Cost-Effective Strategies for Producing Engaging Online Courseware

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ABSTRACT

As distributed learning (dL) and computer-based training (CBT) continue to proliferate, the methods of delivery often remain unengaging and bland for participants. Though many of the leaders in commercial online learning have improved their delivery style and quality in recent years, they continue to fall short in terms of user engagement and satisfaction. PowerPoint regurgitation and video lectures are commonplace and leave end users uninspired and wanting more. This paper discusses results from an ongoing research project, Captivating Virtual Instruction for Training (CVIT), which is aimed at understanding and improving dL through a series of recommendations and best practices for promoting and enhancing student engagement online. Though the central focus is on engagement, and how that translates to learning potential, a third variable (cost) has been examined to understand the financial and resource impacts on making content more interesting (i.e. the return on investment, or ROI). The paper presents findings from a 3-year long experiment comparing existing dL methods and techniques both within and outside of the Army. The project developed two dL versions of an existing Army course (Advanced Situational Awareness-Basic (ASA-B)) – the first was designed around producing material that was as engaging and as immersive as possible within a target budget; the second was a scaled-down version using more traditional, yet contemporary dL techniques (PowerPoint recital, video lectures). The two were then compared along three dimensions– engagement, learning and cost. The findings show that improved engagement in distributed courseware is possible without breaking the bank, though the returns on learning with these progressive approaches remain inconclusive. More importantly, it was determined that the quality and experience of the designers, production staff, writers, animators, programmers, and others cannot be underestimated, and that the familiar phrase – 'you get what you pay for' is as true with online learning as it is with other areas of content design and software development.

ABOUT THE AUTHORS

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Sin-hwa Kang, Ph.D. is a Research Associate at USC ICT. Kang does research in the field of communication science with a concentration in human-computer interaction. Kang's research focuses on affective human-computer interaction in social interactions, as well as training situations. She has participated in multiple research projects in which she models a novel approach to explore perceptions of co-presence and the medium of the interaction. She is currently investigating computer-mediated human interactions for training interactions in mixed reality, virtual reality, and smartphone settings. Kang obtained her B.A. in Educational Technology from Ewha Woman's University (Seoul, South Korea), M.S. in Information Design & Technology from Georgia Institute of Technology (Atlanta, Georgia), and Ph.D. in Communication with concentration in Human-Computer Interaction from

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INTRODUCTION

Current approaches for delivering military instruction via distributed learning (dL) technologies often rely on rote regurgitation of classroom material using tools like PowerPoint, simple videos, and recordings of instructors lecturing. This often results in passionless, uninspired delivery of course material, which can result in students who are bored and lose interest in attending to and completing the courseware. This then presents challenges associated with knowledge acquisition and retention. Captivating Virtual Instruction for Training (CVIT) is a 3-year research project (2014 – 2016) hoping to shape the future of distributed learning (dL) within the Army and elsewhere by identifying strategies and techniques for delivering course material that is not only informative and educational, but engaging and stimulating for participants. The core research questions asked as part of the project include:

1. What techniques do effective instructors use in the classroom that motivate and engage students?
2. Are these methods captured in dL solutions currently? If so, how? If not how could they be?
3. What other strategies exist for delivering engaging course material?
4. How can we codify these techniques and instantiate them within online learning environments?

Each of these questions is framed within the context of the costs (financial and time) associated with developing and delivering engaging online material. Fundamentally, the question being asked is – *when does spending more time and money on producing immersive material lead to 1) more engagement, and 2) better learning?* Furthermore, we are attempting to identify strategies that will produce an optimal return-on-investment (ROI) when it comes to maximizing learning/engagement without significant cost burden. For example, if an existing piece of online courseware costs $100K to develop, does spending $1M on a more engaging, more captivating version actually lead to a 10x return in learning? Or, thinking in terms of ROI, when might even a 10% increase in learning gains be worth $1M, such as when the added-value from improved Soldier performance outweighed the additional training cost (e.g., preventing the loss of a single Blackhawk helicopter would pay for multiple such courses)? Fundamentally, these questions must be answered individually for each course, and there is no one-size-fits-all, but certain broad-stroke recommendations may be drawn, some of which are described in this paper.

To understand and study this cost-benefit relationship, the research team developed two versions of an existing course – one using traditional dL approaches (video lectures, multiple-choice) and the other with more progressive / feature-rich capabilities (animated graphics and engaging exercises for students to go through). The learning objectives were the same for each, and we measured the results as compared against:

1. Time/Cost of developing the courseware
2. Level of engagement achieved
3. Level of learning achieved

For this paper, we focused on strategies that increase immediate engagement (i.e., attention to the content as it is presented) and learning efficiency (i.e., learning more from the content in the same amount of time, or learning the same content faster). The factors that increase engagement and learning over longer time horizons might be quite different, such as interventions that lead learners to spend more time studying (e.g., motivational interventions). Initial observations from the study conducted as part of this effort indicate that more investment earlier in the process (on the design, prototyping and early production) yielded more engagement overall. However, this does not scale linearly. The more time and money that is spent, it is expected that lower ROI will be observed (assuming that highest-value additions are done first). While the ranking of ROI for certain additions is not fully known, some intuitions for design have been hypothesized. Specifically, there are certain low-cost strategies that can and should be employed to maximize attention (animating graphics, narrative-driven script, leaderboards), but other high-cost ones do not always yield a return that warrants the investment (A-list professional voiceovers). The list of areas examined and their relationship to Time/Cost, Learning and Engagement can be found in Table 1.

Table 1. Online Techniques & Their Notional Relationships with Cost, Pedagogy and Engagement (Inferred from Development of the "Advanced Situational Awareness – Basic" Course Studied Here)

Technique	Time/Cost	Pedagogy	Engagement
Text	$	–	–
Static Graphics	$ - $$	↑	↑
Animated Graphics / Text	$$	–	↑
Interactivity (i.e. 'clicks')	$$ - $$$	↑↑	↑↑
Voiceover	$ - $$	↑	↑
Games/Exercises	$$$	– - ↑↑	↑↑
Competition / Ranking System	$	–	↑↑

The primary takeaway from this Table is that Time/Cost are not always proportional to Pedagogy and Engagement. For example, with relative little investment (e.g. adding a competition, ranking system), course developers can significantly increase the potential engagement of course participants. Conversely, expending significant resources on the creation of static graphics may not yield either the pedagogical or engagement returns one might expect. These were the techniques examined as part of this research effort. The notional results in the three columns to the right were determined by analyzing the responses of course participants (via survey) going through various versions of the online courseware, and then aligning those responses (on engagement, learning) with the costs associated to produce the material.

It should be made clear that this research effort examined one course, and while some important lessons were learned, there is no one-size-fits-all approach when it comes to delivering engaging and educational material online. There are certain strategies which appear more effective and efficient depending upon the circumstances (course topic, audience type, delivery approach), though even these have only been primitively evaluated as part of this limited research. Not only does the cadre of existing dL tend to be bland and uninspired, there is no empirical research to determine exactly how *engaging* it actually is, what makes it engaging, and whether the costs associated with developing course material are indeed worth the investment. One of the reasons that research findings are limited in this area is that in most cases developers don't have the resources to compare alternate approaches to teaching the same content. In this project we were given the opportunity to produce two distinct versions of the same courseware, and then compare the engagement, effectiveness across them.

BACKGROUND & RELATED WORK

The effectiveness of online, dL and computer-based training has been established as a viable instructional delivery method. The U.S. Department of Education conducted a meta analysis of over one thousand empirical studies related to technology-based distance learning, and reported that students in distance learning environments performed slightly better than students receiving face-to-face instruction (U.S. Department of Education, 2010). The same report highlighted research related to various combinations of distance learning instructional interventions such as quizzes, simulations, individualized instruction, collaborative tools, and self-reflection prompts, but acknowledged that no conclusions could be reached about specific best practices for distance learning courses (U.S. Department of Education, 2010). Clark, Yates, Early and Moulton, (2010) present arguments that the instructional design, not the medium of delivery, leads to learning and motivation. We acknowledge that a large body of evidence-based instructional design resources exists to inform the development of dL content (Clark & Mayer, 2011; O'Neil, 2005; Smith & Ragan, 2005). These strategies and techniques, however, are focused mainly on assisting the practitioner. For example, regardless of the medium, instructional designers should define and develop learning objectives, providing opportunities for students to see demonstrations and practice skills, and design feedback mechanisms to support assessment. If students are not interested and intrigued, however, then they are not paying attention or motivated to focus on the learning objectives, observe the demonstrations or practice the skills. Therefore, exploring evidence-based techniques for developing instructionally sound content *and* captivating delivery strategies ultimately demands more attention from the research community. Even if every instructional design principle is adhered to, it is how the student *experiences* the information that is a major focus of this study.

In seeking to identify effective online learning practices, we are not comparing dL or online instruction to live classroom instruction. Rather, we have dedicated effort to identifying the strengths of live classroom instructional methods to augment the limitations of dL and online instruction. What do the best teachers do to engage students and keep them interested in the content? The limitations of dL and online instruction include the tendency to rely on passive content delivery, difficulty gauging student emotional and cognitive engagement, and limited ability to quickly detect and adapt to changes in student engagement and understanding. Adapting live classroom delivery methods, however, is fundamentally different from similar delivery in digital form. Even in instances where instructor competencies are clearly articulated, and objective measurable behavior demonstrations provided, the techniques applied in a live setting do not easily translate virtually, and are currently not yet detailed enough to translate directly to bit/byte form (see Figure 1).

	Outcomes		
Competency	**Instructor is able to:**	**Senior Instructor is able to:**	**Master Instructor is able to:**
1. Communicate Effectively	use a variety of appropriate written, oral, and body language, and active listening skills to communicate clearly. Acknowledge diverse perspectives and use language that is effective for the learning content and audience.	*Note: Senior and Master Instructors continue to assess and develop this competency; however, defining higher levels of this competency may not be necessary.*	
2. Update & improve one's professional knowledge & skills	assess their own instructional performance and identify areas for improvement; uses mentoring sessions and developmental activities to continuously improve performance.	develop a personal development plan that includes training, college, self development, to increase knowledge of topics related to learning; demonstrate an interest in becoming a learning professional; mentor Instructors.	mentor senior instructors; prepare and conduct training for Basic and Sr Instructors; actively pursue expertise as learning professional; serve on Master Instructor Selection Board.
3. Comply with established ethical & legal standards	exhibit Army values and professional standards; avoid violating copyright law; respect student confidentiality, anonymity and rights; and avoid real or perceived conflicts of interest.	*Note: Senior and Master Instructors continue to assess and develop this competency; however, defining higher levels of this competency may not be necessary.*	

Figure 1. Instructor Competencies & Outcomes (from TRADOC Reg 600-21, 2013)

For example, "use a variety of appropriate written, oral and body language and active listening skills to communicate clearly" is not easily measured objectively when observing a human instructor. What does it mean for a virtual human to use "appropriate" skills? What type of body language should they employ? What are defined as active listening skills? Digitizing this representation can be a formidable challenge, and raises questions about how they impact engagement, learning, and cost of instruction.

Relationships between Engagement, Learning, and Cost-Effectiveness

When courseware is well-designed and implemented, the use of computer/information technologies (i.e. online learning) promotes students' engagement (Robinson & Hullinger, 2008). Chen, Lambert, and Guidry (2010) indicate that online learning technology positively affects students' engagement in learning and their ability to retain information, when using the technology for content delivery is compared to typical classroom learning. Other researchers (Carini, Kuh, & Klein, 2006) further discovered that students' meaningful cognitive engagement could positively influence users' learning achievement. In general, the authors argue that student engagement increases personal investment in learning (e.g., time spent studying) and learning improvement. It is less clear if and when strong engagement increases learning efficiency or retention: prior research has found that students can learn quite efficiently from methods that they dislike (e.g., find overly challenging) or that do not deeply interest them (Willingham, 2009). However, engagement in learning can also lead to greater time spent studying or possibly longer retention that offsets additional cost and/or instructional time needed to increase engagement.

Based on this prior work, we argue that there is a positive relationship between online learners' engagement and their learning outcomes. However, we are concerned that the gain in learning of more engaging online delivery techniques may not be worth the added cost. We investigated the associations among engagement, learning, and cost-effectiveness to find out whether we could ascertain the tipping point at which further investment in expensive courseware techniques no longer produced a commensurate gain in learning. Ng (2010) states that little existing research has been conducted on cost-effectiveness by mainly examining comparative cost-effectiveness of a certain technology (e.g., Computer-Mediated Communication) in more conventional classroom settings. However, open and distance learning online are still experimental and the estimation of their cost-effectiveness is largely undefined. Jung (2007) also addresses that many diverse factors influence the estimation of cost-effectiveness for distance education. Early cost- effectiveness studies (Jung, 2003) found that online learning can be considered more cost-effective than classroom learning purely by counting the potential volume of delivery to more students.

In principle, rather than needing to rebuild courses from scratch when moving from a classroom context to a dL course, it should be more efficient to identify techniques to enhance normal dL activities so that they provide greater engagement and learning. The majority of existing empirical research (U.S. Department of Education 2010) does not provide clear-cut solutions for this problem, especially when cost is taken into consideration. For example, Chi's (2009) Active-Constructive-Interactive model indicates that active learning tasks (e.g., answering questions) is superior to passive tasks (e.g., video lectures), while interactive (e.g., conversational) or constructive (e.g., modeling) tasks are better than active tasks. However, building new interactive or constructive learning activities is essentially remaking the class (i.e., a qualitative change to the curriculum), rather than providing straightforward enhancements (e.g., improving how a passive task like a video is shown). The research that we present here looks at the second issue: generalizable enhancements that could be done when converting an existing course into an online format, without needing to rebuild the overall structure or nature of the activities.

Multimedia Learning Principles

One mechanism known to improve specific learning activities is to improve its use of multimedia and mixed-media. Multimedia Learning Theory (Mayer, 2009) indicates that visual and verbal channels process received pictorial and auditory information through each channel separately. Because of the nature of human cognitive architecture, researchers (Jeung, Chandler, & Sweller, 1997) argue that employing multimedia to enhance learning reduces the cognitive load and helps users process verbal information through an additional auditory channel in conjunction with visuals. The Modality Principle (Mayer, 2009) further suggests that text should be provided in a verbal form rather than written text on a screen in a multimedia setting.

However, this depends on the nature of the information as well; Rasch and Schnotz (2009) indicate that certain types of information are more effective to communicate verbally (e.g., abstract concepts) while other information is better-suited to graphics or animations (e.g., specific objects/examples, certain types of trends or relationships). With regard to the visual aspect of multimedia learning tools, it is unclear whether animation generally works better than static images. There are many uniquely positive attributes that speak to the success of animation in learning (Ghaderi & Afshinfar, 2014). For instance, animations allow learners to enhance their cognitive processing through additional information and a steady stream of broadcast images, compared to static images. English and Rainwater (2006) examined these findings more in depth to contend that animations in learning are not always effective if the animations are used to present more conceptual content than procedural ones. As such, different types of multimedia can be particularly effective for certain types of information.

Use Case: ASA-B (Advanced Situational Awareness – Basic) Course

These principles were leveraged when identifying techniques to translate an existing classroom course into an online course. Though extensive research has been conducted to identify effective strategies for instructors in traditional classroom environments, these strategies do not always map one-to-one with strategies of use to military instructors. ASA-B is one such example, which is taught at the Maneuver Center of Excellence (MCOE), Ft. Benning, Georgia, and is one real-world example that has demonstrated a unique but extremely effective approach for teaching profiling skills and enhanced situational awareness to students in a live classroom setting. The course, however, is hindered by the availability of its very talented, very inspirational instructors, and the delivery medium of the content (i.e. resident classroom). Consequently, despite the utility of such courses, the available training audience is tied directly to the scheduling availability of the few human instructors accredited to teach the program of instruction.

The ASA-B training program is intended to teach students a set of skills and techniques for observing specific cues and behaviors of people and events in situations that may become lethal (Kobus, Palmer, Kobus, & Ostertag, 2009). It covers an assortment of topic areas related to profiling and tuning one's situational awareness. It is taught over a course of five days (three classroom; two field), and instructors were credited as being core to the course's positive feedback and reviews (Spiker & Johnston, 2010). However, the specific techniques employed by ASA-B instructors are often counter to those advocated for in more traditional classroom environments. Spiker and Johnston's (2010) final report on Combat Hunter, a Marine Corps course on which ASA-B is based, describes seven key elements of the instructional delivery as being instrumental to the effectiveness of Combat Hunter:

1. **Pace** — rapid, no "down" periods, high rate of talking
2. **Humor** — frequent use of humor, often profane, many key points emphasized with humor
3. **Personalization** — instructor uses own personal stories to appeal directly to students, personalizes many of the examples to make them concrete
4. **Instructor** —obvious technical expert, high-valence role model for students
5. **Emotion** — frequent use of heighted emotion (fear, anxiety, uncertainty, sympathy) to reinforce points using graphics and verbal examples (emotionally-tagged learning)
6. **Stories** — main theme in each topic introduced, exemplified, and reinforced through stories
7. **Student involvement** — frequent reference to [Soldier] credo, direct contact with as many students as possible (interactivity)

These factors tie into known-effective learning principles such as personalization (#3), anchored learning (#3), emotionally-tagged learning (#2, #5), social influence due to authority (#4), narrative (#6), and interactivity (#7) (Graesser, 2009; Richter-Levin, Kehat, & Anunu, 2015). The challenge, then, is taking the broad-stroke techniques successful military instructors are using in the classroom and translating that into a form that may be incorporated into a digital learning environment. Ideas have been proposed for creating electronic versions of programs like ASA-B for wider dissemination (Spiker & Johnston, 2010), but these proposals have focused on what should be taught (the content and curriculum) and less on how it is taught (the *essence* or *style* of delivery).

In general, synthesizing classroom training material in a dL module presents an entirely different set of challenges. Though extensive research has been undertaken to identify what makes an exciting, engaging and effective instructor, contextualizing it for a military audience and eventually translating it to a tractable interpretation for a computer has proven elusive (Chalmers, 2000). Army Learning Management System (ALMS) guidelines and TRADOC Capability Manager-The Army Distributed Learning Program's (TCM-TADLP) standards for dL courseware are examples of US Army investment to ensure dL technology, content, and methods of delivery are as effective as possible. However, these efforts do not describe how to leverage insights from *human instructors* applying them digitally.

COURSE DESIGN

Two versions of the single-player, online ASA-B course were designed, developed and compared: 1) ASA-B-Lite and 2) ASA-B-Heavy. Both versions taught the same content, but each differed in the manner which the content was delivered. The original classroom version of ASA-B lasts five days – three in the classroom; two in the field. The ASA-B online courseware built as part of this effort focused on Days 2-3 of the classroom training, which was predominantly oriented around declarative and conceptual knowledge, with basic application of that knowledge in various situations. The ASA-B-Lite version used recorded lectures, as well as video aids sourced from the public domain. It was designed to have a more passive learning experience, but also a relatively low production cost at $170,500. It takes approximately 1-2 hours to complete. The Heavy version uses custom animations, actors, and mini games. It promotes more interaction with the application but at a higher production cost of $390,500. It, too, takes 1-2 hours to complete. See Table 2 for the breakdown by module.

Table 2. ASA-B-Heavy (Left) vs. ASA-B-Lite (Right) Time/Cost Breakdown.

	Component	Days	Cost
Heavy	Design	40	$44,000
	Intro Video	15	$16,500
	Geographics Video	12	$13,200
	Atmospherics Video	11	$12,100
	Biometrics Video	12	$13,200
	Proxemics Video	11	$12,100
	Kinesics Video	12	$13,200
	Heuristics Video	12	$13,200
	Danger Zone 1	20	$22,000
	Danger Zone 2	10	$11,000
	Point of View	30	$33,000
	Overall UI	30	$33,000
	Functional Field of View	5	$5,500
	Breaking It Down	10	$11,000
	Blind Gait	25	$27,500
	Body in the Crowd	25	$27,500
	Face in the Crowd	25	$27,500
	Check It Out	5	$5,500
	Channel Capacity	5	$5,500
	Leaderboard/Scoreboard	10	$11,000
	Deployment	30	$33,000
	Total	355	$390,500

	Component	Days	Cost
Lite	Design	20	$22,000
	Intro Video	10	$11,000
	Geographics Video	9	$9,900
	Atmospherics Video	8	$8,800
	Biometrics Video	9	$9,900
	Proxemics Video	9	$9,900
	Kinesics Video	10	$11,000
	Heuristics Video	10	$11,000
	Questions	20	$22,000
	Overall UI	20	$22,000
	Deployment	30	$33,000
	Total	155	$170,500

ASA-B – Lite

The Lite mode is based on a PowerPoint-style format that includes static images, slides, and an instructor's narration, as well as simple question/answer exercises. The 'lectures' are delivered in a traditional style, with an instructor at the podium talking to a faux audience. The instructor who delivers these lectures us a seasoned lecturer on this topic, whose style embodies the effective ingredients from Combat Hunter (Spiker & Johnston, 2010). Learners watch these videos linearly and then respond to the simple exercises to practice what they have just learned. Student interactivity is limited to multiple-choice questions and advancing from video to video. It is most analogous to what is seen with Massive Open Online Courses (MOOCs) today either at schools or available commercially (Lynda.com, Coursera). The ASA-B Lite version took approximately 6 months and $171K to produce. It takes the average user approximately 100 minutes to progress through the experience. This roughly translates to $1710 per minute of produced content.

ASA-B- Heavy

The Heavy mode consists of a variety of delivery styles from introductory videos to professionally-animated images and instructor's narration, and interactive games and exercises. Learners are asked to watch 2-3 minute graphics-rich videos and then complete a series of interactive games to practice what they have just learned from the animated content. The interactive games provide prompt feedback on learners' responses and final scores that are tracked in a centralized leaderboard. Development of the initial ASA-B-Heavy courseware was a 12-month effort and cost close to $391K. On the average users take approximately 90 – 120 minutes to complete the courseware. ASA-B-Heavy employs all facets of the technique-to-technology mapping from animated graphics to professional scripts to interactive exercises. Based on the cost and the amount of time to complete, the cost of the course roughly corresponds to $3910 per minute of final produced material. Figure 2 illustrates the current iterations of ASA-B-Lite and ASA-B-Heavy respectively.

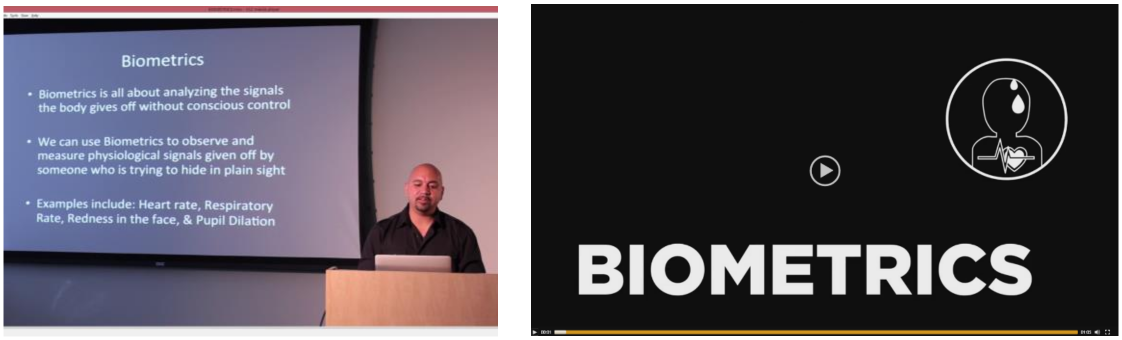

Figure 2. CVIT- Lite (Left) & CVIT- Heavy (Right)

HYPOTHESES

Based on the multimedia principles reviewed earlier, we hypothesized that animated presentations of content may be more effective than static presentations for the ASA-B course, which deals with conceptual content rather than procedural skills.

To explore this subject, we formulated our hypotheses below:
H1: *People will be engaged and learn more when they use an* <u>*animated interface*</u> *(heavy mode) compared to using a* <u>*static interface*</u> *(lite mode –i.e. a PowerPoint slide presentation).*

H2: *People will feel more engaged and successfully retain information when they acquire it using* <u>*richer interactions*</u> *(heavy mode) compared to completing simple* <u>*question and answer*</u> *exercises (lite mode).*

We applied user interaction to ASA-B-Heavy along with animated content for learners to practice what they had acquired from the videos. The interactivity can be defined as ‘‘the extent to which users can participate in modifying the form and content of a mediated environment in real time” (Steuer, 1992). ASA-B-Heavy maintained the same general structure of activities as Lite, where the initial video was replaced with an animated presentation of content and key relationships and the Lite multiple-choice questions were replaced with more advanced active learning approaches such as multi-stage multiple-choice and multiple-choice questions that required recognizing cues in a video or between different animations (e.g., different animations of people walking or reacting to an event). Following Chi’s (2009) categories of learning tasks, Heavy did not qualitatively change the nature of activities, but the tasks and questions were enhanced with multimedia (graphics, animations) that anchored learning into more realistic tasks (e.g., decision-making) as opposed to shallower recall of concepts.

This research provides one data point among the many that will be needed to definitively conclude what the optimum level of online engagement is that translates to maximum returns in learning, as compared against cost. However, these findings should offer insights into general gains to engagement and learning that can begin to map out these curves.

EVALUATION

The evaluation compared student engagement and learning between ASA-B-Heavy and ASA-B-Lite, with an additional consideration of whether the up-front investment in time, money and personnel to deliver more engaging training leads to a more instructionally useful course. USC-ICT, in partnership with Army Research Laboratory (ARL) and MCOE, designed and conducted a study that investigated the utility of the course prototypes, as well as an initial formative evaluation of the learning strategies and outcomes. The evaluations were intended to measure student engagement and learning outcomes along two parameters, based on different variations of:

1. Static vs. animated presentations (videos)
2. Simple vs. interactive exercise (choice tasks)

The goal is to identify which strategies and techniques are more or less effective compared to the current approaches to dL. For example, it may be the case that a user interface with complex animations, fades and interactions are more captivating for students than static text. However, the costs associated with producing such effects may not be worth the investment. Refinements to the software will be made based on the assessments and feedback from students.

Changes may include enhancements to the User Interface, editing the exercises and content, or altering the pedagogical strategy (if needed). Based on the results of the study using Kirkpatrick's (1998) model, we compared these against the time/money to design, develop, deploy and maintain the course. Figure 3 illustrates our approach.

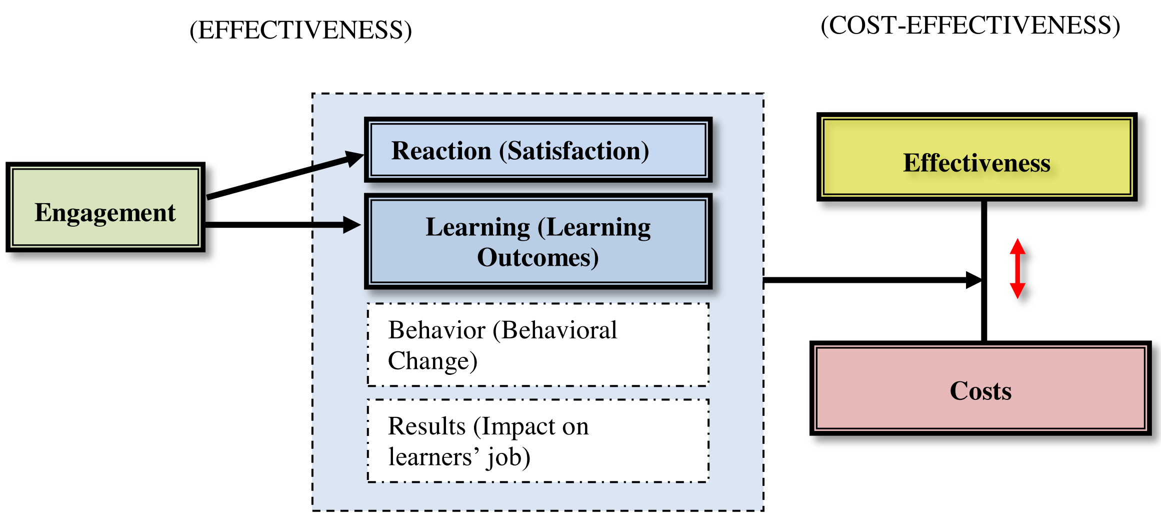

Figure 3. Associations among Engagement, Learning, and Cost-effectiveness

Study Design

We designed a Between-Subject experiment with two conditions: i) ASA-B-Lite (static presentation with a simple exercise); ii) ASA-B-Heavy (animated presentation with an interactive exercise). Participants were assigned randomly to each condition. The measures collected during the study were:

Engagement: We administered the revised and combined form of the measurement of Information Technology Usage Questionnaire developed by Agarwal and Karahanna (2000), Presence Questionnaire created by Witmer and Singer (1998), Flow constructed by Webster and Ho (1997), and six questionnaire items that we constructed (e.g. "The course was fun," "I found the course engaging"). Each item was presented using a 7-point Likert scale (not at all – very much). The items showed good reliability (*Cronbach's alpha*=.95). Users' preferences between the six modules was also collected by having users sort modules based on "how much you liked them" and "how much they held your attention."

Learning Outcomes: The scores from the same 10-item knowledge tests were compared from before and after the course. Two items were devoted to each module of the course.

Cost: We utilized factors that had been used in previous studies (Jung, 2007), such as fixed costs (i.e. capital costs, course development), which are shown in Table 2 above.

Participants

A total of 60 participants (59 males and one female) participated in the study. The participant pool consisted of Soldiers and military and civilian course instructors. There were a total of seven civilian participants, all of which were in the oldest age range. Four of the seven had previous experience with ASA-B, the remaining three had no prior experience with the training. Data was collected at Ft. Benning, GA. All participants either had prior Situational Awareness (SA) training, or had just completed the resident Advanced Situational Awareness-Basic instruction within the course of their scheduled military training. There were 35 participants assigned to the Heavy condition and 25 assigned to the Lite condition. Age groups ranged from '18 - 22' to '43 or older,' with the most frequently occurring age group being '23 - 27' in both conditions. Experience with SA training varied with 33.3% answering "I have never taken ASA-B," and 50% having taken training "0 - 3 months ago."

Procedure

Data was collected over two days with three groups of participants. Day one consisted of two groups, one Heavy condition and one Lite condition. Day two was a single testing session consisting of Heavy and Lite conditions together. Participants were given two hours to complete the courseware and surveys. Average time to complete each course was approximately 80 minutes.

Initial Results

While the Heavy version of the course significantly increased engagement, no significant differences in learning gains were observed. An independent-sample t-test showed a statistically-significant difference between the Heavy version and the Lite version [$t(58) = 2.05$, $p = .045$] for engagement. Participants were more engaged by the Heavy version ($M = 5.17$, $SD = 1.33$), compared to the Lite version ($M = 4.45$, $SD = 1.32$). In both conditions, significant [Post-Pre] learning gains were observed (paired $t(59) = -3.80$, $p < .001$), with an average increase of -.65 points. However, no statistically-significant difference in learning gains was observed between the two conditions.

We determined cost-benefit effectiveness of the two modes by comparing the instructional and engagement values above with the cost per course module (Table 2). The cost per course effectiveness was calculated by averaging the effectiveness scores (average (engagement, learning)), and dividing this by the total cost of course production. In this study, costs are fully inclusive: design, development, and deployment.

$$BCR = \sum_{i}^{\#\ learners} Effectiveness_i / Cost_i \quad \text{where} \quad Effectiveness_i = f(learning_i, engagement_i) \tag{1}$$

Table 3. Benefit-Cost Ratio (BCR)– ASA-B Heavy vs. Lite

	Heavy	**Lite**
Cost	$390,500	$170,500
Engagement (out of 7)	5.2	4.5
Learning (POST score – PRE Score / (100 – PRE Score))	6.542	7.163
Average (engagement, learning)	5.854	5.809
BCR (Average)	**.015**	**.034**

What we see with the table above is that despite a statistically significant return on engagement for ASA-B-Heavy, the roughly 2x cost to produce it, with only marginal (at-best) returns on learning, do not yield a particularly encouraging BCR (average). In fact, ASA-B-Lite actually saw a 2x BCR. Note: the learning values should be taken in context because the cohorts who went through the training were already ASA-B certified with several years of experience. The fact that they did not learn much going through the courses is not particularly surprising.

In order to assess the statistical significant difference in BCR between the modes, an independent-sample t-test was conducted. Because the assumption of homogeneity of variance was not met in the results, a t statistic not assuming homogeneity of variance was computed. The results associated with the "Equal variances not assumed" demonstrated that there was a statistically significant difference in cost-effectiveness [$t(30.688)=-7.785$, $p<.001$] for the Heavy version (M=.0013, SD=.0003), and the Lite version (M=.0026, SD=.0008). The conclusion was that despite the relatively sizable increases in engagement for Heavy that the cost-effectiveness actually favored the Lite version. The primary driver here was the little-to-no difference in learning potential between the two versions. This, coupled with Heavy costing ~2x as much as Lite, and only a marginal improvement in engagement, produced more 'bang for the buck' with Lite.

CONCLUSION & FUTURE WORK

One takeaway from this project is that producing quality, engaging online content (that is aligned with requirements / learning objectives) will, in certain circumstances, yield positive results in terms of user engagement and interest. This content can take the form of any number of different delivery styles and mediums – voiceover, animations, graphics, exercises, and leaderboards. More importantly, this initial experiment led to the conclusion that more money and more engagement does not necessarily translate to more or better learning. Precisely why remains an open question. We know that improving the style and variety of the multimedia and interactions for videos and practice tasks statistically improved engagement. This higher engagement is quite significant, given that the resident ASA-B course many of the participants had taken had a highly-effective and authoritative lecturer. As such, it appears that high-quality animation and rich multimedia tasks can lead to a high level of engagement, even without the recordings of a real-life human instructor. Given that instructors, particularly in the military, may not be available to re-record lectures based on new information, systems that can sequence high-quality animation may produce content that can be more quickly updated or maintained, if their up-front cost can be reduced. In this case, an increase of costs by 2x led to a 16% increase in engagement.

On the converse, increased perceptions of engagement did not result in increased learning. There are a number of possible explanations for this finding. Since all of the participants had already taken some form of situational awareness training and the pre-test could have refreshed some of this prior learning making it difficult to increase knowledge above that level. It might be that the influence of engagement levels was sufficiently high to hit ceiling effects in both conditions, since overall engagement ratings were high in general. This would imply that increasing engagement might increase learning for particularly dull content, but that relatively engaging content such as Situational Awareness might not require additional engagement. This interpretation would imply that particularly uninteresting courses or modules would benefit from this type of intervention, though further research would be needed to demonstrate that finding. Alternatively, as has been hypothesized by some researchers, self-reported engagement may be almost entirely uncorrelated with learning over short periods, and might only become relevant for longer courses where sustained effort and motivation is needed to persist until mastering the material. This would imply that such interventions might benefit longer and more-challenging courses that are much longer than 2 hours.

This highlights the cost-benefit of creating improved material, in terms of balancing engagement, learning, and the cost-savings from reusing existing course materials. These factors are not mutually-exclusive: just because you create a more captivating experience does not mean the pedagogy will be enhanced. However, more often than not the most interesting parts of a dL experience for students are aesthetics – graphics, animations, dynamic text are all part of making the online learning environment more interesting though not necessarily more productive for learning. The flip side is that courseware may be pedagogically-sound but be immensely boring and frustrating for students, leading to disengagement, failure to learn, or even attrition.

After conducting this initial experiment with ASA-B, the same team has gone on to create two new types of courseware adopting the techniques and approaches used in Lite and Heavy – one for the Supervisor Development Course for the Army Management Staff College, and the other for the Military Intelligence School. In both cases, the mantra 'you get what you pay for' has proven itself over and over again – i.e. investing in good writers, designers, developers, programmers, artists, voiceover actors, producers, engineers, managers and others results in quality work. Skimping on 'people capital' has a significantly detrimental effect on the resulting product.

Ultimately, this research effort intended to bring attention to the issue of engagement in online learning. No one study or project can definitively determine which strategies or techniques are most effective. While we assessed participant ability to recall information by administrating pre/post questionnaires, the time and scope of this study did not allow for assessing knowledge retention or impact on user job performance. These are areas for future research. This particular study only scratches the surface in terms of the relationship between engagement, learning and cost effectiveness for a very specific topic (advanced situational awareness training), for a very specific cohort (young Army Officers and seasoned NCOs), in a very controlled environment (as part of their MCOE training). That being said, we hope this effort was the beginning of others examining the issue, and better understanding where the maximum ROI is when it comes to developing engaging online material. At its core, the study hopes to help transform the future of dL learning in the Army by ensuring content is delivered in a way that engages and interests students. The breakdown of instructional techniques into their constituent parts to identify those methods/processes that are most engaging and captivating for students may be leveraged in any pedagogical environment. Though many of these traits and skills are not specifically taught to instructors, they may be applied piecewise to existing programs by dedicated personnel.

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