. This problem/challenge-centered instructional approach encourages peer-to-peer learning and puts the instructor in the role of a facilitator who supports learning through guided questioning to elicit active student participation in the learning process. It provides a high-quality face-to-face learning experience where facilitators are responsible for enabling group discovery. Learners explore ideas, share and apply prior knowledge, examine what works and what does not to effectively address a challenge, and the facilitator guides the group to better solutions. It is a nonthreatening, collaborative environment where mistakes can be made and learning is consolidated. As learning opportunities expand beyond the schoolhouse, considerable care must be taken to develop secure, technology-enabled, integrated assessments tailored to content and expected outcomes.]*

b. *Blended and Affective Learning for Lifelong Learning and Digital Literacy.* This innovation horizon addresses the use of blended and affective learning to help learners acquire and effectively use skills to acquire and update knowledge, skills, and values in support of lifelong learning and digital literacy development using all forms of learning (formal and informal, in-resident, and distributed-delivery formats). Digital-literacy development helps learners to access, evaluate, and use information and digital resources from a variety of sources to successfully leverage technology (hardware and software). This horizon blends the efficiencies and effectiveness of self-paced, technology-delivered instruction[i] with the expert guidance of a facilitator, and can include the added affective and social benefits of peer-to-peer interactions. [*A 30% decrease in the time it takes to learn with no decrease in effectiveness is possible when educators develop technology-*

delivered instruction for appropriate learning content and design instruction according to established learning principles.[ii] *This innovation horizon has prospects to be widely applied in the schoolhouse with engaging, tailored, technology-enabled instruction. Blended and affective learning leverages digital-age learners' strengths using digital media that is standardized for quality, can embed video and game-based learning scenarios, and can include pre-tests, immediate feedback on learning, and assessment of outcomes.* When a blended and affective learning approach balances tailored, technology-delivered instruction with collaborative, context-based, challenge- (or problem)-centered instruction, it creates a powerful combination. *The amount of face-to-face instruction can be reduced, but the quality is increased with a richer, socially supported interactive learning experience. Blended and affective learning can be used in the schoolhouse with live facilitators and peer learners, and also distributed through networked links from facilitators to a distributed-student cohort group using identical technology-delivered instruction. The instructor's role can change from "sage on the stage" to "guide on the side."*[iii] *This change can influence instructor selection and development as well as instructor-to-student ratios for different types of learning events. Facilitation skills will require greater proficiency in communication skills and subject mastery than traditional lecture-centered methods.*]

c. *Educational Informatics and Intelligent Tutors*. Increasingly, real-world systems are being connected to the Internet and 3-D worlds. The result is the infusion of massive amounts of new data on the Web. [*As more and more "things" in the world are connected to the Internet, the amount of data uploaded and downloaded will continue to explode exponentially. In June of 2009, Hewlett Packard CEO Mark Hurd asserted, "More data will be created in the next four years than in the history of the planet" (MacManus, 2010).*] Cloud computing (covered specifically in Appendix D of this paper) provides access to massive data on a global scale. Increasingly, learners and educators need interpretative assistance to retrieve and use data from the Web. The field of educational informatics offers tools to help process and use massive data in learning systems. As an interdisciplinary field, educational informatics focuses on information, data, and knowledge in the domain of education–their storage, retrieval, and optimal use for problem solving and decision making in support of how people learn, instruct, and discover new knowledge. In short, educational informatics turns data and information into knowledge that people can use when learning, instructing, or discovering. The application of educational informatics in the design of intelligent tutors is also helping to process large data sets on individual learning histories in support of adaptive instruction … offering greater precision for developing learning and performance competencies. [*One-on-one individual tutoring is considered the most effective instructional method because it is highly tailored to the individual.*[iv] *While establishing universal one-on-one tutoring is impractical, the Defense Advanced Research Agency (DARPA) and other research agencies are demonstrating significant learning gains using artificially intelligent digital tutors that provide a similarly tailored learning experience.*[v] *Through artificially intelligent tutors, technology-delivered instructional courseware adapts to the learner's previous knowledge level and progresses at a rate that presents an optimal degree of challenge while maintaining interest and motivation.*] In addition, educational informatics can support meaningful connections and data flow between real and virtual worlds [*to provide means for using knowledge within immersive synthetic environments and then transfer insights and acquired skills into higher levels of performance in the real world that can be less forgiving when mistakes are made.*] Connections and data flow between virtual- and real-world systems, enabled by educational informatics, also support stronger ties between formal classroom learning, mobile learning on the job, and on-the-job decision-support systems. Combining technology-delivered instruction with educational informatics and intelligent tutoring results in both time saving and additional gains in effectiveness.

d. *Modular Distributed Learning and Portal Services via Cloud Computing.* A competitive and adaptive learning environment requires a significantly expanded and more robust capability to deliver learning content at the point of need. [*Future learning will benefit from modular design of curricula to better sequence, interconnect, and distribute content and learning activities in support of mobile learning. Instructional modules must be up to date, relevant, engaging, and easily accessible. An extensive repository of learning modules can be made available to support career progression, assignment-oriented learning, operational lessons, and performance-support aids/apps. Distributed learning content can be packaged in short modules that fit conveniently into a student's schedule. Intelligent tutors and feedback can also be incorporated to tailor the learning experience to the individual learner. The supporting development-and-delivery infrastructure must streamline development time, easily enable use of interchangeable content, and overcome localized bandwidth and server issues so users experience no frustration with access.*[vi] *Distributed learning plays a key role in any lifelong-learning model. War fighters will also need a single online portal where digital-learning resources and services can be easily found in two, but no more than three clicks using Google/Bing-like search capabilities. The portal could be a 2-D online site, or a 3-D virtual world with natural navigation and interpersonal interactions through avatars. The portal should provide access to mentors, peer-based interactions, facilitators, and learning-and-knowledge-content repositories. The portal requires multiple security access levels with ready access to unclassified learning material, and more stringent security requirements for secure and for-official-use-only information. Cloud computing can also support learning-tracking tools to provide a single user interface that draws data from multiple databases to allow learners to monitor their progress toward completion of required education and training requirements and career goals. Tools can help individuals select and enroll in resident and non-resident military courses as well as seek civilian educational opportunities through partner colleges and universities. Individuals can manage their lifelong learning objectives and accomplishments and be provided a visual depiction of possible career paths, facilitating goal setting and encouraging personal responsibility and initiative.*]

e. *Weak-Tie Networking and Peer-Based Learning for Informal Lifelong Learning.* [*The advent of Web 2.0 technologies opened a world of digital social interactions that have become a natural part of life for digital-age learners.*] In addition, educators are increasingly using digital social-networking tools and platforms to meet and collaborate with others in weak-tie networks (networking with others outside of domain areas) to be better aware and prepared for learning innovations. Likewise, learners are connecting with peers across institutions and programs. [*Future learning systems must leverage this capability to build dynamic vertical and horizontal social networks for formal and informal information sharing. Providing mobile Internet devices as part of a learner's kit will facilitate this emerging style of communication and collaboration. The ease in communicating with peers across networks suggests digital-age learners will readily establish trust across operational communication networks—trust that is essential in the conduct of decentralized operations. Future learning systems must employ guidelines and security protocols to maximize the value of peer-based learning and information sharing. Competitive and adaptive learning environments are characterized by a flow of information across networks between the learner, their peers, and the institution. This flow goes both ways. Learners will possess tools and knowledge to create learning content such as digital applications, videos, and wiki updates. Recent trends in user-created content will become more widespread and can be of tremendous value. War fighters are at the edge of operational adaptation and in an ideal position to gather and share operational experiences and lessons. While allowing freedom to share information and create learning content, issues of security and information verification need to be addressed. The benefits far outweigh the organizational-management challenges in a learner-centric environment that values initiative, critical thinking, and collaboration.*]

f. *Linkage of Learning, Performance, and Decision-Support Applications.* Mobile Internet devices will provide access and linkage to learning content, courseware, and career data, as well as performance and decision-support applications or "apps." [*Memorizing* *is less important than referencing information, so perishable knowledge (such as infrequently used procedural information) should not be taught in the schoolhouse, but instead converted to apps. War fighters should be taught how to find and use apps in the schoolhouse and then continue their use in their units. Mobile computing will have a game-changing impact on knowledge access and learning approaches.*[vii] *A priority for the Military must be to move quickly to resolve security and distribution issues so future learning environments can take maximum advantage of this capability. Future learning systems must develop a robust capacity to develop, manage, store, and distribute apps with user-friendly interfaces for searches and access.*]

g. *3rd-Space Virtualization of Learning Environments.* Future learning environments will increasingly employ platforms (e.g., 3-D worlds and virtual environments) and tools enabling learning in 3rd space (neither school, work, nor home) as part of resident and non-resident learning events for individuals and groups. A range of 3rd-space options will be employed to support simulations, simulators, game-based scenarios, virtual worlds, augmented reality, massively multiplayer online games (MMOG), etc. [*While 3-D worlds/virtual environments do not replace all live training or education, they do offer a number of advantages. They can provide learning events that are highly compressed in time, simulate environments that cannot be replicated in live training/education, can be tailored to the learner's level of knowledge, can ramp up complexity and stress on demand, allow multiple repetitions to increase mastery, and have advantages of accessibility and adaptability.*] 3rd-space options, such as virtual-learning environments, will be integrated into distributed-learning products, used in blended learning at both resident and distributed locations, as the basis for collaborative problem-solving exercises, and for capstone exercises. [*User interfaces (joystick, haptic, voice, etc.) should be familiar to learners to enhance acceptance and encourage repeated practice. Many of the 3rd-space tools used in the schoolhouse will be used in units for both individual and collective learning events, providing familiarity to learners across domains. The Joint Counter-IED Center's use of Virtual Battlespace 2 (VBS2) to rapidly* *replicate operational events provides an excellent example of 3-D worlds/virtual technologies to bring realism and relevance to education and training now.*] A capacity to rapidly develop, update, and distribute real-life scenarios, using 3-D worlds, will be a critical feature of future 3rd-space learning environments.

Interpretation and Recommendations

The ability to successfully leverage innovations through technology for developing competitive and adaptive learning systems and environments for Air Force education benefits goes beyond the identification and analysis of emerging horizons. Processes and methods must also be in place to continually assess the learning needs of Airmen, adjust to new operational demands being placed on war fighters to better serve their learning needs, and do so by successfully incorporating advances in learning and assessment sciences through enabling technology. Moreover, key measures of effectiveness ultimately rest on the performance of learners in their operational positions. Progress needs to continue with the creation and use of external evaluations of individual performance through data gathering to inform professional military education (PME) and professional continuing education (PCE) improvements through applied innovations. For this reason, each recommendation below includes the development of learning and performance assessment rubrics.

<u>Recommendations</u>. An Air University *Learning Innovations Laboratory* environment should be established and resourced for engaging Air University educators in the collaborative design and prototyping of innovations through technology for Air Force education benefits. Laboratory staff needs to be skilled to support resident, non-resident, or blended applications of innovations through technology using collaborative-prototyping methods involving the active participation of Air Force educators.

Specific recommendations are provided below for each of the seven innovation horizons described in this paper, across the three innovation lifecycle management milestones:

a. Challenge-Centered Instruction and Assessment
    1. Milestone A: Convert and prototype existing set of lessons in targeted AU resident

PME course(s) into collaborative, challenge-centered framework; construct learning and performance assessment rubrics.

2. Milestone B: Conduct alpha and beta testing of framework using instructor and student samples and assessment rubrics.

3. Milestone C: Summarize and interpret results for further-action decisions.

b. Blended and Affective Learning for Lifelong Learning and Digital Literacy

1. Milestone A: Create and prototype a blended and affective learning-enabled environment in support of lifelong-learning attitudes and digital-literacy development; construct learning and performance assessment rubrics.

2. Milestone B: Conduct alpha and beta testing of prototype using instructor and student samples and assessment rubrics.

3. Milestone C: Summarize and interpret results for further-action decisions.

c. Educational Informatics and Intelligent Tutors

1. Milestone A: Establish educational-informatics test bed of virtual tools, and prototype application using intelligent tutors in a serious game supporting a targeted PME subject area (e.g., leadership, campaign planning); construct learning and performance assessment rubrics.

2. Milestone B: Conduct alpha and beta testing of serious game using instructor and student samples and assessment rubrics.

3. Milestone C: Summarize and interpret results for further-action decisions.

d. Modular Distributed Learning and Portal Services via Cloud Computing

1. Milestone A: Establish cloud-computing test bed to prototype the use and delivery of targeted cloud services and apps; construct learning and performance assessment rubrics.

2. Milestone B: Conduct alpha and beta testing of services and apps using instructor and

student samples and assessment rubrics.

3. Milestone C: Summarize and interpret results for further-action decisions.

e. Weak-Tie Networking and Peer-Based Learning for Informal Lifelong Learning

1. Milestone A: 1. Design and prototype 3-D world immersive environment in support of weak-tie networking among peers to create scenarios to integrate operational lessons learned from returning war fighters into PME; construct learning and performance assessment rubrics. 2. Design and develop forum-style learning-module prototypes using design-studio methodology and rapid prototyping to include a comprehensive change-management module, planned-curriculum modules, planned post-graduation modules, and unplanned, informal learning.

2. Milestone B: Conduct alpha and beta testing of peer-based lessons-learned scenarios and forum-style learning-module prototypes using instructor and student samples and assessment rubrics.

3. Milestone C: Summarize and interpret results for further-action decisions.

f. Linkage of Learning, Performance, and Decision-Support Applications

1. Milestone A: Design and prototype a mobile app that can be used and spanned across learning-, performance-, and decision-support environments (e.g., risk analysis); construct learning and performance assessment rubrics.

2. Milestone B: Conduct alpha and beta testing of app using instructor and student samples and assessment rubrics.

3. Milestone C: Summarize and interpret results for further-action decisions.

g. 3rd-Space Virtualization of Learning Environments

1. Milestone A: Design and prototype an integrated set of innovation-horizons 3rd-space applications (e.g., cloud services, 3-D world, mobile-learning app), in support of existing set of lessons in targeted AU resident/distance PME course(s); construct learning and performance assessment rubrics.

2. Milestone B: Conduct alpha and beta testing of integrated 3rd-space applications using instructor and student samples and assessment rubrics.

3. Milestone C: Summarize and interpret results for further-action decisions.

Summary of Horizons in Learning Innovation through Technology

	Short-term		Mid-term		Long-term		Totals	
Horizon	**Duration**	**Cost**	**Duration**	**Cost**	**Duration**	**Cost**	**Duration**	**Cost**
1	9	50	7	70	12	150	28	270
2	9	100	5	60	9	120	23	280
3	3	150	6	50	3	60	12	260
4	5	120	10	30	12	20	27	170
5	6	150	12+	260	12	150	30+	560
6	12	50	7	70	12	150+	31	270+
7	8	70	6	80	12	125+	26	275+

Table Key:

1) Challenge-Centered Instruction and Assessment
2) Blended and Affective Learning for Lifelong Learning and Digital Literacy
3) Educational Informatics and Intelligent Tutors
4) Modular Distributed Learning and Portal Services Via Cloud Computing
5) Weak-Tie Networking and Peer-Based Learning
6) Linkage of Learning, Performance, and Decision-Support Applications
7) 3rd-Space Virtualization of Learning Environments

Note: Duration indicated in months; cost indicated in thousands of dollars.

Conclusion[3]

Future learning systems and environments can be shaped and transformed to better support the education of Airmen through two related innovation channels of effort:[4]

- One involves "warriorware" and requires cognitive and learning scientists, behaviorists, and social scientists to help with how best to leverage innovations through technology to educate, prepare and support warriors with enhanced learning and performance-support technologies.
- The other involves strengthening the adaptability and capabilities of "learningware," the IT infrastructures, enterprises, and knowledge engines behind learning systems, to better bridge and link learning environments across informal self-development efforts, formal schoolhouse programs, and operational experience.

The innovation horizons addressed in this report provide Air University educators and leaders with prospects to help ensure Air Force learning systems remain competitive and adaptive by addressing both innovation channels from an integrated effort.

The impetus to obtain Air Force education benefits from the innovation horizons described in this report is driven by the rapid cycles of innovation in warfare, which is increasing the need for learning systems to adapt more quickly to changing demands of war fighting. This has the consequence of elevating the importance of how innovations through technology are successfully leveraged to help ensure the Air Force has a competitive and adaptive learning system capable of meeting future learning needs of Airmen. The last decade of warfare has introduced multiple challenges to each military service in the DoD as adversaries quickly adapt and innovate to counter U.S. advantages in kinetic force. The challenges have also provided insights into constraints that can limit the adaptability and competitive responsiveness of PME to operational-force needs (e.g., incorporating lessons learned from returning warriors into PME in a timely fashion). While war-fighting units are learning to adapt to new challenges,

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[3] The conclusion offered in this report incorporates arguments from the conclusion provided in the draft TRADOC PAM 525-X-X, dated 18 May 2010, p. 12.
[4] The two innovation channels of effort were introduced by Stricker (2010, June). *Disruptive innovations and educating future Airmen*, Air University, Maxwell-Gunter AFB, Montgomery, AL: Wright Stuff.

cultures, and adaptive adversaries, the ways in which the learning needs of those war fighters are addressed can be limited by instructional strategies and practices that have not stayed current with advances in learning sciences and new media capabilities to extend relevance, access, and mobility to timely instruction at the point of need.[viii] The Air Force must prevail in a competitive learning environment with limited time and resources to prepare Airmen for uncertain operations of long and short duration that involve considerably more contact with local populations and coordination across services and with interagency and intergovernmental coalitions in blended applications of kinetic and non-kinetic force. Airmen and other military leaders are increasingly having to apply knowledge and skills to adaptively perform in very unforgiving circumstances. Consequently, it is imperative to provide Airmen with learning environments capable of providing learning at the point of need across a lifelong continuum of service. Operational adaptability demands learning systems and environments that have the capacity to develop adaptable Airmen and leaders, rapidly develop and deliver relevant learning content on demand, and can sustain adaptation over the long term by smartly leveraging innovations through technology.

Air University has a long tradition of excellence in intellectual leadership for developing Airmen to be prepared to fight future wars. In that tradition, Air University is using innovations through technology to transform learning systems to better educate Airmen with the capacity to learn faster and adapt more quickly to changing demands of war fighting where knowledge, critical-thinking skills, and performance are required in unforgiving circumstances.

Appendix A:

Challenge-Centered Instruction and Assessment

Appendix A

Challenge-Centered Instruction and Assessment

Overview. The technique of providing instruction using real-life challenges or problems in support of adaptive instruction and assessment methods during and across learning sessions is challenge-centered instruction. The emergent innovation behind challenge-centered instruction and assessment is how new forms of social-media technologies can provide for mobile and social interactivity in support of how people learn in different ways and at varying rates and locations by offering different amounts of instructional support on the basis of insight provided by assessing learning and performance regardless of location. Of particular interest is the capability to provide challenge-based instruction and assessment in 3rd space (neither home, school, nor work, but where the person is present via mobile connectivity).

Innovative 3rd-space learning environments can accommodate and build upon how people learn through challenge-centered instruction, in which a variety of real-life challenges or problems are adopted and tailored to the needs and learning characteristics of the individual and the team. Specific dynamic interventions can be adaptively applied to increase each person's and team's abilities to benefit from the challenge-centered learning environment. Individual and team differences in learning are no longer considered static, but rather capable of modification, either before the instructional process begins or as a part of the process when addressing the challenge.

In challenge-centered learning environments where a high degree of implementation is achieved, instructors tend to spend more time on facilitation of learning, and students tend to be highly task oriented. Steady and productive interaction between instructors and students, and among students, replaces the passive-learning mode typically found in conventional learning environments. Interactions among students, for the most part, focus on sharing ideas and working together on learning tasks associated with the challenge.

Innovative challenge-centered instruction and assessment frameworks, employed by social media, can apply Vygotsky-like scaffolding for developing advance problem-solving and critical-thinking skills by adaptively tailoring the level of difficulty or challenge appropriate for the person when learning independently as well as when learning in team environments. With regard to team-learning challenge environments, the major theme of Vygotsky's theoretical framework is that social interaction plays a fundamental role in the development of complex thinking. Vygotsky (1978) states, "Every function in … development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological) and then inside … [the person] (intrapsychological). This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relationships between individuals" (p. 57).

A second aspect of applying a Vygotsky-like adaptive challenge-centered instruction and assessment framework is the idea that the potential for cognitive development depends upon the "zone of proximal development" (ZPD): a level of development attained when people engage in social behavior and problem solving (1962, 1978). Full development of the ZPD depends upon full social interaction. The range of skills that can be developed with guidance or peer collaboration exceeds what can be attained alone (Wertsch, 1985).

The application of a Vygotsky-like adaptive challenge-centered instruction and assessment framework, using social-media and mobile-learning applications, in service to Air Force education benefits centers around the value of offering precision learning for uniquely developing future war fighters across global locations, in a timely fashion, and at an appropriate learning level with greater accuracy, efficiency, and assurances for expected performance results in the use of new knowledge.

Connection to Innovation Triangle. This is an emergent innovation that can leverage advances occurring in the science of human learning and assessment, particularly as enabled by newer forms of social- and mobile-technology mediation. Precision learning, in the form of adaptive challenge-centered instruction and assessment, can introduce a new generation of Air Force education enabled by social media (e.g., in the form of 3-D space delivery and interactivity), mobile learning (mobile apps designed to support Air Force education), and cloud computing (a global architecture capable of supporting worldwide access, collection, and usage of data and access to learning services).

<u>Prototyping/Assessment/Implementation Projected Costs and Timeline</u>. This is an innovation prospect best evaluated for larger-scale implementations over a span of integrative prototyping:

- Short (design and development phases): Design and develop instructional and assessment plans (using a lesson or learning activity from an existing Air Force PME or PCE curriculum) on the basis of applying Vygotsky-like adaptive challenge-centered instruction and assessment framework. Determine 3-D space environment, data-

Challenged-centered instruction and assessment using new media (e.g. immersive 3D world and mobile-learning applications) to develop critical-thinking skills necessary for real-life problem solving.

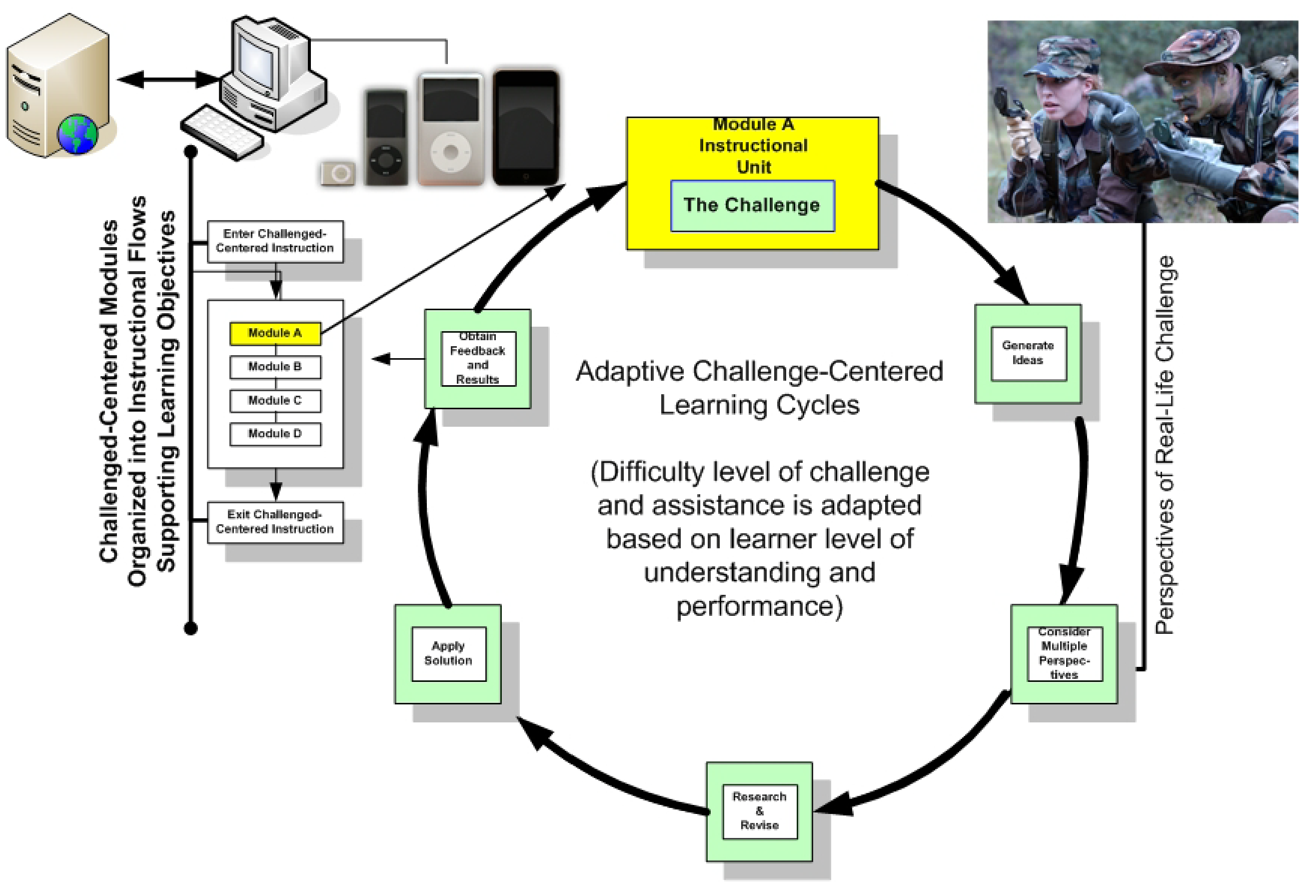

Figure 1. Adaptive Challenge-Centered Instruction.

collection architecture, and media support for interactivity and mobility. Design and develop prototype using design-studio methodology and rapid prototyping. AU Educational Technology Innovations Analysts work with identified faculty from the curriculum area in all phases. Expected duration for design and development phases: 9 - 12 months. Estimated cost: $50K (reflects internal costs associated with staff and faculty time on project and cloud services used for rapid-prototyping activities).

- Mid (integration and testing phases): Integrate instructional and assessment plans with identified forms of 3-D space delivery, mobile devices, and cloud-computing services. Conduct alpha- and beta-testing sequences, and analyze test data for refinements and decision points for continuation of effort. Expected duration: 5 - 7 months (occurs during second year of effort). Estimated cost: $70K.
- Long (implementation and sustainment phases): Based on test results, implement proven innovation into selected Air Force curriculum areas via rapid curriculum-design adaptation methods. Establish sustainment services. Expected duration: 9 - 12 months (or longer depending on the scale of implementation). Estimated cost: >$150K.

<u>Conclusions/Recommendation(s)</u>. The application of this emergent innovation offers Air Force educators a systematic and data-driven approach to leverage advances in learning and assessment sciences smartly for advancing the development of future Air Force war fighters in a world increasingly interconnected through social media and mobile devices. The Vygotsky-like adaptive challenge-centered instruction and assessment framework is supported by extensive research across higher education. Application of this emergent innovation, in support of precision learning enabled by integrative social media and mobile devices, provides the means for Air University educators to directly address and improve how Airmen learn and perform across a global and highly mobile Air Force. Recommend prototyping of this emergent innovation by Air University educators, in collaboration with colleagues across the Global Learning Forum, using the above-suggested timeline. If approved, detailed project timelines, cost tracking, and project milestones and deliverables can be identified and tracked using an AU Innovation Portfolio-Management plan.

Appendix B:

Blended and Affective Learning for Lifelong Learning and Digital Literacy

Appendix B

Blended and Affective Learning for Lifelong Learning and Digital Literacy

Overview. Blended learning generally refers to combinations of online or technology-delivered instruction (e.g., mobile-learning devices) with face-to-face instruction. Ensuring that learners have opportunity to interact with the instructor and peers is important for supporting affective learning benefits.

Affective learning involves the melding of thinking and feeling in how people learn. Importance is placed on social learning environments for knowledge construction and application wherein deeper awareness and understanding of the role played by mental dispositions in how a person views, engages, and values learning can result in better understanding and use of knowledge and skills. Learning outcomes are focused on enculturation of norms, values, skillful practices, and dispositions for lifelong learning (Stricker, 2009).

In the late 20th century, affect grew in importance with investigations on the ways people acquire, interpret, shape, and sharpen information via thinking and affective skills (Marzano et al., 1988). A number of researchers began to explore the habitual affective ways (dispositions) people approached thinking and learning. Ultimately, insights emerged from social cognitive theory research on the role played by several dispositions across critical, creative, and self-regulated thinking (Bandura, 1986, 1988; Bandura & Schunk, 1981; Schunk & Zimmerman, 1997, to name a few). It is worthwhile to list the explored dispositions in the following table (Table 1):[5]

[5] The composite list, originally compiled by Idol & Jones (1991), comes from the research of Amabile (1983), Lipman, Sharp, and Oscanyan (1980), Paris & Lindauer (1982), Perkins (1984, 1985), and Raudsepp (1983).

Table 1. Human dispositions on thinking and learning
1. Seeking clarity and precision when information is unclear 2. Trying to be well informed 3. Seeking reasons for what you believe 4. Taking into account the total situation 5. Carefully analyzing information 6. Remaining open-minded 7. Taking a position (and changing it) when the evidence is sufficient to do so 8. Showing sensitivity to the feelings, level of knowledge, and degree of sophistication of others 9. Resisting impulsivity 10. Engaging intensely in tasks even when answers or solutions are not immediately apparent 11. Pushing the limits of one's knowledge and abilities to keep improving on one's knowledge and skills 12. Generating, trusting, and maintaining one's own standards of evaluation 13. Generating new ways of viewing a situation outside the boundaries of standard conventions 14. Planning 15. Being sensitive to feedback 16. Evaluating progress 17. Making use of available resources

Research on the relation between cognition and affect shows strong connections relative to specific contexts or actions. The interplay between cognition and affect is also driven by the level of awareness people have regarding the role of dispositions. The term "attitude" can be used to describe long-term generalized mental positions taken by people governing actions. Allport (1935) defined attitude as "a mental or neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related" (p. 810). For example, people can form mental positions about learning in certain contexts or situations, with strong associated emotion, reflecting attitudinal evaluations of good, bad, or neutral (Idol et al., 1991). Thus, mental attitudes can play a large role in how a person views, engages, and values a learning context or situation. Mental attitudes are reflected by the extent the learner (McCombs, 1984, 1986):

1. Views the content as valuable,
2. Believes he or she has control over the learning task, and
3. Believes he or she has the necessary abilities for the learning task.

Self-regulation of these mental attitudes on learning is largely determined by a person's dispositions for shaping cognitive abilities and affect adaptively and appropriately for the context or action via self-reflection (Johnson-Laird, 1998; Sternberg, 1998).[6] Research also confirms the importance played by communities in shaping dispositions and how people learn (Lave & Wenger, 1991, 91-100; Bransford, 2000; Greeno et al., 1996). Self-regulation of mental attitudes on learning is shaped and influenced by social interactions (Festinger, 1954; Weiner, 1985; Zimmerman, 1994, 1996, 1998, 2000).

Deeper understanding about the importance of community and social interactions on learning has grown from an appreciation developed by educators that knowledge is not a commodity to be transmitted (Bransford & Schwartz, 1999). Rather, knowledge is essentially situated and should not be separate from the contexts in which it is actively constructed and reconstructed through direct interactions, contemplative inquiry, and interpretation (Brown, et al., 1996; Lave & Wenger, 1991; Rogoff & Lave, 1984; Armon-Jones, 1986).[7] Knowledge is inherently associated with human interpretations and dependent very much on "the point of observation" of the person, and that the process of interpretation simultaneously shapes and is shaped by

[6] Self-reflection does not suggest a person can inspect his/her own thought processes in complete detail. What is accessible is an incomplete model of one's own abilities. The ability of the mind to inspect this model and then adapt thinking and dispositions is the basis of so-called metacognitive skills. For instance, a person can think about the task or social situation at hand and work out a strategy for action. When people start to think about how he/she is thinking and feeling, it can help with improving what one is doing (see Johnson-Laird, 1988, p. 451, and Ward et al., 1995, pp. 19-21).

[7] It is interesting to point out the influence of existential cognition's rejection of the separability of mind from the world on the emerging understanding regarding the role played by communities on shaping the mind: the inside mind and outside world are inseparable (see Merleau-Ponty, 1962, p. 407 and McClamrock, 1995, pp. 191-193).

social interactions. Research indicates there is a close relationship between affect and social-knowledge structures (Forgas, 2000).

Researchers on human learning have also developed deeper appreciation for how knowledge is embedded in context and the media allowing its expression (Bransford et al., 2000; Cognition and Technology Group at Vanderbilt, 1997; Kafai, 1996). This appreciation has expanded research on the deeper and ubiquitous connections between people and technology via the use of personal and cultural tools now supporting human minds, senses, and bodies.[8] Also, there is growing research interest on the symbiotic connection between human minds and digital tools, making possible phenomenal capabilities via interconnected and distributed ways of knowing and learning. For example, new-media digital technologies can affect learning in several fundamental ways. Electronic texts can have hypertext providing for multidimensional and less linear-oriented interaction between the learner and content. Through implementation of graphics, sound, animation, and streaming live video, it is now possible to merge symbolic components of communication with traditional content.[9] Such capabilities give rise to digital-literacy requirements associated with new media. For example:

> "… Some of the most successful teachers use information technology in concert with a shift in a role from lecturer to mentor of student learning through inquiry. Students are encouraged to learn by finding information about assigned subjects and then to piece together the information in some well-structured way that can be reported and discussed with the class. In this way, the student actively constructs an ordered view of the information in his or her mind that tends to be remembered and understood better than information absorbed through passive listening. The teacher's role here is to structure the sequence of assignments, help the student find and understand

[8] See VaNTH ERC, Vanderbilt University, Northwestern University, University of Texas at Austin, and Health, Science and Technology at Harvard/MIT Engineering Research Center. Available: http://www.vanth.org; also, see SMETE, Science, Mathematics, Engineering and Technology Education. Available: http://www.smete.org.

[9] See Langer, A. M., & Knefelkamp, L. L. (Nov, 2001). Forms of literacy development with technology in the college years: A scheme for students, faculty, and institutions of higher learning. Paper presented at the Association of American Colleges and Universities (AACU) Conference on Technology, Learning, & Intellectual Development, Baltimore, p. 10. The authors cite research by Reinking, D. (1994), Electronic literacy, Perspectives in Reading Research (4), (ERIC Document Reproduction Service No. ED 427 780).

> the information, help the student piece the information together, perhaps establishing a larger context, promote discussion, evaluate results, and redirect as needed. In some cases, teachers have built Web sites for students to explore, often with links to outside materials. Such student inquiries are often conducted in collaborative groups. The learning skills developed by these students form a basis for independent lifelong learning."[10]

Higher levels of digital-literacy development, involving the global extension of the boundaries of mental, sensorial, and corporal connections, made possible and supported via mobile and interconnected digital tools, is prompting educators to consider that the relationship between new media, affective learning, and situated place is anything but simple.

Well-designed blended-learning frameworks and environments supporting affective learning can be extremely important for developing dispositions for lifelong learning, and can help in the development of higher levels of digital literacy associated with becoming more adaptive with technology. In many respects, a blended-learning environment can be used to help develop and mature lifelong learners with digital-literacy skills necessary to manage lifelong learning objectives and benefit from distributed environments offering learning content at the point of need. Rassool (1999) claimed that efforts to define literacy serve to "frame the range of knowledge and skills that are valued and accredited within particular societies" (p. 5). Technology has multiple relationships with culture (Langer & Knefelkamp, 2008; see Figure 1).

[10] *See President's Information Technology Advisory Committee, Panel on Transforming Learning (Feb, 2001). Report to the President: Using information technology to transform the way we learn, p. 9.*

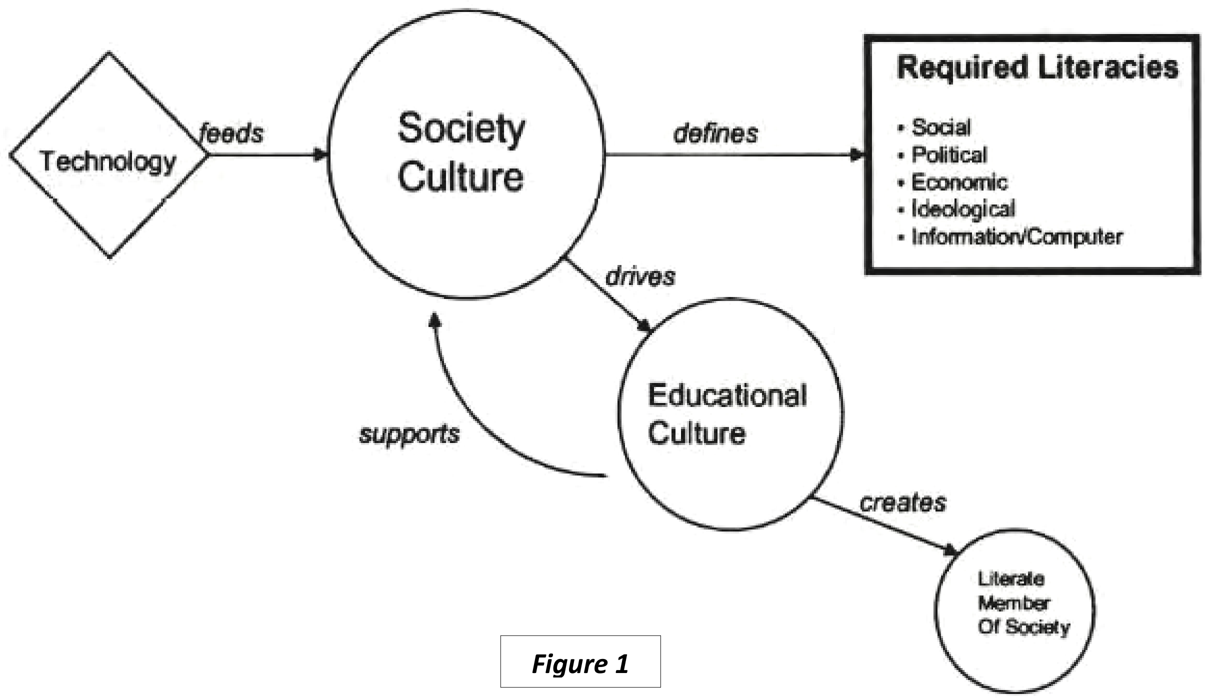

Figure 1

The adaptive and successful use of technology in learning and performance, involving a range of digital literacy, plays a large role in modern society and is particularly critical in warfare. The U.S. Air Force is facing future learning environments where Airmen must learn more rapidly and adapt more quickly to swiftly evolving demands of war fighting where knowledge, critical-thinking skills, and performance are increasingly important in unforgiving circumstances. Evolving-conflict environments demand evolving-education processes. Well-developed digital literacy is needed by Airmen to effectively learn and perform across informal self-development efforts, formal schoolhouse programs, and a variety of operational experiences.

Advanced technological developments require educators to think and plan strategically regarding the role of digital literacy to help ensure the Air Force has a competitive and adaptive learning system capable of meeting future learning needs of the Airman. Educators should be actively involved in devising updated learning frameworks and curricula to help develop the digital-literacy knowledge and skills needed by Airmen. Posner (2002) observed that students do not simply need to know how to manipulate computer or digital tools and resources, they must develop the desire for, and a habit of, critical thought. The learned capacity for critical thinking includes improved discernment when using the Internet and forms of social networking as well as interpreting reliable information sources on the Web (Kirkwood & Price, 2005). In addition, the ability to use technology does not necessarily involve consistent ethical considerations among students, or an understanding of the possibilities for cross-cultural understanding and access to multiple perspectives the cyberspace provides.

Blended- and affective-learning frameworks and environments can also be designed to support modular curricula to help sequence learning in better ways with Airmen's schedules and operational tempos. This capability introduces prospects for integrating performance-support applications that are also blended with learning applications to help foster stronger ties between schoolhouse learning and on-the-job performance and decision-support tools. Bridging the schoolhouse to on-the-job environments, using blended- and affective-learning frameworks, can strengthen the continuum of lifelong learning across formal, informal, and life experiences for the Airman. Competitive and adaptive future-learning environments will increasingly evolve to better-blended and distributive models simply because it matters to an expeditionary force to educate war fighters regardless of place. Nonetheless, most educators place high importance on the role of place in learning, even with distributive-learning environments. In addition, educators are increasingly designing and developing good virtual surrogates for traditional physical learning places. Some educators go so far as to suggest that traditional physical places for learning operate, in part, with critical virtual elements through the sociocultural practices of the learning community.

The distributed nature of learning, among members of a global learning environment, is supported by a common network-level language of communication operating in the sociocultural environment of the ecosystem to mediate transactions (e.g., roles, privileges, accessibility, performance expectations, behavioral norms, conflict resolution, negotiations, to name a few) (Lucariello, et al., 2004 & Nelson, 1996). It is the cultural ecosystem of the learning community that makes mediated and purpose-driven communication and social interactions possible; and operates, in the minds of its members, as a distributed virtual operating system used for enculturation of values, learning, and skillful practices.[11] Learners should participate in communities of practitioners since the mastery of knowledge and skill requires movement

[11] The original idea of a cultural ecosystem as a distributed virtual operating system is from the work of Donald (2001).

toward full participation in the sociocultural practices of a community (Lave and Wenger, 2002, p. 29). Thus, most educators are likely to place high value on the importance of a situated place, whether geographic-centered or otherwise, wherein purposefully designed formal communications, memory technologies, and social interactions can effectively operate in a supportive sociocultural environment for contributing to the learners' developing minds and lifelong mental attitudes/affect toward learning.

Immersive Virtual Reality: Surrogate for Geographic-Centered Situated Place?

Meredith Bricken (1991) and Hilary McLellan (1991) argued immersive virtual reality can be very supportive of situated and constructivist learning. Immersive virtual reality provides the means for a person to enter a virtual spatial multi-sensory environment and embody it in such a way as to actively inhabit, interact, and create the next event (Walser, 1992, n.p.).

According to Bricken (1991), immersive virtual-reality learning environments can be designed to be experiential and intuitive, providing learners with control over time, scale, and physics for a shared experience and information context supporting interactive hands-on learning, group projects and discussions, field trips, simulations, concept visualization, and observation from many perspectives. Prototypes of immersive virtual-reality learning environments, constructed by Air University researchers and learners for assessing differences between classical and future designs, are illustrated in the following Figures 2 and 3, respectively (n.p.).[12]

[12] The reader can visit the illustrated prototype designs, constructed in Second Life by Air University, at http://slurl.com/secondlife/Huffman%20Prairie/128/128/27. In addition, videos of the designs can be seen at http://www.screencast.com/t/QBt6u3uyTjX. Second Life is a virtual 3-D environment available to the public via the Internet at http://secondlife.com.

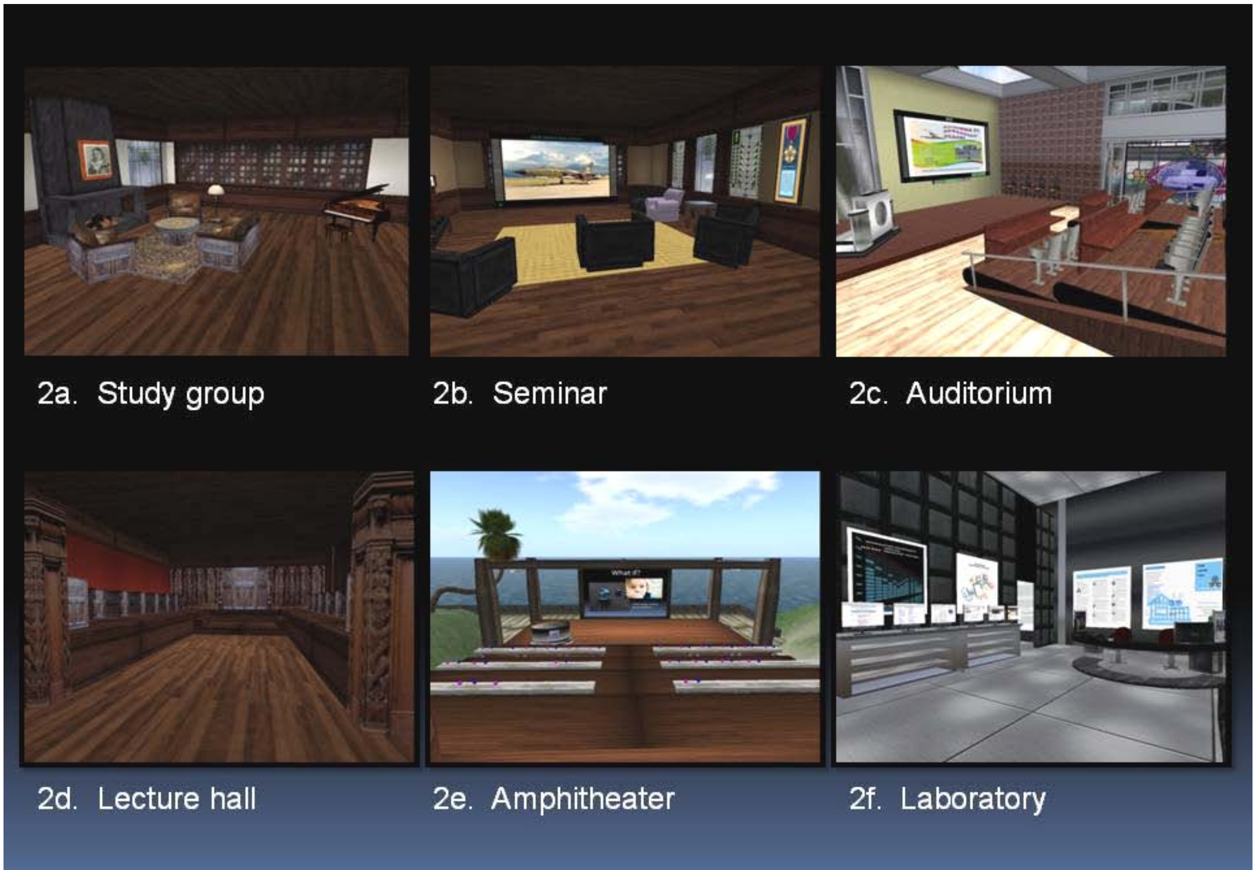

Figure 2. Classical-oriented, immersive virtual reality learning environments.

The immersive virtual-reality images, shown in Figure 2, depict classical-oriented learning-environment designs. Recognizable visual cues of social roles for instructors and learners, interactive-learning tools (e.g., virtual computers, plasma screens, and books), and auditory features, help to establish a sense of a situated place supporting classical learning environments. Digital-immigrant learners are more likely to recognize and accept the validity of these designs as suitable places for situated learning. Various future-oriented, immersive virtual-reality learning-environment designs are shown in Figure 3. Image 3a depicts a hologram arena wherein learners can select from multiple learning-environment options and have them instantaneously appear, or "rez," for use. Hologram examples include interactive villages, depicting various worldwide locations, used for supporting language and culture courses. Several arenas are also provided for learners to create 3-D objects for hologram constructions. Image 3b shows a machinima (*machine cinema*) studio environment for creating, editing, and showing animations using virtual equipment. The interactive museum in image 3c provides

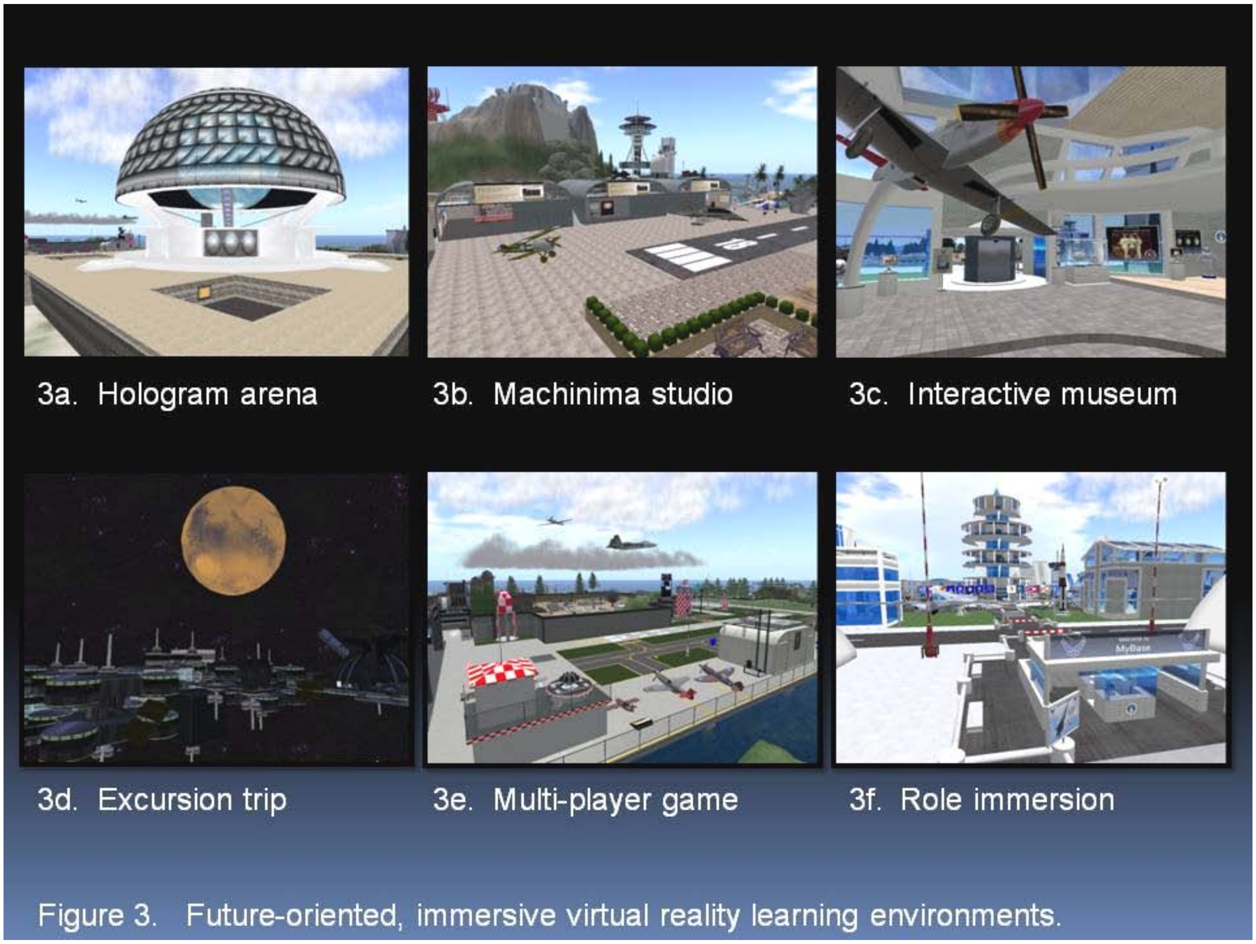

Figure 3. Future-oriented, immersive virtual reality learning environments.

learners with "step-in-experience" displays. For example, learners can experience a virtual flight of the Tuskegee Airmen P-51 Mustang. More extensive "step-in-experiences" are provided by excursion trips. In the excursion trip example depicted in Image 3d, learners can travel to Mars by first taking a multistage rocket to a space station for transition to a deep-space travel vehicle. Upon entering the orbit around Mars, the learners are then taken to a surface station via a landing craft. Throughout the trip, learners are interactively engaged with challenges associated with space travel and research. A multiplayer, nonlinear simulation game environment, involving the use of a scenario-based learning framework for engaging learners with real-life challenges, is shown in Image 3e. A game kit for educators has been developed to support the creation of games for learning within virtual worlds (Stricker & Clemons, 2009; Hughes & Stricker, 2009). A situated virtual Air Force base (MyBase) is depicted in Image 3f. Visitors can enter MyBase and be immersed into various Air Force roles (e.g., military recruit/trainee, chaplain, pilot, and physician) in support of multimodal experiential learning in the context of an Air Force community. Interestingly, while some digital-immigrant educators visiting the future designs have reported cognitive dissonance and question the validity or utility of the environments as suitable places for situated learning, others have reported insights about the “art-of-the-possible” with prospects of virtual worlds for supporting learning, instruction, and discovery. Educators are drawn to the affordances or opportunities for action (learn by doing), bundled together with learning tools and devices, offered by the future designs. In addition, educators are drawn to the surrogate settings of actual work environments supporting apprenticeship, collaborative teamwork, coaching, and monitored performance feedback.

Interpretation of the Research

Many digital-immigrant educators are members of an “in-school” socioculture associated with formal-learning ecosystems. The sociocultural context and practices of educators in formal-learning ecosystems can be misunderstood, and perhaps undervalued at first glance, by overly interpreting the need to radically change education systems to better support how the millennial generation learns with new media. Nonetheless, the immersive virtual-reality learning-environment research, conducted by Air University, suggests assistance may be necessary to help educators transition between classical- and future-oriented learning environment designs. The need for assistance, however, does not minimize the importance served by educators for establishing and facilitating viable learning ecosystems within future-oriented virtual-reality learning environments. While it may be true that digital natives have grown up with new-media technology as an integral part of their lives, it does not necessarily follow that millennial-generation youth know how to learn well with new media, nor is there inherent higher forms of literacy associated with the social-ethical responsibilities of its use (Langer, A. M., & Knefelkamp, 2001; and Langer, 2005).

The sociocultural context and practices of educators have evolved over centuries to maximize benefits from contemplative inquiry defined by the intermittent nature of how knowledge is constructed and interpreted for reliability and validity for inclusion, shared use, and communication. The socioculture context and practices of educators support predictable and systematized ways to enhance social-knowledge structures and communication from a geographic-situated place (see Figure 4).

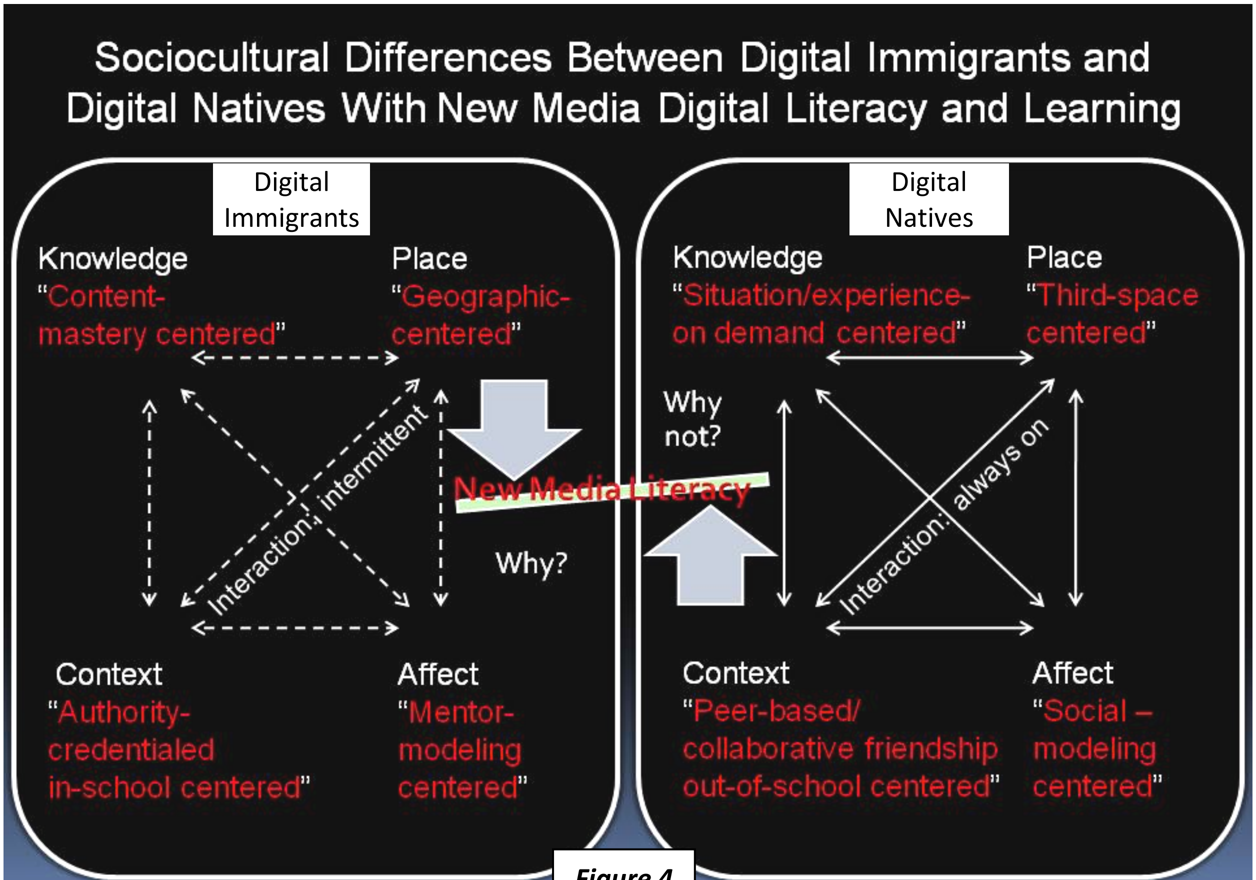

Figure 4

Many educators attribute their development and lifelong dispositions to learning—to an epistemology associated with value placed on affective connections between instruction and learning. Equally true, from nearly the inception of formal-learning ecosystems, some form of technology (e.g., printing of books) has been used as an augmented tool in service to the human mind.[13] Considerable effort is expended to enhance technology, generation by generation, largely because the human mind has been extraordinarily successful in going for generations using augmentation tools to construct, connect, and communicate. The mind's

[13] Modern-day examples can be found with Internet-connected digital devices enabling people to search all of human knowledge. Via the Internet, people can access knowledge in digital collections created by traditional libraries, museums, archives, universities, government agencies, specialized organizations, and even individuals around the world. Very high-speed networks enable groups of digital-library users to work collaboratively, communicate with each other about their findings, and use simulation environments, remote scientific instruments, and streaming audio and video. With these capabilities, no classroom, group, or person is ever isolated from the world's greatest knowledge resources (President's Information Technology Advisory Committee, Panel on Digital Libraries, p. 1).

desire to construct knowledge, to connect with other social constructions for forming better and larger or more complete insight, are fundamental to the nature of learning ecosystems, whether they are formal or informal. Thus, on the one hand, most educators associated with formal-learning ecosystems do not dismiss the value of informal "out-of-school" learning ecosystems and the sociocultural context involving the use of new media by digital natives. On the other hand, most educators also believe affective learning in a situated place matters, facilitated by mentored modeling, for enculturation of skillful practices, lifelong dispositions, and values. That being said, there is also recognition of the inherent constraints associated with limited accessibility to geographic-situated places for learning.

Typically, the benefit of physical proximity is limited by availability of space and resources. Interestingly, these constraints are driving up interest among educators to explore the use of virtual worlds, particularly if the immersive social-knowledge structure can be designed and supported well enough to offer the best qualities associated with affective learning in a situated place.[14] Virtual worlds are primarily about creating a spatial environment in which people interact with other people in real time—they are in a concurrent space … and changes made will persist after they leave the environment (Prentice et al., 2009, p. 5.). Prentice also reports that by year-end 2011, 80% of heavy Internet users will have a presence in one or more virtual worlds (p. 5.).

Beyond prospects of virtual worlds for providing geographic independence of a suitable situated place for affective learning, there is little doubt new media is fundamentally altering the literacy experience in learning, instruction, and discovery. Importantly too, even though new media is altering the literacy experience of digital immigrants and natives, discussion of new-media literacy has helped invigorate educators to share why affective learning in a situated place matters for the millennial generation.

The growing interconnectivity and interdependencies between new media literacy, knowledge, place, affect, and context can impact how well social-knowledge structures, employed by

[14] This is particularly true if emotional and cognitive activities are significantly mediated in a virtual-world environment supporting the perception of opportunities for acting and the means for acting involving the modalities by which people interact (e.g., locating, tracking, identifying, grasping, moving, and modifying objects) (Allen et al., 2004; Bricken, 1991).

formal-learning ecosystems, support learning by the millennial generation. It is generally recognized that a formal-learning ecosystem, such as a university, is composed of reciprocal or ecological relationships that influence one another. For instance, new-media, instructor, and learner interactions shape the sociocultural context of the learning ecosystem, which in turn produces reciprocating qualities effecting change in each. Likewise, new media introduces unprecedented reciprocity arising from global communication, connection, interaction, and mobility.

In the case of advanced new-media technologies, such as those found in the visualization of complex systems, there is growing recognition that new ways of understanding complexity, creating, and sharing knowledge constructions are emerging only because technology makes it possible. Nonetheless, most educators, for good reasons, advise against technocentrism and its tendency toward breaking down important affect and social interactions in a situated place, all of which are critically important with human learning. Increasingly, however, educators also accept the importance of addressing new-media literacy and leveraging new ways learners can construct meaning, connect, and communicate.

New media is fundamentally transforming not only how the millennial generation learns, but also how people will learn using higher forms of digital-literacy and social-knowledge systems for generations to come. The understanding of this phenomenon, including individual and institutional efficacy to thrive with new media, is, in itself, an emerging new form of digital literacy to grasp and harness for the 21st century.

Connection to Innovation Triangle. This innovation horizon has strong ties to the innovation triangle for enabling better integrations among learning, assessment, and technology advances in helping develop lifelong learning skills and mature levels of digital literacy of Airmen.

Prototyping/Assessment/Implementation Projected Costs and Timeline. This is an innovation prospect best evaluated for larger-scale implementation over a span of integrative prototyping:

- Short (design and development phases): Design and develop a blended affective-learning framework that makes use of modular curricula supported by mobile devices to create new forms of blended-learning environments between resident schoolhouse programs, immersive virtual worlds, and on-the-job usage. Apps can be designed to help bridge the environments in mobile ways to support instruction on content, digital literacy, and performance support. Design and develop advanced forms of blended and affective learning framework and environment using design-studio methodology and rapid prototyping. Air University Educational Technology Innovations Analysts work with identified faculty from the curriculum area in all phases. Expected duration for design and development phases: 9 – 12 months. Estimated cost: $100K (reflects internal costs associated with staff and faculty time on project and used for rapid-prototyping activities).
- Mid (integration and testing phases): Conduct alpha- and beta-testing sequences, and analyze test data for refinements and decision points for continuation of effort. Expected duration: 5 - 7 months (occurs during second year of effort). Estimated cost: $50K.
- Long (implementation and sustainment phases): Based on testing results, implement proven innovation into selected Air Force curriculum areas via rapid-curriculum design adaptation methods. Establish sustainment services. Expected duration: 9 – 12 months (or longer depending on the scale of implementation). Estimated cost: >$120K.

Conclusions/Recommendation(s)**.** Blended affective-learning frameworks can provide Airmen with global-connection prospects for participating in highly interactive learning environments that can include face-to-face instruction and support for instantaneous, or near-instantaneous, communication with others through enabling mobile and advanced distributed technologies, offering independence of place. Thus, “being mobile” is no longer restricted to a matter of traveling, but increasingly reflects the degree to which learners can interact with others in new configurations of blended learning independent of geographical proximity (Kakihara & Sorensen, 2002). New instructional-design configurations can introduce improved ways to support blended- and affective-learning environments for supporting how people learn and the mobility of the learning place itself. These new configurations can provide Air Force educators prospects for designing competitive and adaptive learning environments that can span the schoolhouse and on-the-job locations. Recommend prototyping of this emergent innovation by Air University educators, in collaboration with colleagues across the Global Learning Forum, using the above-suggested timeline. If approved, detailed project timelines, cost tracking, and project milestones and deliverables can be identified and tracked using an AU Innovation Portfolio-Management plan.

Appendix C:

Educational Informatics and Intelligent Tutors

Appendix C

Educational Informatics and Intelligent Tutors

Overview. Educational informatics is the study of informatics science with analysis of learning information and knowledge, to address the interface between technology, learning, and assessment sciences in the design of interactions between natural and artificial systems supporting learning, instruction, and discovery. Informatics, and related application areas such as educational informatics, is an interdisciplinary field (Scheessele, 2007). There are multiple supporting or component sciences behind educational informatics: decision sciences, cognitive science, information science, and management sciences. As an interdisciplinary field, educational informatics focuses on information, data, and knowledge in the domain of education—their storage, retrieval, and optimal use for problem solving and decision making in support of how people learn, instruct, and discover new knowledge. In short, educational informatics turns data and information into knowledge people can use when learning, instructing, or discovering. The application of educational informatics in the design of intelligent tutors is also helping to process large data sets on individual learning histories in support of adaptive instruction … offering greater precision for developing learning and performance competencies. One-on-one individual tutoring is considered the most effective instructional method because it is highly tailored to the individual.[ix] While establishing universal one-on-one tutoring is impractical, the Defense Advanced Research Agency (DARPA) and other research agencies are demonstrating significant learning gains using artificially intelligent digital tutors that provide a similarly tailored learning experience.

The growing field of educational informatics offers applied-research and prototyping efforts to leverage advances in informatics to help interconnect natural and artificial education systems supporting learning, instruction, and discovery. The capabilities of new media and modern networks provide for services that can transcribe and integrate information between interfaces, whether they are informational services (informal, broad public access) or business services (contractual, user access only). Such capabilities can help interconnect natural and artificial education systems across live, virtual, and constructive (LVC) learning environments. In the case of LVC applications, improvements offered by educational informatics can help to better interconnect LVC learning environments for hybrid and mobile uses. For example, mobile-learning devices can help bridge or provide for a continuum of learning services as the learner moves across LVC learning environments. With seamless connectivity, learners could interact easily and intuitively between natural and artificial education systems. Interestingly, cloud computing (providing for on-demand configurable, scalable, shared computing resources through the Internet, many of which can be virtualized) offers architectures for the application of educational informatics to help secure and use data spanning across LVC learning environments.

The following basic functions, or cornerstones, are typically addressed within the work of educational informatics: data acquisition and presentation, recordkeeping and access, communication and integration of information, monitoring, information storage and retrieval, data analysis, decision support, education, and managing change. The education function is briefly described here:[15]

Education. Because of the rapidly increasingly growth of knowledge, learners cannot learn all they need to during attendance or participation in formal-education programs. Instead, learners must learn *how* to learn for lifelong development across formal- and informal-learning environments. In addition, limited resources can place additional time, availability, and access constraints on formal training and education programs. Fortunately, computer-aided instruction and new-media social networking and virtual-world capabilities offer means to offset limited resources while also providing benefits from distributed electronic availability, on-demand access, mobility, and applications from educational informatics. At this level of application, educational informatics enables the next generation of learning technologies operating across formal- and informal-learning programs and across virtual- and real-world learning environments. A closer integration of information flowing between applications and systems across virtual- and real-world learning environments offers multiple benefits for future

[15] Basic functions (or cornerstones), adapted in this paper for application with educational informatics, are from medical informatics; cornerstones of medical informatics were originally offered by Dr. Nancy M. Lorenzi and Dr. William W. Stead (Lorenzi, 2000, p. 204); functions were later described by Wiederhold and Shortliffe (2001, pp. 182-186).

learning. For instance, learning technologies, supported by educational informatics, can offer interfaces that effectively integrate virtual simulation tools, three-dimensional instantiated models, and data mashups using real-world datasets—all in support of "what-if" analysis behind model-based reasoning development. In addition, in similar ways, educational informatics used in real-world systems can support virtual-world learning environments to help enhance learners' abilities to apply abstract knowledge by situating education in virtual contexts similar to environments in which learners' skills will be used, e.g., virtual hospitals for medical training (Alessandro et al., 2005), virtual Joint Air Operations Centers for network-centric warfare training and education, biodefense learning collaboratories (Alessandro et al., 2005), and virtual pre-deployment training.

Connection to Innovation Triangle. This emerging technology is crossing boundaries and reaching many areas of study. Though well received and established in the medical community, the educational community is still discovering its capabilities and usability. Educational informatics can support meaningful connections and data flow between real and virtual worlds to provide means for using knowledge within immersive synthetic environments, and then transfer insights and acquired skills into higher levels of performance in the real world that can be less forgiving when mistakes are made. Precision learning can introduce prospects to the Air Force education community through social media (e.g., 3-D space delivery and interactivity), mobile learning (mobile apps designed to support Air Force education), and intelligent-tutor systems (one-on-one tutoring, measuring individual attainment, and/or evaluating a program).

Prototyping/Assessment/Implementation Projected Costs and Timeline. Educational informatics can offer considerable benefits for supporting how people learn, and help with integrating decision-support and education services across an enterprise. Harvesting benefits from educational informatics does entail varying levels of system-development effort coupled with organizational change management to address levels of change. Educational informatics design-build efforts can introduce macro or micro levels of change. Participatory design-build efforts, involving prototyping, provide means for the active role of users in the process while helping to reduce resistance and managing realistic expectations (Kautz, 1996). A prototype is a working model involving key features of the system under development. A collaborative design-build CDB approach, involving iterative prototyping, is increasingly used to engage designers, developers, and users in crafting and adapting future education systems (Stricker et al., 2009).

Crafting future education systems often introduces challenges with integrating a myriad of software and information services, many of which rely upon Web-based services using remote access to databases supporting distributed local applications. It is not uncommon for learning enterprises to consist of a variety of purchased (commercial off-the-shelf, or *COTS*), adapted, and in-house developed systems and subsystems that overlap with replicated data and have gaps in service levels for user groups. In addition, making changes to education systems can introduce 2^{nd}- and 3^{rd}-order change effects in the environment or learning ecosystem involving information flows, patterns of communication, perceived influence, authority, and control among users. Introducing new system capabilities also tends to increase tension for change to existing policies, business rules, governance, support resources, and methods of how work is done across learning, instruction, discovery, and administrative areas of the education system. Thus, the use of a CDB approach, involving iterative prototyping, can help to not only ensure that essential features of the system under development are addressed, but also facilitate consideration and planning for anticipated 2^{nd}- and 3^{rd}-order change effects to education systems. Specifically, addressing 2^{nd}- and 3^{rd}-order change effects can introduce prospects for maximizing innovation efforts by introducing orders-of-magnitude improvements to workflows, efficiency levels, quality, and overall service levels not usually encountered through incremental improvements of system features.

- Short (design and development phases): Establish educational informatics test bed of virtual tools and prototype application using intelligent tutors in a serious game supporting a targeted PME subject area (e.g., leadership, campaign planning); construct learning- and performance-assessment rubrics. Duration: 3 months. Cost: $150K.
- Mid (integration and testing phases): Conduct alpha and beta testing of serious game using instructor and student samples and assessment rubrics. Duration: 6 months. Cost: $50K.

- Long (implementation and sustainment phases): Summarize and interpret results for further-action decisions. Duration: 3 months. Cost: $60K.
- Consultant suggestions: James W. Pellegrino (co-chair), Peabody College of Education, Vanderbilt University; Christopher Dede, Graduate School of Education, Harvard University; John R. Anderson, Department of Psychology, Carnegie Mellon University; Wink Bennett, Air Force Research Lab; Nancy Lorenzi, Assistant Vice-Chancellor for Health Affairs and Professor of Biomedical Informatics, Vanderbilt University Medical Center.

A prototyping path of educational informatics builds from fundamental conceptualization of the art-of-the-possible to evaluation. A suggested sequence for a prototyping path is offered here:[16]

- Formulating models for the acquisition, representation, processing, display, and transmission of information or knowledge in support of learning, instruction, and discovery.
- Developing innovative educational technology-based system working examples, using these models, to deliver information and knowledge to users.
- Assessing and refining working examples for increased reliability and validity for functioning as intended in learning environments.
- Studying the effects of implemented systems on the reasoning and behavior of users, as well as on the organization and delivery of educational informatics services for improvements.

Conclusions/Recommendation(s). From relevant observations made, application of educational informatics, functional areas, and intelligent tutors should be closely aligned with the science

[16] The suggested path is an adaptation of a proposed typology of the science in medical informatics offered by Friedman (1995).

and knowledge about how people learn. For example, the following principles about the nature of how people learn can inform thinking about the application of educational informatics:[17]

- Learners interpret every learning experience through an existing mental model (Bransford, Franks, Vye, & Sherwood, 1989; Cognition and Technology Group at Vanderbilt, 1990).
- Acquiring and retaining new concepts and skills can be strengthened when connected and integrated with existing knowledge if learning is active and constructive rather than passive and assimilative (Resnick, 1987).
- Learning is dependent on beliefs, attitudes, affect, and style of learning based on cognitive, sensory, psychomotor, and social factors; tailoring instruction to individual styles can increase learning effectiveness (Cohen, 1987).
- Learning is enhanced by situating learning in an environment similar to that in which the knowledge will be used (Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991).
- Learning is continuous and unbounded; people who treat every situation as an opportunity for growth learn more than those who limit their education to classroom settings (Dede & Fontana, 1995).

Application of the above principles on how people learn can be supported by educational informatics to better support or augment and bridge formal- and informal-learning environments and their representations in both the real world and virtual worlds. The bridging work of educational informatics can support connections and data flow between real- and virtual-world education systems to provide means for using knowledge within immersive synthetic environments, and then transfer insights and acquired skills into higher levels of performance in the real world that can be less forgiving when mistakes are made. Connections and data flow between virtual- and real-world systems, enabled by educational informatics,

[17] The list of learning principles is an adaptation from the list offered by Dede and Fontana (1995).

also support stronger ties between formal classroom learning, on-the-job mobile learning, and on-the-job decision-support systems.

Example of how to demonstrate the capability and usability of educational informatics and intelligent tutors: Developing and testing a version 2 of the simulation game using the simulation gaming kit/framework developed by HQ AU A4/6I, fully utilizing bots, mobile learning (applications/devices), and rubrics. This could be a 1-year joint effort with the Wargaming Institute; content areas from AU schools/programs meeting AF PME learning objectives would be reviewed and utilized.

Appendix D:

Modular Distributed Learning and Portal Services via Cloud Computing

Appendix D

Modular Distributed Learning and Portal Services via Cloud Computing

Overview. There has been exponentially increasing hype about portable digital devices and cloud computing over the past couple of years, and distributed/distance learning (DL) is also experiencing vastly increased interest despite its existence for over a century.[18] This heightened interest is obvious in these headlines from February, March, and April of 2010: "Carnegie Mellon Joins Test Bed for Cloud Computing Research," "Microsoft and Citrix Boost Desktop Virtualization Efforts," and "AT&T Plans $1 Billion Investment in Enterprise Cloud Services"—and these are only three of literally countless stories of industry heavyweights making substantial investments just to keep up with the demand. Granted, these are for-profit organizations, but the Air Force frequently uses the corporate world to model its own practices, which is even more practical with continued budget and personnel cuts looming. Apple is most certainly not the only company to tout for their tech offerings of the iPod, iPod Touch, iPhone, and now iPad, but they most certainly do warrant acclaim for their contributions to the seemingly "mobile-everything" market today. When it comes to actually using those portable devices "at the point of need" as mentioned earlier in this paper, be it for education, training, or just simple socialization or networking, the business world has definitely stood up and taken notice.

Big companies such as IBM, Microsoft, Amazon, and Google have acted upon their previous-year strategies for cloud computing, and smaller companies, even startups, have also begun offering services. With the challenges facing the world, the Nation, and ultimately the Armed Forces, one valid question abounds: Is the U.S. Military anywhere in the mix of these promising technologies? As always, when something is hyped a lot, it is good to ask why anyone should care about it and what benefits may be gained by all concerned. Moreover, when it involves the Department of Defense (DoD) and its forces, increased scrutiny is required because of the nature of the organizations and missions involved, not to mention what is at stake. In the case of military education, the spectrum of those concerned ranges from the end users—the

[18] It is worthy to note that DL can actually be traced back to the early 1700s as "correspondence education," but *true* tech-enabled DL was born in 1910 with the advent of instructional films.

students themselves—all the way to the highest-level stakeholders and decision makers. This section of the paper explores the exciting and oft-mentioned innovations of portable digital devices and cloud computing as they relate not only to each other individually, but also collectively to the “anytime, anywhere” education-and-training needs of the Military.

Although subject to some debate, portable/mobile digital devices generally span the continuum from what were called *PDAs* (for *personal digital assistants*) in their heyday to the ultra-small, powerful, and feature-rich “smart phones” and other like devices everyone now seems to have and be using at any given time. Subject to much more debate, or at least confusion, is what really constitutes cloud computing; and, much of that centers on what it is that even makes something a component of cloud services. Clearing up this issue will affect the choices the Air Force makes in this arena and determine whether “the cloud” becomes a consistently valuable and viable model for military education. Further, the associated digital devices selected and used will depend on the off-premise computing and/or storage chosen by the decision makers, as well as the learning materials’ complexity, file size, and security requirements.

The cloud has become a very handy, very trendy way of describing all things that occur “outside the firewall” as it were. In this context, if it is not happening on premise, it is happening in the cloud—whether it is storage, applications, or computing. To ensure diversity, impartiality, and a higher degree of totality, offered here are several explanations of cloud computing, its benefits, and its vulnerabilities; also, several examples of the growing diversity among handheld mobile devices that may capitalize on this technology for true learner mobility enabled by content portability.

In May of 2010, *Federal Computer Week* (*FCW*) reported that earlier in the year, “Federal CIO Vivek Kundra sent out a challenge to agencies: consolidate their data. With the number of federal data centers nearly tripling in the last 10 years, and their upkeep and maintenance a continuing burden, Kundra underscored the need for the government to get a handle on the sheer volume of information in its trust.” To further punctuate the serious nature of the issue and the need to succeed, he imposed a deadline of June 30, 2010 for agencies to present their data-consolidation plans. One pressing question: “But, where will the data go?”

The *FCW* article does not answer the question outright, but it does offer this: "Cloud computing promises a long-term solution, enabling agencies to migrate their existing data into the cloud. The General Services Administration has already launched its cloud services, and the Defense Department will present an enterprisewide strategy in early 2011." Much discussion is focusing on "the possibilities of cloud computing from a federal perspective, addressing key issues facing its adoption and the evolving role it will play in meeting the federal government's storage needs" (Anderson, 2010, n.p.).

On a smaller scale, cloud computing offers numerous benefits for education in the military environment. The most practical of these are increased/improved access, stability, and mobility/portability of services. Often called *Software as a Service* (SaaS), cloud computing is also sometimes referred to as *Everything as a Service* (EaaS) because of its vast and diverse offerings. It can include the servers, databases, software, or any combination of them. Hosting services have been around for quite some time, allowing focus to be more on business than on the information-technology infrastructure, and even the term *cloud* as it relates to computing traces back to pre-Internet computer networks as a representation of "the thing you connect to." Still, cloud computing has something new and improved to offer, especially as it relates to the contemporary Military.

The ultra-mobile nature of today's Air Force requires server and infrastructure access to effectively support all spikes in demand based on peak hours of day, peak days of the week, and so on, as well as many different time zones. However, most of the time they can manage with smaller capacity. It is logical, then, to start wondering if it is *truly* necessary to own and sustain so much infrastructure that is not fully used much of the time. With a hosting service, the Air Force could buy the needed infrastructure as a service, pay a monthly or yearly fee, and worry less about infrastructure. They would buy the capacity needed, as it is needed, at peak times or otherwise. With cloud computing, they would pay for peak capacity based on usage. The benefits for the Air Force are obvious:

- They do not have to know (or buy) the full capacity they *might* need at peak times. Cloud computing makes it possible to scale the resources available to the application.

There is no need for concern that the first day(s) of a new academic year, class term or session, or other high-demand instances will bog down or jam up the servers.

- They pay only for what they use. It is not necessary to buy servers or capacity for their maximum needs. This alone is often a cost savings.
- The cloud will automatically (or, in some services, with semi-manual operations) allocate and de-allocate CPU, storage, and network bandwidth on demand. When there are few users on a site, the cloud uses very little capacity to run the site, and vice versa.
- Because the data centers that run the services are huge and share resources among a large group of users, the infrastructure costs are lower for electricity, buildings, and so on. Thus, the costs passed on to the Air Force are smaller, or the savings passed on are larger. From either perspective, this bodes very well for a military force and country as a whole that are continually trying to reduce expenditures and ecological footprints.

Gartner, Inc.[x] believes that cloud computing is a way "as an enterprise, to do something they couldn't do before, do it dramatically better, or save a lot of money." They also compare the various benefits of cloud computing and how they will evolve:

> There's an assumption that the major benefit of cloud computing is about saving money—[that] it's about having lower cost. Clearly … there is going to be money that can be saved; but, that's not the number-one thing people talk about who are actually using cloud computing. What they talk about is speed and agility, and low barrier to entry; the ability to get in and get out quickly … so, those are the two elements we think are important: speed and cost; but, today [we] think a lot of the benefits are around speed (Bittman, 2009, n.p.).

Two testimonials speak to the issues of money, time, security, and reliability—all high-priority issues for the Military. The first is Western International University, saving "a considerable amount of money by not having an on-premise software solution. The hardware alone would overshadow the subscription cost, and we don't have additional software to install and maintain. [Our solution provider] has proven over the years to be a company that listens to its customers, asking for product ideas and improvements and incorporating customer feedback into new products and releases. Perhaps most importantly, [their] solutions allow [us] to focus on education, rather than technology" (Wiegand, 2009, 1-2).

The second success story is Northeast Iowa Community College (NICC), which serves nearly 5,000 non-resident students through two main campuses and six outlying centers, with more than 600 faculty and staff in full- or part-time positions. They laud the SaaS products, which are offered via annual subscription, housed in a secure data center, has requisite backup-and-restore functionality, and their service-level agreement provides for a minimum of 99.7 percent system uptime. Moreover, system updates delivered during scheduled maintenance windows ensure that NICC is always on the most current version of the software. There are no upgrades to manage and no version-control issues. The director of computer information systems at NICC summed it up by saying, "We wanted to get technology out of the way of education. This technology does that" (Wiegand, 2009, 1-2).

There is an obvious pattern, and these are just two of endless accounts of how cloud computing has been a win-win initiative: Users were enabled to focus on education instead of system administration, and they also saved money while getting equal or better computing and/or storage hosting. These being civilian entities surely does not make them mutually exclusive from the Military, especially as information and accessibility relate to education; and, the success at NICC demonstrates how DL students and faculty have benefitted from cloud computing. There is no doubt about the truly mobile nature of military learners in today's Armed Forces. As it stands even now, the Military could realistically justify cloud computing solely based on its mission and resulting dynamic. U.S. war fighters must be as mobile as possible—especially when the mission demands it so often—and their essential data/information access should be equally as portable.

Whether it is just for data storage or full-on computing, the cloud would allow the military student to maintain, leverage, and even enjoy that portability inherent to the expectations of, and demands upon, the Armed Forces of today and tomorrow. Out of the necessity to have more access to data and computing power comes the need for the Force to keep up—to give people what they need, balanced of course with the risk involved. Things such as security, up time, reliability, scalability, cost, compromise, ownership, and even dependence must be factored in when considering things like cloud computing and modular distributed learning. However, given those aspects and possible others not listed, the move from the current state of things to a higher, more-ideal state—and soon—lies in the cloud.

In the January 2010 magazine issue of *Chief Learning Officer*, an article titled "Leading Learning Innovation: Leveraging Creativity at the U.S. Air Force," General Stephen Lorenz, commander of Air Education and Training Command, stated, "In addition to recruiting, education, and training, innovation must be one of AETC's core competencies." His belief in cutting-edge programs for education and training (E&T) led to projects focused on social networking, podcasting, virtual classrooms, mobile learning, and online testing security (Lessel, 2010, p. 50). To this point, returning to the larger collective of cloud computing and portable devices, the following is provided from a different, unrelated article in the same publication titled "Learning in 2010: Predictions and Trends": "We are seeing … signals about new learning systems located in the computing cloud and more focused on learners who engage in social, mobile, and contextual learning (Masie, 2010, p. 10).

Even without factoring in the pressing issues of the mobility and portability required of today's Airmen, there are still huge things to seriously consider concerning resources at stake. The January 2010 *eSchool News* (eSN) publication supplement, *Money Matters: Strategies and Solutions Your Schools Need Right Now,* speaks to the very-real budgetary constraints and cutbacks easily used to support the cause for cloud computing. Additionally, the contemporary issues of "going green," "being eco-friendly," or just being good stewards of the environment lead to yet another cogent argument for cloud computing. The financial and environmental costs of operation decrease when energy consumption, printing, individual networks, and computer hardware and software are reduced through desktop virtualization, online collaboration, and network convergence/migration, i.e., the cloud (Stansbury, 2010, pp. 2-3, 6-7). A *Government Computer News* (GCN) article from January 14, 2010 entitled "10 Technologies to Watch in 2010" made some key arguments in support of this:

> 2010 will be a year where every government agency will be expected to have a robust [Web] 2.0 presence just to get to average. The culture changes needed to allow the exposure of increasing amounts of information, even in intermediate form, will take energy to overcome. But, the result is extremely powerful, allowing external interested parties to create mashups and produce much more interesting and often more user-friendly versions of the data, which the government might never have achieved (Yasin, 2010, n.p.).

To quickly revisit the environmental aspect, another GCN article from the same day provides the following concerning desktop virtualization—where all programs, applications, processes, and data reside on a remote central server, so users can access information from almost any secure client device. "Client virtualization is an area that a lot of federal agencies are moving into," said a solutions architect at the Energy Department's Los Alamos National Laboratory. Two years ago, the laboratory created a virtual environment in which officials decommissioned 100 physical servers and deployed 250 virtual machines on 13 physical host servers"; and, from yet another GCN article, "[We] have used virtualization technology to address issues of cooling, limited floor space, and power consumption as [we] sought to ramp up capacity in data centers on the sprawling, 36-mile campus" (Yasin, 2010, n.p.).

Security is always a concern, and even more so for the DoD. The following also comes from the same GCN article series:

> Another movement that will spur deployment of client and desktop virtualization is the emergence of zero-client offerings. With zero-client computing, a client device has no operating system, CPU, or memory. Instead, it connects only a monitor and peripherals, such as a keyboard, mouse, or USB device, back to a virtual desktop infrastructure in the data center.

In addition, "Security-conscious government agencies will certainly appreciate the delivery of a desktop to a stateless device." Also mentioned is the need for organizations to have better visibility into what is going on in the virtual world to protect systems from attack and data compromise, to include the implementation of virtual firewalls, intrusion-detection systems, and intrusion-prevention systems solutions into virtual environments (Yasin, 2010, n.p.).

As with most things new or different, a few key elements are necessary from the very beginning to ensure success. First, concerning security, experience has shown how implementing advanced learning technologies (ALT) can readily comply with security and intellectual property policies if managed properly from the very beginning of the project. This includes strategies to mitigate risk and help to deliver a compliant platform with the enormous potential ALTs offer. Second and third crucial elements are teamwork as the backbone of the project and an executive sponsor who fully supports its purpose, principles, *and* funding requirements.

When it comes to Airmen-learners, it is imperative to stay on the cutting edge. An American Research Institute article on 3-D immersive learning states:

> In the ever-evolving and competitive world, it is no surprise that learning processes are also changing and promising an enhanced, more-fulfilling experience. New technologies are influencing the ways people live, work, and learn. From the Digital Native population (typically under 38 years of age), the Digital Immigrants of the world (typically over 38) are now realizing the power and value of interactive learning. … Several exciting technologies are now driving fundamental improvements in the way learning is delivered. Examples include serious games and simulations, virtual reality, and social networking. … In today's world, we learn teamwork and leadership in multiplayer online games, competitive/challenging simulations, creativity, and exploration in virtual worlds, and social interaction in social networks. Since many existing learners are most likely already using one or more of the social-interaction networks, the learner is a willing and enthusiastic participant.

It concludes by saying it is a great advantage that contemporary military learners are already well accustomed to technology-enabled learning; and, some may argue, desire or even require it to truly improve and increase learning performance (American Research Institute, 2010, pp. 1-3, 5-6).

Connection to Innovation Triangle. This rapidly emerging innovation can leverage advances occurring in the science of human learning and assessment, particularly as enabled by newer forms of mobile-technology mediation. Done correctly, point-of-need learning materials and experiences could introduce the new generation of Air Force education enabled by social media, mobile learning, and cloud computing. Web 2.0 and mLearning are teaching tools generally believed by higher-education institutions to be effective for motivating and engaging students via learner-centered approaches and techniques. These are demonstrated in Vygotsky's adaptive learning-and-assessment framework, which asserts that social interaction plays a fundamental role in the development of cognition. His findings suggest that learning environments should involve guided interactions, such as those offered in individual/team challenges and problem-solving exercises, permitting students to reflect on inconsistencies and change their perspectives through communication. Mobile technology, Web 2.0 tools, and modularized curricula are well suited to create a social-learning environment for the mobile student, allowing them to collaborate with others around the world to increase their understanding of complex issues and concepts.

Prototyping/Assessment/Implementation Projected Costs and Timeline. This innovation prospect would be best evaluated for larger-scale implementation over a span of integrative prototyping:

- Short (design and development phases): Determine provider most and best capable of delivering campus services via cloud computing. Prototype a framework for accessing the selected services for Air Force educators. Expected duration: 3 – 5 months. Estimated cost: $120K.
- Mid (integration and testing phases): Conduct alpha and beta testing of selected cloud services and apps; construct learning and performance-assessment rubrics using instructor and student samples. Expected duration: 8 – 10 months. Estimated cost: $30K.
- Long (implementation and sustainment phases): Summarize and interpret results for further-action decisions. Expected duration: 10 – 12 months. Estimated cost: $20K.

Conclusions/Recommendation(s). This section of the paper has one overarching message concerning military education and what can be done today to properly prepare for tomorrow: There are vast benefits of technology-enabled education that warrant serious consideration by the U.S. Military. Using innovation to leverage cutting-edge technologies for educating military students and providing networked social-learning access and/or services is meeting them where they already are and capitalizing on their knowledge and comfort levels with current technologies. Cloud computing, portable access via smaller and more powerful devices, mobile apps, collaborative and hybrid educational courses, conserving resources, and being good stewards of the environment are already in place and being used or practiced throughout the world. The ease and cost-efficiency of upward and downward scalability of cloud computing is just one argument in support of adopting and adapting this rapidly emerging technology and the mobile-device-enabled modular education from which the Military could benefit.

The fundamental elements of education may never change, but the methodologies for ensuring optimum educational experiences and their results continue to advance at seemingly exponential rates. Secure, reliable, innovation-driven, technology-enabled-and-enhanced methodologies for bettering the highly mobile Force—for delivering learning content at the point of need—are the ways to do business in the 21st Century, and cloud computing is the enabler to ensure the U.S. Air Force's place as the best-educated, most-advanced, and always-mobile force in the world.

Appendix E:

Weak-Tie Networking and Peer-Based Learning

Appendix E

Weak-Tie Networking and Peer-Based Learning

Overview: Peer-based (or networked) learning is defined as a "process of developing and maintaining connections with people and information, and communicating in such a way to support one another's learning" (Networked Learning, 2010). It may also be seen as the process of computer-enabled learning specifically acquired through the interaction with domain-specific peers. Mark Granovetter (1973, 1983) argued that weak interpersonal ties define most social networks in society as well as account for the greatest novelty of ideas and information passing through such networks. A weak interpersonal tie is defined as a network consisting mostly of acquaintances. Consequently, novel information tends to flow through weak-tie rather than strong-tie networks since acquaintances are more likely to know people not generally known to others in the network.

People have always learned by communicating with other people. Charles Darwin wrote more than 15,000 letters to his colleagues to refine and share his thinking, and these "were one of the most important means by which he gathered data and discussed ideas" (Darwin's Letters). He discussed his "ideas in correspondence with other notable scientific figures such as the geologist Charles Lyell, the botanists Asa Gray and Joseph Dalton Hooker, the zoologist Thomas Henry Huxley, and the naturalist Alfred Russel Wallace."

Emerging technologies (e.g., email, discussion boards, and social networks) have allowed people to have instant access to peers. Cloud-computing technologies (e.g., wikis) have made it possible for domain experts to add their knowledge to the network, which is then available for anyone to reference. Cloud applications like Google Docs and Microsoft Business Productivity Online Standard Suite (BPOS) allow real-time editing of documents by many people, creating a multiplying effect in productivity and learning. It is becoming more common for people to use their mobile devices to access these capabilities to retrieve just-in-time information, ask a colleague a question via email or instant message (IM), or post a question to a discussion board for other experts in the domain to answer.

Peer-based learning, also known as *networked learning,* is a valued commodity amongst Airmen. One of the unique benefits in-resident students get out of their academic experiences is what they learn from their fellow Airmen, both in and out of the classroom. These formal and informal discussions consist of sharing their experiences with their colleagues and providing feedback on how situations were handled. A. Barabási (2002) states that each person provides others with varying learning experiences, and the community as a whole becomes the curriculum and the classroom. According to Siemens (2004), when knowledge is needed, but not known, the ability to plug into sources to meet the requirements becomes a vital skill. As knowledge continues to grow and evolve, access to what is needed is more important than what the learner currently possesses.

We derive our competence from forming connections (Siemens, 2004). Since the cognitive load would be too great for us to experience everything ourselves, other people (the network) become our source of knowledge.

Peer-based/networked learning can be either formal or informal in structure. The focus of this section is on the *informal* form of learning, which can be obtained by unstructured interaction with fellow learners and experts in their domains. The 2008 Horizon Report calls this kind of learning "collective intelligence" and predicts it "will see educational applications for … explicit collective intelligence—evidenced in projects like the Wikipedia and in community tagging" (Horizon Report, 2008). According to Marsick and Watkins (2001), **"**Informal and incidental learning take place wherever people have the need, motivation, and opportunity for learning." In the same work, the author notes that informal learning can be characterized with the following attributes:

- It is integrated with daily routines.
- It is triggered by an internal or external jolt.
- It is not highly conscious.
- It is haphazard and influenced by chance.
- It is an inductive process of reflection and action.
- It is linked to learning of others.

According to Mark K. Smith (Introducing Informal Education, 2009), informal education “works through, and is driven by, conversation, involves exploring and enlarging experience, and can take place in any setting. Air Force members need a way to access a network of their peers to tap into the vast knowledge available when and where they need it.

Lifelong learning has become necessary to keep up with the rapidly changing world of technology, innovation, and learning. Lifelong learning is the “lifelong, voluntary, and self-motivated” (Department of Education and Science, 2000) pursuit of knowledge for either personal or professional reasons. As such, it not only enhances social inclusion, active citizenship, and personal development, but also competitiveness and employability (Commission of the European Communities, 2006).

The idea of lifelong education was first fully explained in the early 20th century by Basil Yeaxlee.[19] Together with Eduard Lindeman, they provided an intellectual basis for a complete understanding of education as a continuing necessity of everyday life (Smith, 1996, 2001). When it comes to lifelong learning, Air Force PME does not necessarily meet the needs of all Airmen or the Air Force. For example, most AF PME is restricted to short periods of intensive in-resident or distance-learning situations followed by periods of no formal PME learning. That is to say, there are no formalized programs of continuation learning that would reinforce the lessons learned while in formal PME. For example, the current Senior NCO Academy course is completely asynchronous with no interaction with a live instructor or other students.[20] Ideally, learning should begin before formal PME classes start and then continue until the learner attends their next scheduled PME opportunity. Peer-based/networked learning could be the bridge that spans these gaps between formal learning opportunities.

Finally, mobile access to these learning opportunities has become part of daily life for digital natives (and, more and more, the digital immigrants) who demand instant access to the boundless learning resources available on the grid when and where they want them.

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[19] Basil Yeaxlee's place in the canon of adult education was achieved through the publication in 1929 of *Lifelong Education*. This book, according to Angela Cross-Durran, “represents the first formal attempt this century to combine the whole of the educational enterprise under a set of guiding principles with each phase of agency (formal, informal and non-formal) enjoying equal esteem.”

[20] This information verified via personal email communication with Mr. Frank Mileto.

As Schwartz notes, networked learning can be successful because “Feeling that one is contributing something to others appears to be especially motivating.” Furthermore, McCombs states, “Learners of all ages are more motivated when they can see the usefulness of what they are learning and when they can use that information to do something that has an impact on others.” Vygotsky notes that “The emphasis on establishing communities of scientific practice builds on the fact that robust knowledge and understanding are socially constructed through talk, activity, and interacting around meaningful problems and tools” (National Research Council, 2000).

Finally, Terry Anderson[21] (2008) defines social-learning tools (educational social software) as “networked tools that support and encourage individuals to learn together while retaining individual control over their time, space, presence, activity, identity, and relationship.”

Problems: Learners in general are not always willing to share their knowledge in online forums. Military learners are no different, being at least as unwilling to share their knowledge online as their civilian counterparts. It can be expected that as the workforce transitions to domination by the digital natives’ adoption of social learning will increase. Until then, sharing-averse learners will need to be coaxed into contributing to the greater good of their professional communities. In *Influence on Willingness of Virtual Community’s Knowledge Sharing: Based on Social Capital Theory and Habitual Domain* (2009), the authors conclude the following:

- Individuals trust that their contribution efforts will be reciprocated by other members therefore it is important for members to reward individual efforts.
- Individuals are more likely to contribute to virtual learning communities if they have strong direct ties to a large proportion of the community.
- Learners with more experience in the field are better able to understand how their expertise is relevant, and are thus better able and willing to share.
- It is interesting for individuals to help others with challenging problems and doing so makes them feel good.

Anderson, T. (2008). Social software to support distance education learners. In T. Anderson, *The Theory and Practice of Online Learning* (p. 227). Edmonton, AB: AU Press.

- Learners who make a habit of sharing their knowledge will begin to share unconsciously if they consider this habit to be valuable.

Additionally, operational security will always be a concern. Learning communities focused on operational or sensitive topics must be secured to the extent that operational data not intended for public release is protected.

Connection to Innovation Triangle. Successful implementation of this emerging use of technologies could transform how Air Force war fighters are educated, during distance as well as in-resident courses; and, more importantly, how they continue to share their acquired knowledge within their domains with colleagues between formal education opportunities. As long as the latent knowledge gained by individuals continues to remain locked within them, the compounding effects of networked learning opportunities and the operational advantages this learning would facilitate will not be realized.

Prototyping/Assessment/Implementation Projected Costs and Timeline. Design and develop forum-style learning-module prototype using design-studio methodology and rapid prototyping to include a comprehensive change-management module and appropriate taxonomy. The purpose of this prototype would be the soliciting, organizing, and compiling of leadership lessons learned from returning war fighters for the ultimate purpose of integrating those into immersive scenarios. At Air University, there already exists an established framework for implementing networked informal learning by means of the Air Force Forums. Squadron Officer College (SOC) is currently using the system for programs focused on network-learning opportunities for commanders, lieutenants, and other closed communities of practice. This tool would be appropriate for the data-collection phase of this prototype. The owners of this system have some available licenses for small-group prototyping and assessment. Assuming licenses are still available or that a potential user has funds to expand the license base, this system is currently available for prototyping at very little cost. Current users of the system have extensive knowledge and data, which would expedite prototyping and implementing a test plan.

Using the data mined from the data collection phase, design and prototype a 3-D world immersive environment in support of weak-tie networking among peers to create scenarios to integrate operational leadership lessons learned from returning war fighters into PME; construct learning and performance assessment rubrics.

- Short (design and development phases): AU Innovation Analysts work with identified faculty from the curriculum area in all phases. Design and develop a forum capable of collecting leadership experiences from returning war fighters to include peer-based collaboration and evaluation of the material. Design and develop a notional scenario in the 3-D immersive space based on a representative leadership topic. Expected duration for design and development phases: 6 months. Estimated cost: $150K (reflects internal costs associated with staff and faculty time on project).
- Mid (integration and testing phases): Conduct alpha- and beta-testing sequences, and analyze test data for refinements and decision points for continuation of effort. Expected duration: 12+ months. Estimated cost: $260K (reflects internal costs associated with staff and faculty time on project).
- Long (implementation and sustainment phases): Based on test results, implement proven innovation into selected Air Force curriculum areas via rapid curriculum-design adaptation methods. Establish sustainment services. Expected duration: 12 months (or longer, depending on the scale of implementation). Estimated cost: $150K (reflects internal costs associated with staff and faculty time on project).

Conclusions/Recommendation(s). Implementation of this emergent innovation of integrating informal learning, lifelong learning, peer-based learning, and mobile delivery could greatly increase the synergies possible when people can take advantage of the collective knowledge of others in their domains. One of the biggest hurdles for successful implementation of this technique will be to change the culture of maintaining knowledge silos within individuals and organizations. Unless this cultural and personal bias can be overcome, the long-term value of peer-based learning in the Air Force will be greatly reduced. Therefore, a change-management plan must be developed and implemented to show the value to the students.

Recommend prototyping of this emergent innovation by Air University educators, in collaboration with colleagues across the Global Learning Forum, using the above-suggested timeline. If approved, detailed project timelines, cost tracking, and project milestones and deliverables can be identified and tracked using an AU Innovation Portfolio-Management plan.

Appendix F:

Linkage of Learning, Performance, and Decision-Support Applications

Appendix F

Linkage of Learning, Performance, and Decision-Support Applications

Overview. In today's ever-progressive world of new and exciting innovative technologies, there is an increasing movement within institutions of higher education (IHE) to implement new methods of providing instruction that is more conducive to learning from the perspective of today's students and those of the future. It is commonly believed that today's learners are more comfortable (as digital immigrants) learning with the technologies they have become accustomed to in their daily lives. Traditional "1.0 methods" of instruction are inadequate and do not allow them to make use of the technological resources currently available to them. This is because of the traditional constraints that do not allow them to learn through research and experimentation outside the classroom walls. These technologies, however novel and sometimes controversial, do provide the learner with the ability to collaborate and experience their world through rich media, as well as a multitude of online and mobile resources anywhere and at any time.

The definitions of Web 2.0 and mobile learning (mLearning) vary. Web 2.0 technologies generally feature free, hosted services that enable users to post and share content. These include social-networking sites, video-sharing sites, wikis, and blogs. Roughly speaking, Web 1.0 highlighted one-way communication from a website to its users. Web 2.0 enables much richer, two-way communication that includes the users themselves. Web 2.0 technologies can help the Federal Government foster a sense of community, increase transparency, and provide ways for more people to participate in governmental processes.

According to *Wikipedia*, mLearning has different meanings for different communities. Although related to eLearning and distance education, it is distinct in its focus on learning across contexts and learning with mobile devices. One definition of mLearning is any sort of learning that occurs when the learner is not at a fixed, predetermined location, or learning that occurs when the learner takes advantage of learning opportunities offered by mobile technologies. In other words, mLearning remedies the limitations of learning location with the mobility of general portable devices. The term covers learning with mobile (or portable) technologies, including but not limited to handheld computers, MP3 players, notebooks, and mobile phones. MLearning focuses on the mobility of the learner interacting with portable technologies, and learning that reflects a focus on how society and its institutions can accommodate and support an increasingly mobile population ("MLearning," 2010, n.p.).

MLearning is convenient in that it is accessible from virtually anywhere. Like other forms of eLearning, mLearning is also collaborative; sharing is almost instantaneous among everyone using the same content, which leads to the reception of instant feedback and tips. MLearning also brings strong portability by replacing books and notes with small RAM-enabled devices filled with tailored learning content. In addition, it is simple to utilize mobile learning for a more-effective and entertaining experience.

The dominant issue within many IHEs appears to be that today's learner has a much better understanding of, and proficiency with, these technologies than the faculty. So the questions become, how can the gap be closed? How long will it take for future leaders to be taught by educators who can and will take full advantage of the available technological resources ?

A single indisputable fact is that military students are currently using these tools to connect with other people outside their physical spaces, and to learn in ways that were not even imaginable just 10 years ago. According to Richardson (2009), "This tectonic shift of connections has huge significance for the way we think about our roles as educators, our classrooms, and most important, our own personal learning." There is a growing consensus that Web 2.0 social Web tools such as wikis, blogs, and podcasts, as well as larger network sites such as Twitter, Facebook, LinkedIn, and YouTube have important implications for the learning lives of students. However, despite that fact, many institutions still refuse to consider their introductions into the classroom. Furthermore, Richardson also states that while the world changes around us, we continue to ignore the realities of what Dov Siedman (2007) refers to in his writings as the "hyperconnected and hypertransparent" future in which the next-generations' kids will be living (n.p.). Simply stated, Web 2.0 tools are generally not being used by children for learning because parents, adults, and/or educators have no understanding of how these tools can be used to facilitate learning in positive ways—not just as a social-networking platform for connecting with others, but to learn how to learn on their own.

Although students may be able to use a range of digital technologies, evidence suggests they use them in relatively shallow ways when it concerns their learning. Institutions need to establish a digitally literate teaching culture if they are to support positive experiences and strategies on the part of students. It will become increasingly important for teaching staff to become much more literate concerning mLearning and Web 2.0 technologies. Students in the future will expect faculty to know how to use these tools appropriately and competently, with consistency, and with a clear rationale for the technology that will enhance their experience of learning.

Many development projects have explored the potential of Web 2.0 technologies to enhance the experience of higher-level study. There is now a considerable body of evidence linking the social affordances of Web 2.0 with academic practices such as shared knowledge-building (through wikis, social bookmarking, and folksonomies), peer review (through tagging, recommending, and rating), freedom of ideas (through open content, open-source software, blogs, and discussion sites), personal research (through new tools for navigating and analyzing information spaces), and specialist communities of interest (through community sites).

According to Attewell (2005), there is a project underway to develop a practical, easy-to-use mobile-learning toolkit for instructors. The project is inspired by a four-year mLearning project that included planning, research and development, plus reflection and large-scale trials of mobile-learning systems and learning material with hard-to-reach learners in diverse situations in three European countries. Attewell suggests that the experience of the project and lessons learned can also inform the work of other research-and-development projects and those working to implement mLearning systems or to embed mobile-learning elements into education or training.

The project developed learning material and systems accessed on or via handheld mobile devices intended to stimulate an interest in learning and to assist with improvement of literacy, numeracy, and life skills. The project explored whether the enthusiasm of young adults for mobile phones can be harnessed to encourage participation in education and training. One result was to determine whether mLearning can result in improved literacy, numeracy, or changed attitudes or behavior, including greater enthusiasm for learning and progression to further learning.

Findings from the work indicated that mobile learning:

- Allows true anywhere, anytime, personalized learning.
- Can be used to enliven, or add variety to conventional lessons or courses.
- Can be used to remove some of the formality which non-traditional learners may find unattractive or frightening and can make learning fun.
- Can help deliver and support literacy, numeracy, and language learning.
- Can help learners and teachers recognize and build on existing basic-literacy skills that allow young people to communicate in notational form via text messages.
- Facilitates both individual and collaborative learning experiences.
- Enables discrete learning in the sensitive area of literacy.
- Has been observed to help young disconnected learners to remain more focused for longer periods.
- Can help raise self-confidence and self-esteem by recognizing uncelebrated skills, enabling peer-to-peer learning, and supporting non-threatening, personalized learning experiences.

Some of the key lessons learned during the mLearning project were:

- A mixture of online learning and learning using materials previously downloaded onto handheld devices helps reduce costs as well as the inconvenience of signal disruption when traveling or poor signal in some remote rural areas.
- The use of software layers to insulate learning materials from device-specific features and delivering learning materials in a browser helps overcome some lack-of-standards issues, but does not offer full platform independence.

- Attempting to deliver a monolithic mobile-learning system leads to inflexibility, limits ability to take full advantage of the heterogeneous mixture of hardware and services available, and detracts from facilitating blended approaches to learning delivery.
- An iterative approach to development informed by learner feedback results in better learning materials and systems.
- While it is possible to re-purpose learning materials developed for desktop- or laptop-computer delivery to run on mobile devices, this approach may not make best use of the strengths of the mobile technologies.
- A flexible, collaborative, and pragmatic approach to development works well in an environment where the technologies are new and standards are evolving. This is aided by working within a small consortium.
- It is important to be aware that when delivering learning or offering support services to learners' mobile phones, one is encroaching on their personal space.
- For the target audience, teacher/mentor enthusiasm and involvement seem to be very important for successful mobile learning. Sufficient training preceded by training needs analysis is important for teachers/mentors as mobile literacy and confidence varies.
- Fast response to mentor and learner problems is crucial to avoid disillusionment and stalling momentum, and proactive support for those just starting to support mobile learning plus ongoing access to advice is helpful (n.p.).

Batson (2008) suggests that although a significant amount of research supports the use of mobile-learning and Web 2.0 technologies, there is still a great amount of concern over how these instruments can be used in learning. Moreover, many concerns derive from the current use of these technologies and the opportunity for students to learn the wrong things. However adequately structured, students may find themselves wandering off the expected path on the Web when in search of materials related to an assignment. It is human nature to explore and learn through discovery, but can students be trusted to learn the right things on their own? A classical school of thought is, if you want students to learn, you need to tell them what is right, rather than taking a more conventional approach, which is to let them discover and learn for themselves within a learning structure created for them.

According to Batson, for others to trust students to learn by their exploration of Web 2.0, they must first feel safe “out there” themselves. He believes that with daily use, trust in this technology will increase. However, measures must surely be taken to safeguard the information presented and shared in these environments (n.p.).

Connection to Innovation Triangle. When you integrate learning and assessment sciences with mobile-app technologies, the capability exists to span across learning, performance, and decision-support environments. This capability helps to bridge between informal and formal learning with on-the-job application of new knowledge and skills.

Prototyping/Assessment/Implementation Projected Costs and Timeline. This is an innovation prospect best evaluated for larger-scale implementation over a span of integrative prototyping:

- Short (design and development phases): Design and develop an integrated application prototype consisting of Web 2.0/mobile-technology-based instructional content, performance-assessment activities/exercises, etc., and a decision-support tool that will link the learning experience to “real-world” applicability. Design and develop the prototype using design-studio methodology and rapid prototyping. AU Educational Technology Innovations Analysts work with identified faculty from the curriculum area in all phases. Expected duration for design and development phases: 6 – 9 months. Estimated cost: $50K (reflects internal costs associated with staff and faculty time on project and cloud services used for rapid-prototyping activities).
- Mid (testing phases): Conduct alpha and beta testing sequences, and analyze test data for refinements and decision points for continuation of effort. Expected duration: 3 – 5 months. Estimated cost $70K.
- Long (implementation and sustainment phases): Based on test results, implement proven innovation into selected Air Force curriculum areas via rapid curriculum-design adaptation methods. Establish sustainment services. Expected duration: 9 – 12 months (or longer depending on the scale of implementation). Estimated cost: >$150K.

Conclusions/Recommendation(s). A number of institutions of higher education are committing to study and explore the impact(s) Web 2.0 and mobile-learning technologies can have on learning outcomes. This testing has already reported astonishingly positive results. It is not a matter of *if* the technology will be advanced enough to become standard practice throughout institutions of higher education, but rather a matter of *when*. Consequently, it may be in the best interest of Air University and the Air Force to collaborate with these institutions to prototype Web 2.0 and/or mobile-technology-based applications, which will link learning content to an expected performance-activity application and decision-support application. The benefit of the prototype would be to produce an integrated system of applications that would allow students to practice and apply what they have learned to "real-world" issues and situations they may encounter on the job.

One of the challenges facing the Military and academia today is the development of curricula that support competency-driven objectives using mobile and Web 2.0 technologies. Currently, there are numerous "Web-2.0" technologies and social-software tools being used throughout the world that allow educators to create content with a new set of dynamics leading to increased user-led content and knowledge production that is transforming higher-education curriculum and instruction. These tools enable educators, allowing them to apply the different ways in which social-computing applications can be used for teaching and learning, and implement changes to pedagogy based on greater learner control, agency, and engagement in content creation, as well as peer-to-peer sharing and review of ideas (Lee, 2006, 832-848).

The following identifies several of the tools currently available to educators to create a Web-2.0 learning environment. These tools may be used to create a mobile-learning environment as well. The information below is provided from the book, "Web 2.0: New Tools, New Schools":

Blogs

A *blog*, short for *Web log*, is a set of personal commentaries on issues the author deems important. It contains text, images, and links to related information on other blogs, Web pages, and media. Readers can reply easily and thus participate in discussions in which they share knowledge and reflect on topics. Blogs promote open dialogue and encourage community building in which both the bloggers and the commenters exchange opinions, ideas, and attitudes. Examples of blog-service websites include Blogger, WordPress, and Drupal.

Instructors can use blogs to publish instructional materials that students can access to read and/or download, and where they may make comments. Instructors can also let students set up their own blogs for a particular subject or for several subjects and then assign tasks to students. The tasks should be done using blogs (i.e., publishing articles and sharing them with other students). While the students develop their own blogs, instructors can observe and monitor the students' progress and identify the learning needs that have not been considered (e.g., students may directly or indirectly express their doubts on blogs). As the information on students' blogs is growing, instructors need to classify, summarize, and evaluate the different blogs and then publish their opinions, directions, and feedback using their own blogs or class blogs. By doing this, instructors are actually putting students on the right track, because when allowing students to publish whatever they like, the blog could get out of control, and the relevance between the blog, the content taught, and the desired learning will be reduced.

Wikis

A wiki is a Web page, and, as such, it is accessible to anyone with a Web browser and an Internet connection. This is where the similarity to a traditional Web page ends, because a wiki allows readers to collaborate with others in writing by adding to, deleting from, editing, and/or changing the Web page's contents at any time. Its ease of use makes a wiki an effective tool for collaborative authoring. Examples of wikis are Wikipedia, Brainkeeper, and various Government forums such as Intellipedia.

Wikis' implications for education include group collaboration and problem solving, peer editing during the writing process, and electronic portfolios. Students can work from anywhere, which means they are able to contribute on their own schedule rather than being limited to the class period. Wikis keep track of changes, so instructors can look at successive versions of documents for electronic portfolios or the contributions each student has made. When the work is complete, students can ask others to read their work and comment. Instructors can use wikis for students to collaborate on documents by writing, editing, and revising them in their own classes; across a grade, school, or district; or even outside those traditional boundaries.

Social Bookmarking

Social bookmarking is a Web-based service that displays shared lists of user-created Internet bookmarks. Instead of keeping long lists of “favorites” in their own browsers, people use these Web sites to organize, rank, and display their resources for others to see and use. They classify the content using tags based on folksonomies of community-acceptable keyword classifications. Examples of social-bookmarking services include Delicious, Backflip, and Furl.

Social-Networking Services

Social-networking services are online communities of people who share interests and/or activities, or who are interested in exploring the interests and activities of others. Most social-network services are web based and provide a variety of ways for users to interact, such as e-mail and instant-messaging services. The main types of social-networking services are those containing category divisions (such as former school year or classmates), means to connect with friends (usually with self-description pages), and a recommendation system linked to trust. Popular methods now combine many of these. Popular social-networking sites include Facebook, MySpace, Twitter, and LinkedIn.

Using social-networking sites for educational purposes is not solely for the purpose of giving students permission to use social-networking sites such as Facebook and MySpace, but to create a special social environment and tailor it for particular learning objectives. This process includes defining educational outcomes, defining themes and/or topics of the sites, and using typical social-networking sites’ features to design and facilitate learning activities.

RSS

RSS, which is short for *really simple syndication*, is a family of Web-feed formats used to publish frequently updated works, such as blog entries, news headlines, audio, and video in a standardized format. An RSS document, which is called a *feed*, *Web feed*, or *channel*, includes full or summarized text, plus metadata such as publishing dates and authorship. Web feeds benefit publishers by letting them syndicate content automatically; and, they benefit readers who want to subscribe to timely updates from favored websites or to aggregate feeds from many sites into one place. RSS feeds can be read using software called *RSS readers*, *feed readers*, or *aggregators*, which can be web based, desktop based, or mobile-device based.

Podcast

Podcast is a way to distribute multimedia files such as music or speech over the Internet for playback on mobile devices and personal computers. The term *podcast*, a word created by combining Apple's *iPod* and *broadcast*, can mean both the content and the method of delivery. Podcasters' Web sites may offer direct-download or streaming audio, and a podcast is distinguished by its ability to be downloaded automatically using software capable of reading RSS feeds.

In education, podcasting is a convenient way of automatically downloading audio or video files students can then download to a mobile device or computer. *Podcast* generally refers to audio; *video podcast* (or *vodcast*) refers to the distribution of video files in the same manner.

Online Photo Sharing

Flickr is perhaps the best known of the free online photo-management and photo-sharing applications. Rather than sending photos from desktops and cell phones to friends and family using e-mail, people can post them on Flickr and invite people to view them in online albums or slideshows. They can add notes and tags to each photo, and their viewers can leave comments, notes, and tags as well. Tags are searchable so it is easier to find related photos later. Other examples of online photo-sharing sites include Webshots and Photobucket (Solomon & Schrum, 2007, pp. 55-64).

Appendix G:

3rd-Space Virtualization of Learning Environments

Appendix G

3rd-Space Virtualization of Learning Environments

Overview. The growing availability of cost-effective, virtual-world technology to simulate interactions in the real world has re-emphasized their value (Prentice, 2009). The ease with which real-world geospatial data can be imported into the virtual environment makes creating realistic "mirror worlds" a viable option for training, engagement, and familiarization. Virtual worlds provide a powerful, collaborative environment; however, to minimize the risk of failure due to excessive enthusiasm and too-rapid expansion, it is important to stress the value of evaluating and prototyping technologies based on the needs of the organization and expected curriculum outcomes. Past technology initiatives have shown it is common for educators to fail to evaluate or prototype technology efforts, and this often results in their discovering the technology implemented is not applicable to the expected need or outcome.

Online interactive technologies have the potential to reach students at home, in their dorms, between classes and work, and on weekends. Over the past 5 years, there has been rapid growth in virtual-world applications, with over 180 worlds in operation or under development. Two of the most well known are Second Life and OpenSim. A virtual world is defined as an interactive simulated environment accessed by multiple users through an online interface. The largest and most common type of virtual world is the *MMORPG*, which stands for *Massively Multiplayer Online Role-Playing Game*. According to ongoing surveys of the MMORPG sector carried out and published at *MMOGCHART.COM*, there are approximately 16 million active subscriptions to MMORPGs. Keep in mind the gaming sites count subscriptions rather than subscribers (players may maintain several accounts), and it is unclear in some cases whether subscriptions during the initial free trial period are included. Nevertheless, most (allowing for an element of counting free subscriptions) of these numbers represent individual accounts that are being paid for—generally a good indication of active usage (Baker, 2009, pp. 59-65).

Social-media websites such as Facebook and MySpace can be considered virtual environments with games like Yoville and Farmtown, where people socialize in environments of their choosing by using an avatar. Social-networking worlds are effectively providing a Web *place* to residents, rather than the typical Web page offered by conventional social-networking sites. They tend to offer residents a personal space—usually borrowing the “room” metaphor—and encourage the personalization of the space through the purchase of items. Critical to the success of these environments is an emphasis on continual activity, staging events, concerts, and new products to drive individuals to return on a frequent basis. This can best be likened to programming a television station and emphasizes the role of virtual worlds as an immersive media and communications channel, rather than a content-creation environment.

In addition to the traditional fantasy role-playing and social-networking worlds, there are many commercial community-focused virtual worlds that emphasize socializing rather than gaming. These worlds offer a more open-ended experience and are strongly influenced by the cultures of text-based chat rooms. Although small in scale, casual games may be incorporated into a social world where participants are not necessarily there to play or win a game, but rather to socialize with others and, in many cases, create and decorate a personal space such as a home, room, or apartment. Virtual worlds have also been built for purposes other than gaming.

The use of 3-D immersive environments for live, virtual, and constructive (LVC) applications and augmented reality offers educators the flexibility of a variety of stimuli to enhance learning by reaching a specific outcome. Learning through simulated real-world context is not a new idea, with the most-recognized use of LVC found within military training.

Live, Virtual, and Constructive

What is LVC? Commonly accepted definitions of live, virtual, and constructive systems are provided here:

- Live Systems – Involve real systems operating with real people in the real world. An example is air-combat training where real aircraft are operating in the real world against real adversaries.
- Virtual Systems – Involve real people operating real equipment that simulates a platform in a simulated environment. An example is an aircraft trainer where real pilots operate a trainer that simulates a real aircraft operating in the real world.

- Constructive Systems – Involve simulated people in simulated environments, where all entities and activities are simulated. Constructive simulations are typically used in theater- and command-level training scenarios.

Integrating LVC systems enhances the realism of test and training scenarios and can also provide scenarios difficult to achieve with only live systems. Test and training scenarios with LVC interactions can provide meaningful training and help achieve the Department of Defense goal of high fidelity, cost effectiveness, and enhanced test and training capabilities (Testa, 2006).

Building on the foundation of simulation, the ability to link multiple systems together and enable multiple individuals to interact in a common virtual space has extended the role of virtual worlds into human-based, complex, nondeterministic scenarios. Role-playing scenarios are widely used and recognized as effective training environments, and typical examples include military exercises, emergency services, and disaster scenarios. The advantages of cost, safety, and the ability to repeat exercises are clear. Leading vendors who have concentrated on this space include Forterra Systems and ProtonMedia; however, many organizations have created effective environments in generic virtual worlds, such as Second Life (Prentice, 2009).

Augmented Reality

Another concept used over the years in movies, commercials, and mobile devices, adding a sense or presence to the user, is augmented reality. Augmented reality (AR) is a variation of virtual environments (VE), or virtual reality (VR) as they are commonly called. VE technologies completely immerse a user inside a synthetic environment. While immersed, the user cannot see the real world around him. In contrast, AR allows the user to see the real world, with virtual objects superimposed upon, or composited within, the real world. Therefore, AR supplements reality rather than completely replacing it (Azuma, 1997).

Columbia University computer science professor, Steve Feiner, and Ph.D. candidate Steve Henderson have created their Augmented Reality for Maintenance and Repair (ARMAR) project. It combines sensors, heads-up displays, and instructions to tackle the Military's maintenance needs. Imagine putting on a pair of special goggles to investigate a car's engine or a computer's innards, and the details needed would pop up. That is the sort of idea ARMAR is trying to implement, although initially only for the Military (Arthur, 2010). The following are examples of how AR can be used:

Education: Augmented-reality systems in combination with other technologies such as WiFi could be used to provide instant information to its users. For educational purposes, AR systems can be employed to view a panoramic recreation of a historical event superimposed on its real-time background. Students could use this system to have a deeper understanding of things like the formation of clouds, the structure of the universe and the galaxy, etc., through realistic and easily understandable AR systems simulations.

Defense: The Military, particularly the Office of Naval Research and the Defense Advanced Research Projects Agency (DARPA), are some of the original pioneers of AR systems. One of the main uses of these systems for the Military is providing war fighters in the field with crucial information about their surroundings, as well as friendly troops and enemy movements in their particular area. Augmented-reality systems will also play a big role in law-enforcement and intelligence agencies. This system will enable police officers to have a complete and detailed view and information about a crime scene, a patrol area, or a suspect lineup ("Augmented-reality," 2010).

Connection to Innovation Triangle. The concepts of LVC and AR are quickly emerging in today's technological environment. The growth and advances of VR and VE occurring in the science of human learning and assessment have proven to enhance the experience of the learner. A 3-D immersive environment for LVC applications and AR offers educators the flexibility of a variety of stimuli to enhance learning by reaching a specific outcome.

Prototyping/Assessment/Implementation Projected Costs and Timeline. This is an innovation prospect best evaluated for larger-scale implementations over a span of integrative prototyping:

- Short (design and development phases): Design and develop instructional and assessment plans on the basis of applying LVC and augmented-reality concepts. Determine 3-D immersive environment, data-collection architecture, and support for interactivity and mobility. Design and develop prototype using design-studio methodology and rapid prototyping. Analyze curriculum, gather team of faculty, research best practices, and apply learning theory. Expected duration for design and development phases: 6 – 8 months. Estimated cost: $70K (reflects internal costs associated with staff and faculty time on project and cloud services used for rapid-prototyping activities).
- Mid (integration and testing phases): Integrate instructional and assessment plans with identified form of 3-D immersive environment. Conduct alpha- and beta-testing sequences, and analyze test data for refinements and decision points for continuation of effort. Expected duration: 4 - 6 months (occurs during second year of effort). Estimated cost: $80K.
- Long (implementation and sustainment phases): Based on test results, implement proven innovation into selected Air Force curriculum areas via rapid curriculum-design adaptation methods. Establish sustainment services. Expected duration: 9 – 12 months (or longer depending on the scale of implementation). Estimated cost: >$125K.

<u>Conclusions/Recommendation(s)</u>. Education and training in 3-D immersive environments have led to greater challenges for the learning and teaching communities. The use of virtual worlds and the concepts mentioned in this paper can be used to focus on unique context or very broad ways to support learning. 3-D immersive environments may offer cost-effective solutions to education and training. The only way to be sure of this is to experiment with concepts such as LVC and augmented reality. Recommend prototyping the virtual and constructive components of LVC and augmented reality in collaboration with Air University educators.

Abbreviations and Acronyms List

2-D	2-Dimensional
3-D	3-Dimensional
A4/6I	Innovations and Integrations Division
AETC	Air Education and Training Command
AF	Air Force
ALT	Advanced Learning Technologies
AR	Augmented Reality
ARMAR	Augmented Reality for Maintenance and Repair
AU	Air University
Blog	Web Log
CDB	Collaborative Design Build
CEO	Chief Executive Officer
CIO	Chief Information Officer
COTS	Commercial Off-the-Shelf
CPU	Central Processing Unit
DARPA	Defense Advanced Research Agency
DL	Distance/Distributed Learning
DoD	Department of Defense
E&T	Education and Training
EaaS	Everything as a Service
eLearning	Electronic Learning
eSN	eSchool News
FCW	Federal Computer Week
GCN	Government Computer News
GLF	Global Learning Forum
HQ	Headquarters
IED	Improvised Explosive Device
IHE	Institution of Higher Education

IT	Information Technology
LVC	Live, Virtual, and Constructive
mLearning	Mobile Learning
MMOG	Massively Multiplayer Online Game
MMORPG	Massively Multiplayer Online Role-Playing Game
NCO	Noncommissioned Officer
NICC	Northwest Iowa Community College
PCE	Professional Continuing Education
PDA	Personal Digital Assistant
PME	Professional Military Education
Podcast	iPod + Broadcast
RAM	Random Access Memory
RSS	Really Simple Syndication
SaaS	Software as a Service
SOC	Squadron Officer College
TRADOC	Training and Doctrine Command (U.S. Army)
U.S.	United States
USB	Universal Serial Bus
VBS2	Virtual Battlespace 2
VE	Virtual Environments
Vodcast	Video Podcast
VR	Virtual Reality
ZPD	Zone of Proximal Development

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Endnotes

[i] Technology-delivered instruction is the generic term used in this concept to describe a range of instructional delivery means that may include computer-based instruction, web-based instruction, gaming, video, interactive-multimedia instruction, virtual worlds, massively multiplayer online games, simulations, etc.

[ii] Fletcher, J. D. & Chatham, R. E. (in press). Measuring return on investment in training and human performance in J. Cohn & P. O. Connor (Eds.) *Human Performance Enhancements in High Risk Environments*.

[iii] King, A. (1993). From sage on the stage to guide on the side. *College Teaching*, 41(1), 30.

[iv] One of the most stimulating insights in contemporary educational theory is Benjamin Bloom's (1984) discussion of solutions to what he calls "the two-sigma problem." Bloom shows that students provided with individual tutors typically perform at a level about two standard deviations (two "sigmas") above where they would perform with ordinary group instruction. This means that a person who would score at the 50th percentile on a standardized test after regular group instruction would score at the 98th percentile if personalized tutoring replaced the group instruction. This improvement is not a wild dream. Bloom supports his claim with valid research, and numerous experts agree with his conclusion. As cited: http://education.calumet.purdue.edu/vockell/edpsybook/edpsy2/edpsy2_strategies.htm

[v] Fletcher, J. D. et al.

[vi] Army Research Institute, Research Report 1921, *Army* in*stitutional* t*raining: Current status and* f*uture* r*esearch*, Mar 10.

[vii] Mobile computing may prove to meet the criteria to be labeled a disruptive technology. Disruptive technologies, later termed disruptive innovations, are discussed by Clayton Christensen in his book, *The Innovator's Dilemma* (1997).

[viii] Burns, W. & Freeman, W. *Developing more adaptable individuals and institutions*. Institute for Defense Analysis, 2010, 2.

[ix] See item iv, above.

[x] Gartner, Inc. is the world's leading information-technology research and advisory company. Founded in 1979, Gartner is headquartered in Stamford, Connecticut and has 4,300 associates, including 1,200 research analysts and consultants, and clients in 80 countries. Delivering the technology-related insight necessary for their clients to make the right decisions every day, Gartner is the valuable partner to 60,000 clients in 10,800 distinct organizations. Through the resources of Gartner Research, Gartner Executive Programs, Gartner Consulting, and Gartner Events, they work with every client to research, analyze, and interpret the business of IT within the context of their individual roles.