Measuring the Effectiveness of Enterprise Application Training: A Comparative Analysis of Dynamic and Integrated Instruction

by

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ABSTRACT

The purpose of this study was to investigate the impacts of three types of instructional presentation methods on learning, efficiency, cognitive load, and learner attitude. A total of 67 employees of a large southwestern university working in the field of research administration were randomly assigned to one of three conditions. Each condition presented instructional materials using a different method, namely dynamic integrated, dynamic non-integrated, or non-dynamic non-integrated. Participants completed a short survey, pre-test, cognitive load questions, learner attitude questions, and a post-test during their experience. The results reveal that users of the dynamic integrated condition treatment showed significant improvement in both learning and efficiency. The dynamic non-integrated participants had a faster mean time to complete an assigned task, however, they also had significantly lower average test scores. There were no other significant findings in terms of cognitive load or learner attitude. Limitations, implications and future studies are discussed.

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Chapter 1

INTRODUCTION

Commercial computer software programs designed for corporate or business use have traditionally included some sort of assistance or learning mechanism to make it easier for new users to learn their operation. Different styles for presenting this assistance material have become common in the software industry.

When accessed either by a user inquiry or by a specifically designed instructional task set, many modern commercial software applications provide assistance for multi-step procedures by displaying explanatory text and images in a small window adjacent to the application. These same applications often include more visually integrated single-step guidance in the form of a “mouse over tool tip” that appears briefly for an individual action. This method is both dynamic, in that the tool tip is related to the current information on the screen, and it is visually integrated directly adjacent to the object it describes within the commercial software. One particular style of task guidance, non-dynamic and non-integrated in its display, is a commonly used method currently employed in the software industry. For example, modern and large-scale applications like Microsoft Office and Adobe Photoshop offer detailed steps and help topics displayed in a separate application or browser window as illustrated below (Figure 1). This example shows instructions on how to copy a formula in Microsoft Excel displayed on the right with the Excel application resized to make room on the left. Several steps are displayed at the same time with no feedback or update based on the progress that may have already been made. The learner either sees the main application and topic side-by-side as illustrated here, or one at a time by switching back and forth.

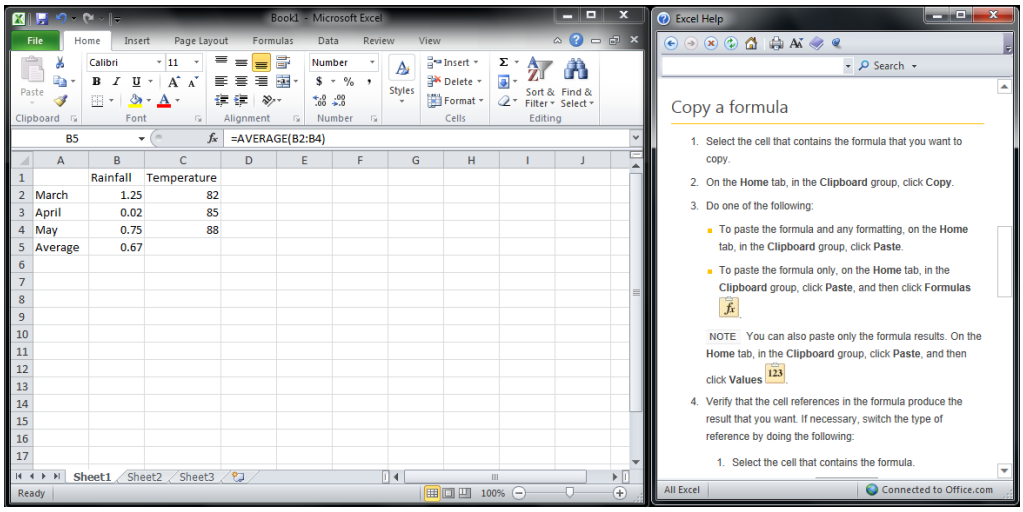

Figure 1 Non-Dynamic Non-Integrated Guidance In Microsoft Excel

A second style of task guidance, integrated into the software and dynamically changing with other content on the screen is illustrated in Figures 2 and 3. Two of the most popular computer operating systems—Apple OS and Microsoft Windows—each use or have used certain elements of dynamic and integrated user-assistance methods. For example, Apple OS can display search results on the computer, while also highlighting the location of a search result dynamically on the screen. Figure 2 shows results from a search for the word “document” that includes a menu option choice to see recently used folders. When the mouse is placed over the optional search result, the system dynamically opens the recently used folders selection and places a blue arrow to highlight the option.

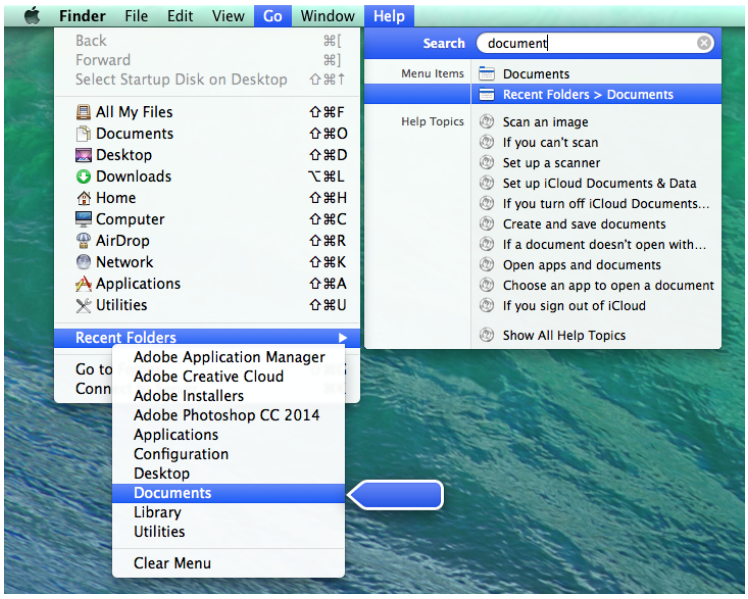

Figure 2 Dynamic Integrated Guidance In Mac OS.

When the Microsoft OS known as Windows Vista shipped in early 2007 it included a similar feature known as Guided Help that would dynamically walk a user through various procedures by providing directions for each step and highlighting options or information as the situation progressed. Note in Figure 3 the green arrow and highlight box are an attempt to make it easy for the learner to focus attention on a particular point on the screen.

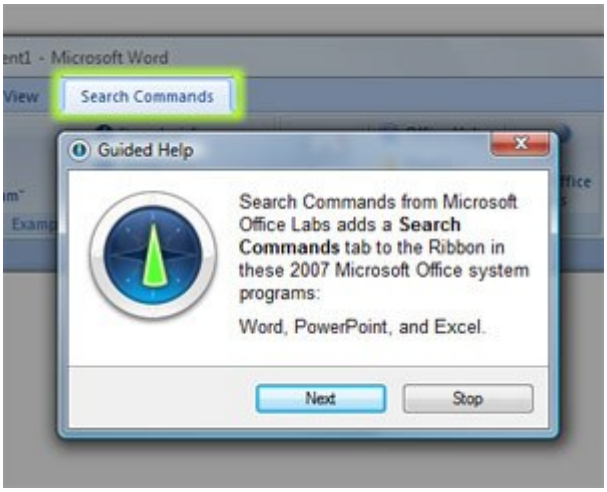

Figure 3 Dynamic Integrated Guidance In Microsoft Windows Vista.

Another included feature in Microsoft's Guided Help was a "do it for me" option which let the user skip any instruction but still watch the steps of a procedure happen on the screen. While fun to watch and somewhat practical it was dropped from subsequent operating systems by Microsoft. Developers from the company said the feature had an inherent security problem. They did not want any Trojans or bots masquerading as Guided Help (S. Straub, personal communication, June 10, 2008). It may be a great loss that this type of technology existed but was removed from a very popular operating system. A dynamic and integrated version of instruction would seem to have advantages over the more common and still in use methods. According to cognitive processing theory and related multimedia design principles, an integrated approach to providing user help with software procedures should have a positive impact on a user's learning and experience (Sweller, Chandler, Tierney, & Cooper, 1990).

Given these issues, this dissertation study investigated the learning, efficiency (time required to learn new tasks), and relative cognitive load of three styles of task guidance for learning new software applications, each of which are designed to scaffold a learner when exposed to tasks they have not completed previously. Non-dynamic non-

integrated guidance presents information in the form of a fixed set of static directions on the right side of the screen. Dynamic non-integrated guidance presents information in the form of dynamically updating directions positioned to the right side of the screen. Dynamic integrated guidance presents information in the form of dynamically updating directions positioned next to the action to be taken.

Theoretical Framework

Cognitive processing theorists state that the unaided learner is severely limited in the amount of information they can receive, process, and recall (Miller, 1956). Working memory is made of mechanisms and processes that maintain task-relevant information (Miyake & Shah, 1999). Working memory can store and process no more than a few discrete items at any given time (Sweller, 1994). Instructional designers can, however, provide aid to learners in dealing with limited working memory capacity through various techniques (Miller, 1956). Because of this limited capacity for dealing with information, poor design of instructional materials can overload the learner's working memory capacity, which can lead to high levels of cognitive load. This study examined three styles of software integrated help systems to determine the relative power of each to help reduce user cognitive load, increase efficiency, and support learning of software functionality.

Cognitive load theory says that the cognitive load to process some new information is made up of three parts: intrinsic, extraneous, and germane load (Sweller and Chandler, 1994.) Intrinsic load is experienced as a natural part of learning a particular item. It may be high or low depending on the difficulty of the topic relative to the learner's current understanding of that topic, or prerequisite topics. This type of cognitive load cannot be affected by changes to the instructional design (Sweller and

Chandler, 1994). For example, learning how to fly combat aircraft is a difficult task taking many months of training. There is no presentation method or media that can take a learner from novice pilot to deadly combatant in a matter of hours or even days. The nature of the topic requires the learner to begin with individual pieces that may not be fully understood until all parts have been addressed, one at a time. The level of intrinsic cognitive load is dependent on the complexity or difficulty of the subject. It is the memory required by the thinking task at a given time.

Another contributor to cognitive load is what is known as extraneous cognitive load. It is a byproduct of the instructional material, and does not itself produce schema development (Sweller and Chandler, 1994). Sweller and Chandler (1994) described how extraneous load created by the instructional design or format can be detrimental to learning.

A major source of extraneous cognitive load is known as split attention. Split attention is caused when learners must combine multiple pieces of information presented in separate locations visually to understand a single item. John Sweller found that the act of manually integrating information that is visually independent but not cognitively independent requires a cognitive effort to overcome that physical separation. This extra effort is not intrinsically necessary to understand the topic at hand. Sweller went on to say that the cognitive effort required to mentally integrate visually disparate sources of information can be reduced or eliminated by physically integrating the various entities (Sweller, 1994). In fact, multiple studies have found that students learning technical information from integrated text and diagrams (diagrams with descriptive text combined in the same space) spent less time processing the material, and scored higher on performance tests than students using non-integrated materials (Purnell, Solman, & Sweller, 1991; Tarmizi & Sweller, 1988). This is known as the split attention effect. Any

instruction requiring learners to first learn a structure, organization, or display is in danger of contributing to extraneous cognitive load by splitting the learner's attention between the problem and other supporting information. A commonly seen example can be found in the instructions for a new piece of furniture requiring assembly. Often the parts list, identifying intricate pieces, is on a different page than the instructions describing actions to take to use a particular part. This physical separation of critical information can contribute to split attention and have a negative impact on learning. Studies examining the split attention effect have been done in many areas of learning including biology (Chandler & Sweller, 1991) optics (Ward & Sweller, 1990), kinematics (Ward & Sweller, 1990), mathematics (Mwangi & Sweller, 1998). Also studies have been done in the industrial fields of Numerical Control Programming (Chandler & Sweller, 1992, Exp. 1), and electrical equipment installation (Chandler & Sweller, 1991, Exp. 1). An examination of the literature reveals no published studies on the split attention effect in the world of consumer commercial software and its associated instructional materials. Consequently, this dissertation study examined software help systems that feature different levels of integration and measure the resultant cognitive load of each.

The third type of cognitive load, germane cognitive load, is the mental capacity used for processing, building, and automating schemas (Sweller, van Merrienboer and Paas, 1998.) It is affected by the presentation of the learning material. Paas, Renkel and Sweller described germane cognitive load in this way.

> Like extraneous cognitive load and unlike intrinsic cognitive load, germane cognitive load is influenced by the instructional designer. The manner in which information is presented to learners and the learning activities required of learners are factors relevant to levels of germane cognitive load. Whereas extraneous cognitive load interferes with learning, germane cognitive load

enhances learning. Instead of working memory resources being used to engage in search, for example, as occurs when dealing with extraneous cognitive load, germane cognitive load results in those resources being devoted to schema acquisition and automation. Note that increases in effort or motivation can increase the cognitive resources devoted to a task. If relevant to schema acquisition and automation, such an increase also constitutes an increase in germane cognitive load (Paas, 2003).

These three types of cognitive load combine in the mind of the learner. If the total load exceeds mental capacity, learning is impaired. Instructional designers work to reduce extraneous cognitive load with improved designs that allow additional working memory to be dedicated to germane cognitive load.

Context sensitive or dynamic instruction is that which is modified based on the situation the learner is facing. It goes beyond simply organizing topics or problems into chapters in a book. The instructional content presented at any given moment would be selected by the problem itself and ideally even by what step the learner is on as they progress through a particular problem. Heift (2006) studied task guidance for computer assisted language learners and found that context sensitive guidance, rather than static information, was utilized far more by learners. In 2005 Bartholomé et al produced context-sensitive help materials that were tailored to the specific decision task at each decision step in a botany identification course. This context-sensitive help was dynamic but it was not embedded. The information was displayed below the subject as sub titles. Static instructional content was also made available to students and the use of either was voluntary. Given the choice to use either context sensitive help or non-context sensitive help, context sensitive help was used 24.98% of the time and non-context sensitive help was used 1.88%. They found that context-sensitive help was significantly correlated with

both answering the initial problem correctly but also answering follow up questions correctly. Thus, the use of context-sensitive help was effective in improving task performance. Efficiency as measured by time to complete an assignment or task, was not measured in these studies. The question of efficiency should be examined to fully consider assistance method comparison.

Perceived usefulness and perceived ease of use were found to be critical factors affecting learner satisfaction with e-learning (Sun et all, 2008). A positive attitude toward the presentational style of instructional material does not promise an increase in learning. Rachel E. Milner studied learner attitudes toward instructional images in an introductory biochemistry class. She found that there was no relationship between learning outcomes and the learners self-reported attitude toward instructional images (Milner 2013).

It is logical to combine the precepts of cognitive load theory and context sensitive instruction to hypothesize that new software might best be learned if it includes a task-guidance mechanism with a design that would present integrated text and diagrams to reduce extraneous cognitive load, and be contextual, rather than static in their presentation, to aid the learner. Such a tool should successfully promote learning, be faster to use, and receive more positive feedback from the learner.

Overview of Study

The purpose of this study was to investigate the impact on cognitive load, learning, and efficiency of using spatial contiguity and contextual guidance in the design of an instructional guidance method created to help support learning of new software. There were four research questions:

1. What is the impact of different forms of guidance (i.e. dynamic & integrated, dynamic & non-integrated, non-dynamic & non-integrated) used in a computer-based training module on learning as measured by scores on a learning measure?
2. What is the impact of different forms of guidance (i.e. dynamic & integrated, dynamic & non-integrated, non-dynamic & non-integrated) used in a computer-based training module on efficiency as measured by time to complete a computer based training?
3. What is the impact of different forms of guidance (i.e. dynamic & integrated, dynamic & non-integrated, non-dynamic & non-integrated) used in a computer-based training module on cognitive load?
4. What is the impact of different forms of guidance (i.e. dynamic & integrated, dynamic & non-integrated, non-dynamic & non-integrated) used in a computer-based training module on learner attitude toward the instructional material?

The results of the studies cited previously show that integrated instructions improve learning. Independently, dynamic instruction has also been shown to improve learning (Bartholomé, 2005). Will these findings both hold true when used together, and applied in a computer learning environment? It would also be useful for instructional designers to know what effect each condition will have on the amount of time a participant needs to complete the learning task. One may assume a dynamic integrated method would be faster, but empirical evidence is needed in the area of adults learning new computer applications. It is also desirable to have empirical evidence that may indicate how learners feel about the assistance they receive.

Note: For the purposes of this study integrated instruction is defined as instruction that sits on top of or visually surrounds a given element with a highlight box or arrow

connecting it. Dynamic instruction is defined as instruction that changes as the learner progresses through a process; that is, it displays only a current step with information pertaining to that step visible. Once a given step is complete the dynamic instruction will change to reflect the next step that is required.

Chapter 2

METHOD

Participants & Design

This study was designed to be similar to a corporate training situation. The intention was to simulate a corporate training need where a large company might be training their staff on the use of a critical business application. A total of 67 employees of a large southwestern university working in the field of research administration, most of whom have completed a bachelor's degree, participated in this study. They were recruited because of their work in or around a particular web based application which served as the subject matter for the instructional content. Some participants knew the system well and some had not yet used it at all. Some internal validity of the study had to be sacrificed in order to gain the external validity of approaching a realistic business world setting. For example, participants were allowed to participate in the self-paced training on their own schedule at their desks rather than in a controlled lab. This means that some were inevitably distracted by a phone call, co-worker, or other workplace event, but their responses to the treatment would be more realistic to what an employer might observe. Some adjustments to how the results were analyzed were necessary to deal with

this design and are described in the results section. Participants were assigned to one of three conditions in equal numbers using block randomization. Some results were removed as extreme outliers in the analysis. The independent variable in this study is the instructional guidance method (dynamic integrated, dynamic non-integrated, or non-dynamic non-integrated).

Dynamic integrated (N=24). The task guidance method in this condition is dynamic, and updates itself based on the participant's previous actions. See Figure 4 below:

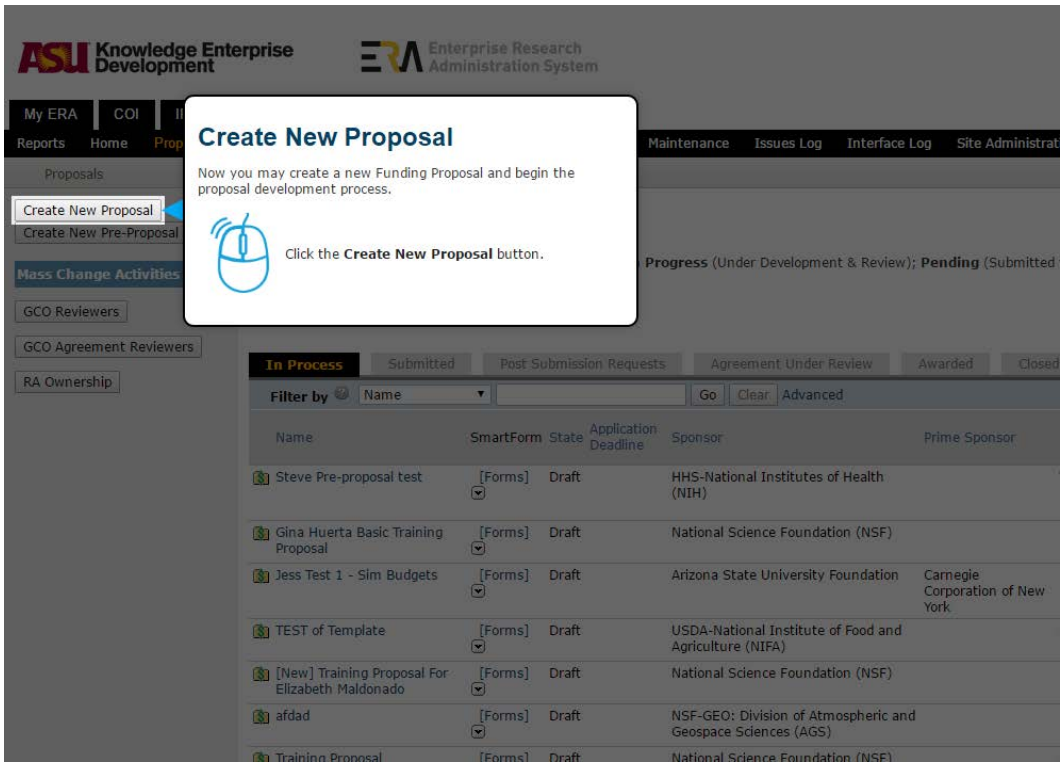

Figure 4 Dynamic Integrated Task Guidance

The display is changed upon the successful completion of each step the participant takes, and only displays one small piece of instruction at a time. This method is also integrated in that the instruction is placed next to the required action, and arrows or other markers connect the instruction with the action needed. This method can't help but be dynamic

while it is integrated into the software being presented, otherwise the full list of instructions would cover much of the application making it unusable.

(2) Dynamic non-integrated (N=27). A single instruction is displayed at a time and is updated based on the participant's previous actions. See Figure 5 below:

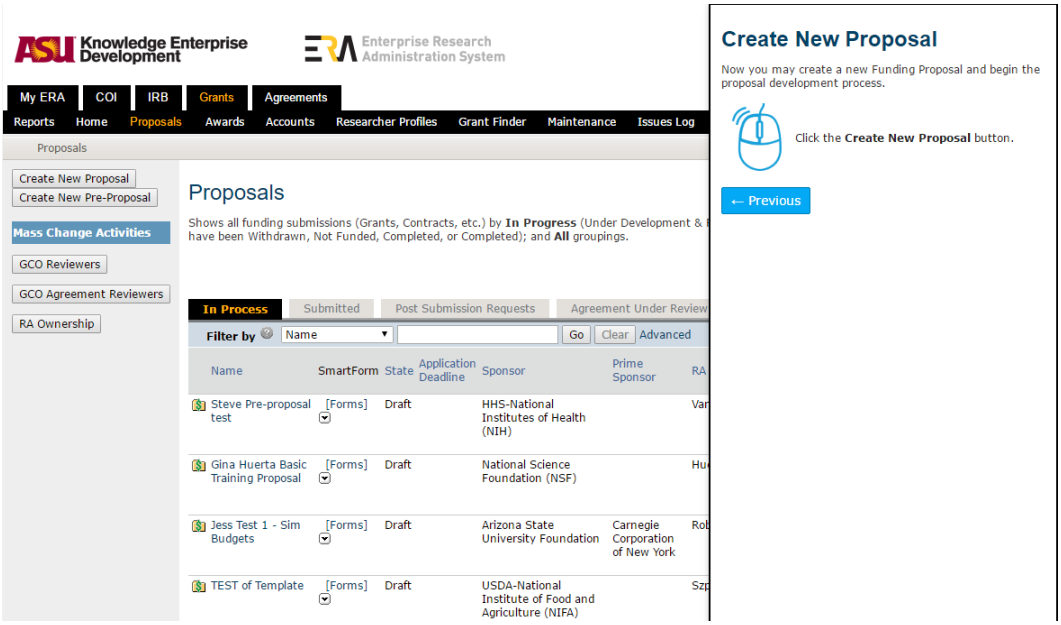

Figure 5 Dynamic Non-Integrated Task Guidance

The instruction is positioned on the far right side of the screen in a separate window from the application the participant is learning. There is nothing visually connecting the instruction to the specific elements of the application that the user must interact with.

(3) Non-dynamic non-integrated (N=22). The participants in this condition were given a static set of instructions identical to condition 1 and 2, however, the entire set of

instructions are displayed at the same time. See Figure 6 below:

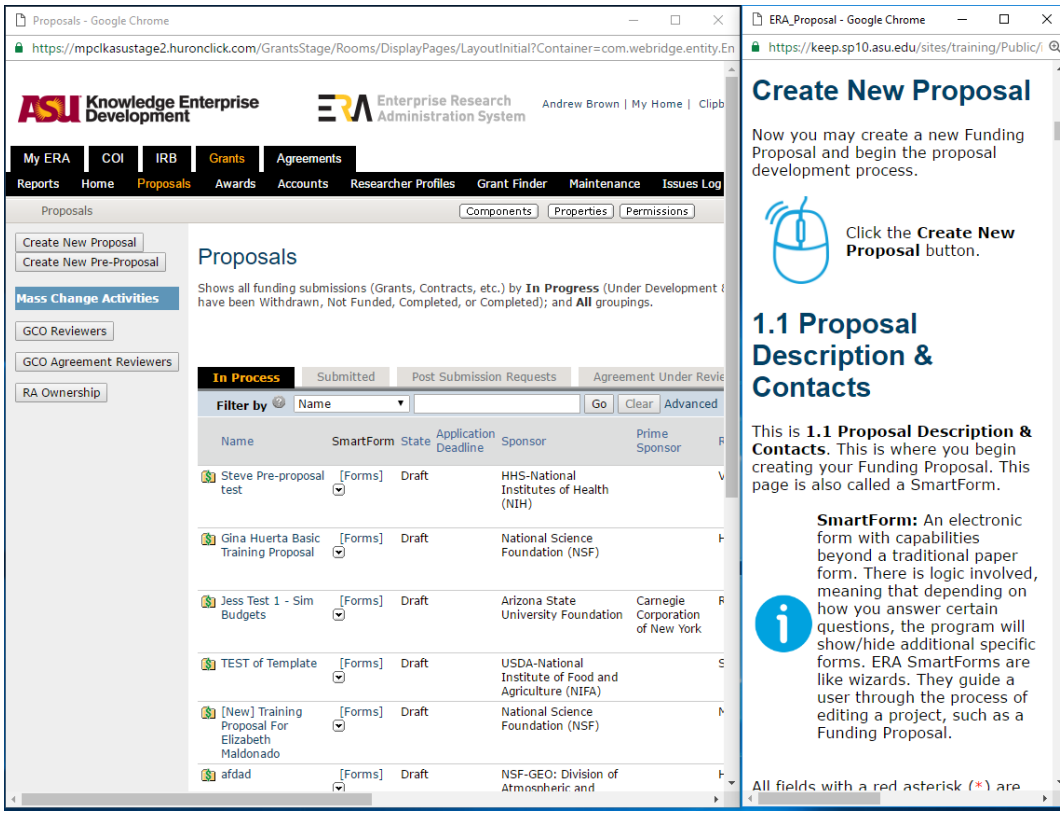

Figure 6 Non-Dynamic Non-Integrated Task Guidance

The display is not altered upon the successful completion of each step. This method is non-integrated with the required action. The list of steps is displayed on the far right side of the screen until the entire task is complete.

This study was not a factorial design because a 4th condition of a non-dynamic integrated design is not physically possible. The static aspect of such a condition would require all necessary information to be displayed at the same time regardless of what a learner has done or needs to do next, while the integrated aspect would demand all instructional content to be internal to the topic being learned. It is not possible to display this volume of information inside an application design all at the same time.

Measure of Learning

A 12-question multiple-choice test was created specifically for this study to measure learning of the instructional content as a dependent variable. Eight questions allowed only one selection and were graded as 1 or 0 with only one correct answer. Four questions allowed multiple selections and all correct responses were required to be graded as a correct response, or a 1. Any extra selections not part of the correct answer resulted in a 0 for that question. The same test was issued before and after participants received their assigned treatment. A small pilot of the study was run with 9 participants divided evenly between three treatments to verify the reliability of the knowledge measure, and to assess technical robustness of the help system types. The knowledge measure was assessed using the Spearman-Brown split-half reliability coefficient where the even and odd numbered questions were each be graded as a set and then compared with each other. The result of $p = .97$ for good reliability is reported in Table 2.

Measure of Efficiency

The dependent variable efficiency was measured by recording the time each participant took to complete each assigned training. Automatic timers tracked from the moment a participant began the first instruction in their treatment until the last. The mean time for all participants was compared between the three treatment groups. Their mean, median, standard deviation, min, max were each examined. A one-way ANCOVA was conducted to evaluate the potential effects of the treatment while controlling for the number of proposals the participant submits per year to account for prior knowledge.

Measuring Cognitive Load

Self-report methods are often used to measure cognitive load because they are easy to administer and have provided an indication of cognitive workload in many previous

studies (Ayres, 2006). Self-report measures have been shown to perform similarly to current physiological measures of cognitive load when the difference in intrinsic load between treatments was large (Joseph, 2013). It should be noted that the use of self-assessment of cognitive load is not perfect. Shadish, Cook, and Campbell (2002) indicated that a person's reaction to being tested was a threat to the internal validity of a study and that being assessed can have an impact on people's behavior. In an effort to reduce any impact, the subjects were asked the self-report questions after they complete the task they are assigned but before the post test.

Some potential biases in self-report data include negative affectivity, social desirability, and acquiescence response bias (Spector, 2006). Negative affectivity is the tendency to experience negative emotions and more stress even in the absence of any objective stressor (Watson et all, 1987). Considering negative affectivity, Chen and Spector (1991) reported significant correlations with a variety of self-reported job stressors and strains, such as role ambiguity, role conflict, interpersonal conflict, situational constraints, frustration, anger, absenteeism, doctor visits, physiological symptoms, and intention of quitting. For this study all self-report questions are directed toward the task completed and not these items identified by Chen and Spector.

Social desirability bias refers to the tendency of respondents to give answers that fit social norms instead of choosing responses that show their true feelings. Regarding social desirability, Moorman and Podsakoff (1992) did a literature search which found 33 empirical studies which may have been affected by a measure of social desirability. Their analysis of these studies found limited support for social desirability as a universal bias. Grimm (2010) summarized that bias in this personality trait is an issue when the topic involves socially sensitive subjects such as politics, or issues like drug use, cheating and smoking. This study did not deal with social norms to avoid social desirability bias.

Acquiescence bias is when respondents tend to answer survey questions in the affirmative without regard to the content of the question causing survey results to be less accurate (Watson, 1992). Acquiescence bias has been found in cases where surveys employed the use of truisms, or claims that can appear obvious or self-evident (Jackson, 1978). By using the NASA Task Load Index, this study did not have any such statements.

The dependent variable cognitive load was assessed by using a rating scale commonly used in cognitive load studies known as the Raw NASA Task Load Index (NASA-TLX). The NASA-TLX has proven to be reliably sensitive to experimentally important manipulations for over 20 years (Hart, 2006). It includes six measurements each with a 20 point scale. The ratings selected by the participant will be combined into a task load index. The assessment will include descriptions of each measurement which have shown to help participants answer accurately (Schuff, 2011). The six measurements with their descriptions are:

- Mental Demand: How much mental and perceptual activity was required? Was the task easy or demanding, simple or complex?
- Physical Demand: How much physical activity was required? Was the task easy or demanding, slack or strenuous?
- Temporal Demand: How much time pressure did you feel due to the pace at which the tasks or task elements occurred? Was the pace slow or rapid?
- Overall Performance: How successful were you in performing the task? How satisfied were you with your performance?
- Frustration Level: How irritated, stressed, and annoyed versus content, relaxed, and complacent did you feel during the task?

- Effort: How hard did you have to work (mentally and physically) to accomplish your level of performance?

Measure of Learner Attitude

Learner attitude toward the instructional material was measured by using the John M. Keller Instructional Materials Motivation Survey (IMMS) (Keller, 1987). Keller also produced another measurement tool called the Course Interest Survey (CIS). He describes the IMMS as being designed to measure students' reactions to self-directed instructional materials and the CIS as being designed to measure their reactions to instructor-led instructions (Keller, 2010). Therefore, the IMMS is more appropriate for this study. It is the most well tested and reliable instrument to use (Rodgers, 2005). Responses were recorded in a Likert scale where the participant indicates how true or not true a given statement is. Not true = 1, slightly true = 2, moderately true = 3, mostly true = 4, and very true = 5. The IMMS has 36 items that focus on 4 categories. Attention, relevance, confidence, and satisfaction. The average score for each of these categories is reported as well as the total score for each participant.

Materials

The instructional materials were made for this study to teach participants how to use the Enterprise Research Administration (ERA) system used by university research administration employees. The ERA is a web based platform for the administration of research and sponsored projects at the university. The development and submission of proposals, management of awards and integrity and assurance activities are all managed by the same system. This subject was selected for this study because all of these functions in one highly specialized web based application inherently add an amount of complexity and many unique requirements that users must deal with. Note in Figure 7, a

single sample screen similar to hundreds in the system, there are many questions, forms, and definitions that must be understood in order to use the system. These pages are already built and part of an existing platform that had been in use at the university for about 16 months before this study was conducted.

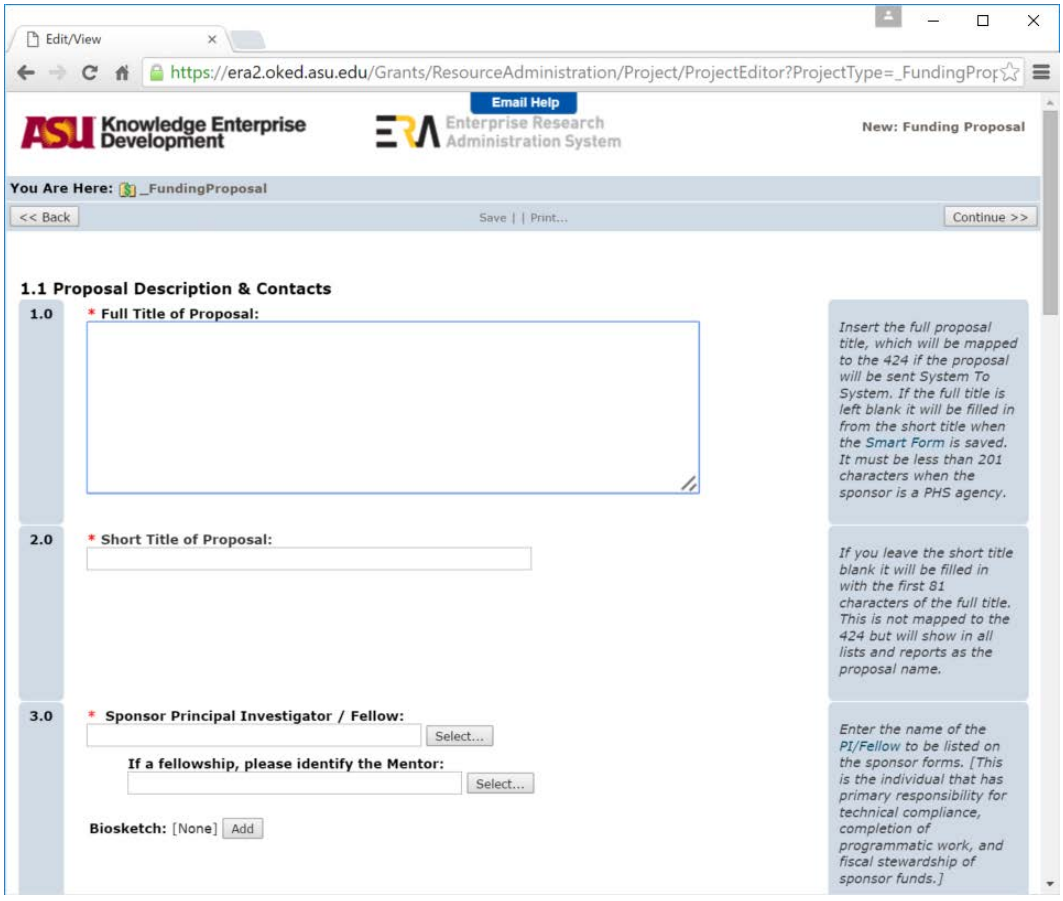

Figure 7 An Unmodified Sample Screen From ERA

The dynamic and integrated treatment features instructions integrated into the web application that update as the participant makes progress through the treatment. The action to take or item to be learned about is highlighted, any needed text is displayed in close proximity to the specific subject, and information regarding a previous or following item is not anywhere on the screen, that is to say the learner will see only one

step at a time. This instructional presentation did not exist and was created for this study. See an example in Figure 8 below.

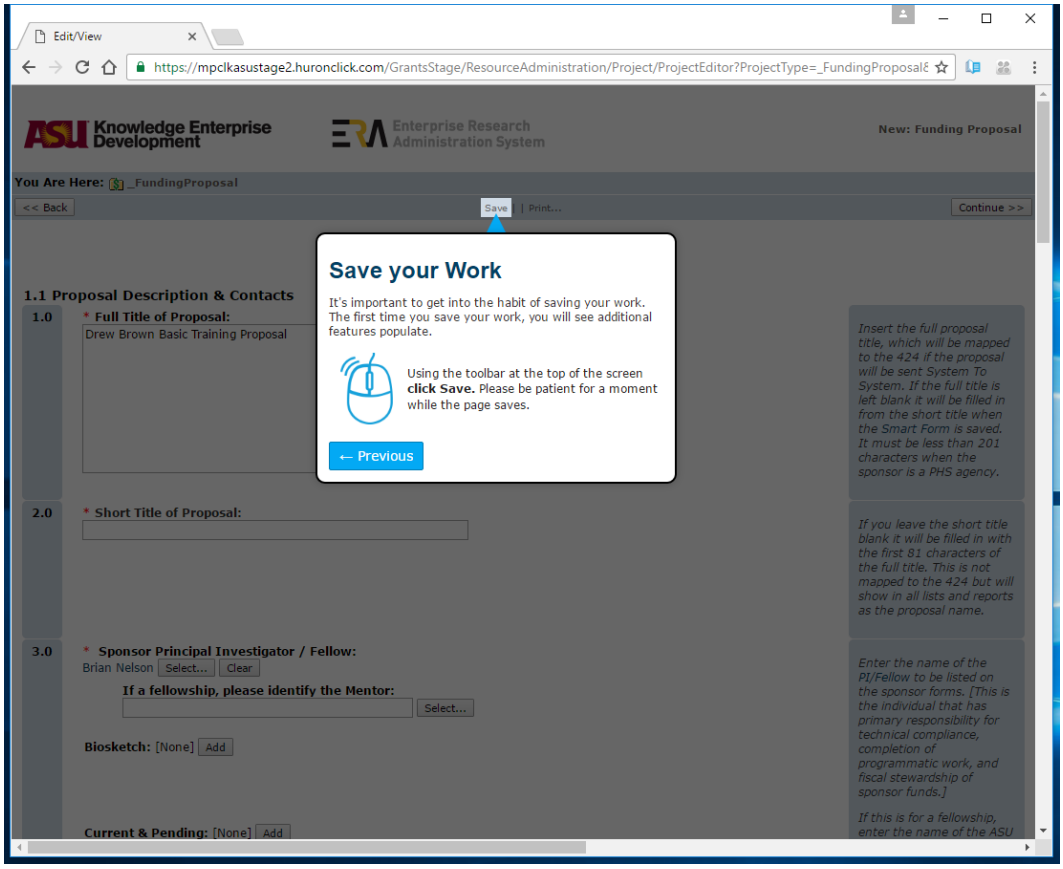

Figure 8 Dynamic Integrated Treatment Screen From ERA

The dynamic yet non-integrated treatment features instructions on the side of the screen. Their placement is not in close proximity to the specific subject. Information regarding a previous or following item is not displayed, that is to say the learner sees only one step at a time. This instructional presentation did not exist and was created for this study. See an example in Figure 9 below.

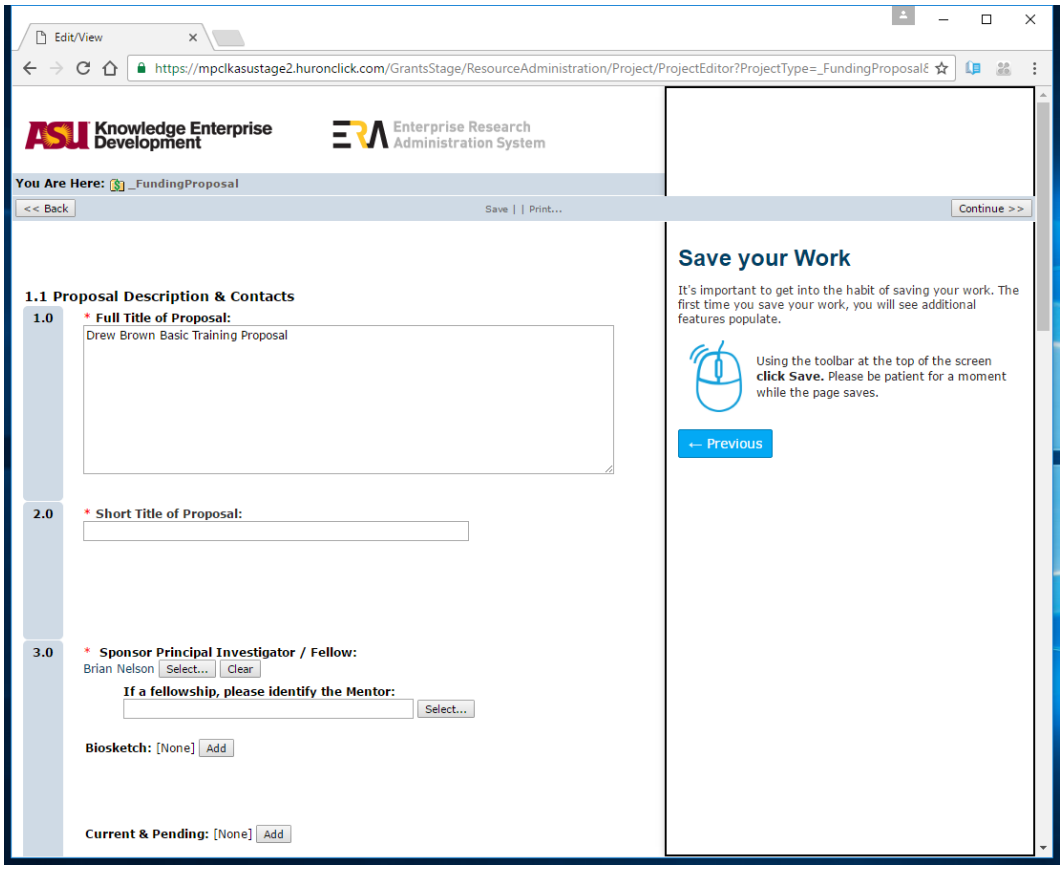

Figure 9 Dynamic Non-Integrated Treatment Screen From ERA

The non-dynamic and non-integrated treatment features instructions on the side of the screen. Their placement is not in close proximity to the specific subject. Information regarding all task steps or items is on the screen at the same time, that is to say the learner must keep track of what they have covered, what they are to learn now, and what information is for a subsequent item. Some of these instructions existed previous to this study but were re-formatted and edited for consistency to ensure the exact same content was provided via each treatment. See an example in Figure 10.

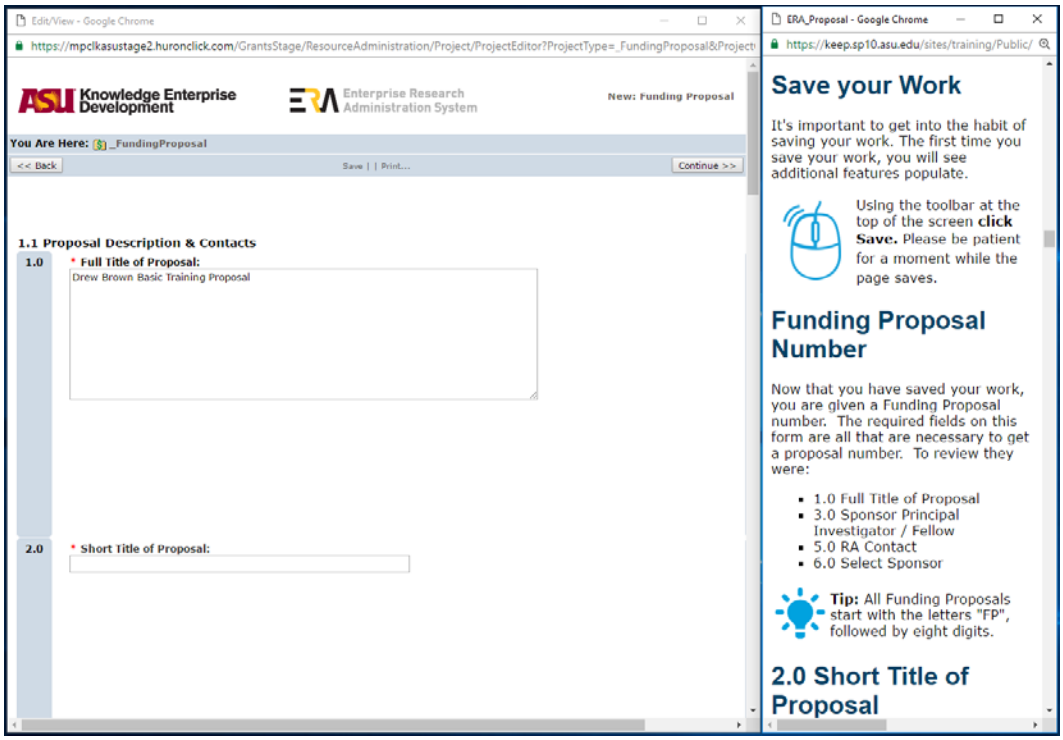

Figure 10 Non-Dynamic Non-Integrated Treatment Screen From ERA

The instructional materials were designed in an authoring application called Inline Manual. It enables an instructional designer to place training content on top of web based applications. The content loads and is displayed as part of the website. The Inline Manual software was used to create the dynamic integrated treatment quickly and without a website coding skillset. The dynamic non-integrated treatment required extensive code changes to produce the required output from Inline Manual mostly in the form of cascading style sheets (CSS) applied to the webpages and Inline Manual content. The non-dynamic non-integrated treatment was created in html from scratch using the same stylings, icons, and sizes as the previous two treatments.

All learners were taught and asked to complete the same set of tasks in the ERA system. Only the delivery method of the instruction varied between the three treatment groups. The topics covered and information provided are the same between the three

treatments. The tasks apply to the participant's use of a system that is either directly related or closely associated to their job and therefore carry some degree of motivation for learning. The assigned instructional tasks were:

- Create a funding proposal from scratch including all required fields.
- Create a budget for a Funding Proposal completing the required smartforms for personnel, travel, and direct costs.
- Rout a proposal for approval via a workflow identifying who will be asked to approve and how to add/remove approvers.

Procedure

Participants were invited to participate in the study via an email invitation promising a $25 gift card to the first 50 to complete the study. They had control of when they began, and what the conditions were like at their individual desks. They were informed that participating in the study is anonymous and not required, and that it had no bearing on their job performance evaluation. The total session time was about 90 minutes with about 60 minutes of instructional time.

Participants were given a pre-survey asking questions about their experience level in the field of research administration, the number of research proposals they generally submit a year, their role in the research proposal process, and how they would rate their own ability to learn a new business application. Next a 12 question pre-test designed to measure knowledge of the topics covered in the treatment was administered. Following the survey and pre-test, they were presented with the instruction in the form of one of the three conditions and asked to complete the assigned tasks. At this stage, the task guidance is displayed constantly for them without the need to invoke it. Following the treatment, the same 12-question multiple-choice test was administered again as a post

test. Next the participants completed the NASA-TLX to measure their cognitive load. Last they completed the IMMS survey to measure how they felt about the instruction they received.

Chapter 3

RESULTS

Removing outliers

A strong external validity of approaching a realistic business training situation as much as possible was desired. A side effect of allowing participants to complete the study at their desks on their own schedule was that they were un-supervised during the study and exposed to normal workday interruptions. This fact proved to be a critical challenge in analyzing the results. Initial participation in the study was actually 158 people. A large number (N = 62) were curious enough to initiate the study and agree to participate only to disconnect before or during the pre-test, never seeing the treatment. No useful data was gathered from this group so any data that was recorded was not included in any analysis. For those that did proceed through each treatment and measure it was not possible to monitor what was entered in the ERA system for accuracy vs blindly clicking or exiting assigned tasks prematurely. Some participants apparently skipped through entire sections indicated by a few results showing participants were done faster than seems possible. To deal with results that could be below a realistic value a minimum amount of time required to complete each of the three assigned tasks was determined. This was done by timing each task, performing every required step as quickly as possible, and recording a conservative value for a minimum time. For the independent variable of time to complete on task 1 it is not possible to have actually completed the required task in less than 5 minutes. Task 2 and task 3 were assigned the minimum times of 6 and 3 minutes respectively. Participants with results that were less than these very conservative minimums (N = 29) were not included in any analysis since their receiving of the assigned treatment was incomplete. A dedicated number of people (N = 28) apparently left the study part way through likely due to an interruption at their desk but

they returned later to complete it. The largest time to complete values looked very much like outliers when displayed on a scatter plot. For example, below see Figure 11, the distribution of values for the first task in the dynamic integrated treatment (N = 30). It is easy to suspect the data has at least two outliers and others could not be visualized with two forcing this scale. Reason would agree that it is not rational to assume that participants remained at their desk struggling through the first assigned task for 18 and 20 hours each.

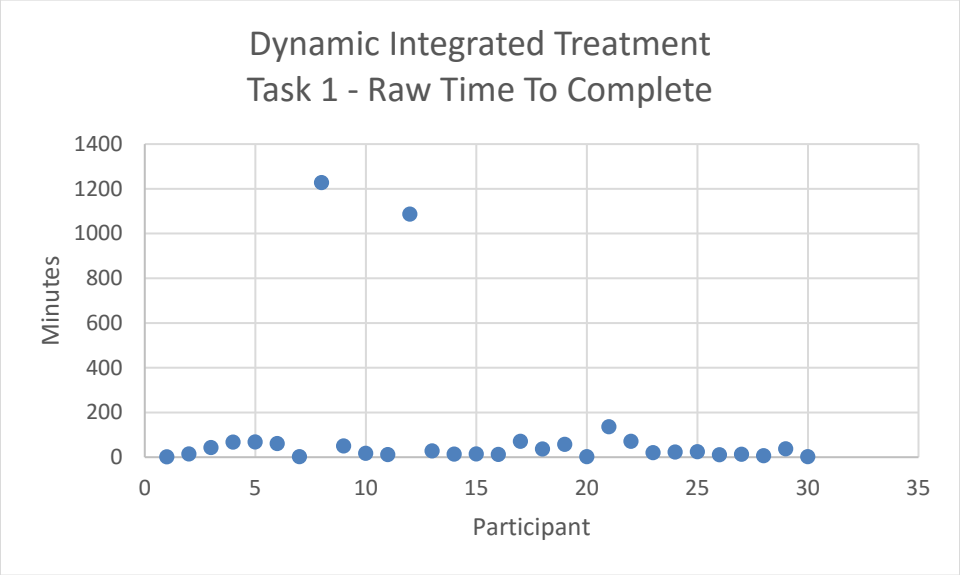

Figure 11 Raw Data Dynamic Integrated Treatment Time to Complete Task 1

To deal with these abnormally high values an absolute deviation around the median was calculated for each task in each treatment. Values found to be more than 3 standard deviations away from the median were also removed (N = 27) from the time (efficiency) analysis only on a per task basis. This method for detecting outliers is known as the median absolute deviation (MAD) and is more robust than using a standard deviation around the mean (Leys, 2013). Since these individuals did receive the intended instruction via one of the three treatments and completed all the assigned measures only the data related to the time to complete (efficiency) of the one task that was the outlier

was removed from the time to complete analysis. There were still time to complete values that appeared abnormally high, however, with multiple participants logging high times. These were not ruled out via the previously mentioned MAD method. These remain in the analysis and are likely having a negative impact on the results as they cannot be removed on speculation alone.

Having removed the previously mentioned time values that were too small and those that fell outside of the median absolute deviation the resulting scatter plot was much more normal looking which could be expected from a variable like time to complete. Below in Figure 12 is the same distribution of remaining values for the first task in the dynamic integrated treatment (N = 19).

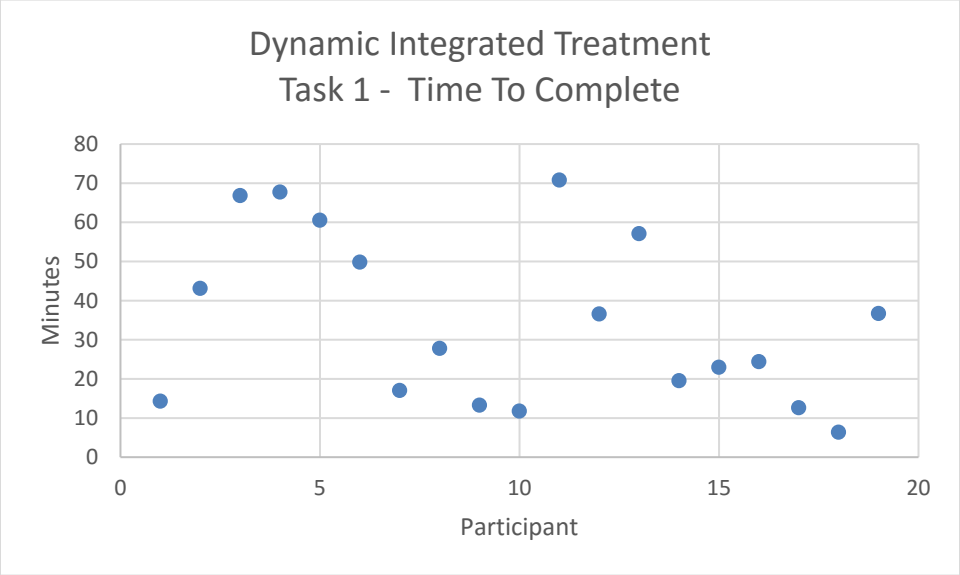

Figure 12 Dynamic Integrated Treatment Time to Complete Task 1 Without Outliers

Learning Analysis

Family wise type I error rate was .05 for all analysis. Means of the 12-question multiple choice pre-test and post-test for each treatment was computed including the delta from pre to post test. The full results were presented in Table 3. The mean score difference

from the pre-test to the post-test for the dynamic integrated, dynamic non-integrated, and non-dynamic non-integrated treatments were 2.58 (N = 19), 1.2 (N = 20), and 2.0 (N = 16) respectively. A one-way between-subjects ANCOVA was conducted to evaluate the potential effects of the form of instructional guidance on learning as measured by a post-test. Pretest scores were used as the covariates to control for the potential effects of prior knowledge. The homogeneity of slope assumption was evaluated and the interaction of treatment and pre-score was not significant $F(2,49) = 1.43$, $p = .25$. Participants assigned to the dynamic integrated condition (N 19) scored slightly higher (adjusted mean = 8.88, standard error .24) on the posttest than those assigned to the dynamic non-integrated (N 20, adjusted mean = 7.70, standard error .24) and those assigned to the non-dynamic non-integrated (N16, adjusted mean = 8.57, standard error .26) condition. The adjusted mean score Fisher's LSD pairwise comparison between the dynamic integrated and dynamic non-integrated groups was significant $p < .01$. The adjusted mean score pairwise comparison between the dynamic non-integrated and the non-dynamic non-integrated was also significant $p = .02$. See Table 1 below where the three treatments are abbreviated as follows: dynamic integrated = D_I, dynamic non-integrated = D_NI, and non-dynamic non-integrated = ND_NI.

Table 1 Post-Test Score Pairwise Comparison

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.[b]
D_I	D_NI	1.179*	.339	.001
	ND_NI	.308	.359	.395
D_NI	D_I	-1.179*	.339	.001
	ND_NI	-.870*	.353	.017
ND_NI	D_I	-.308	.359	.395
	D_NI	.870*	.353	.017

Adjusted means and standard deviations were presented in Table 4. The partial $\eta 2$ of .20 suggests a medium effect size for the treatment on post test score.

Efficiency Analysis.

The previously mentioned risks to intrinsic validity are particularly present in the efficiency analysis. Efficiency as measured by time to complete would be directly impacted by any office distractions. The time to complete each of the three assigned tasks was tracked independently. If an individual was distracted from the task, the increase in time would have only impacted the current task. Potentially the other two tasks were done without interruption. For this reason, the three tasks were evaluated for each treatment individually. A one-way ANCOVA was conducted to evaluate the potential effects of the form of instructional guidance on efficiency as measured by time to complete. The number of proposals the participant submits per year was used as a covariate to control for the potential effects of experience with the system. For task number 1 the homogeneity of slope assumption was evaluated and the interaction of

treatment and proposals per year was not significant $F(2,45) = .40$, $p = .67$. See Table 5 for the full results. The ANCOVA results show that the null hypothesis, that the adjusted means are equal, cannot be rejected $F(2,47) = 2.3$, $p = .11$. Means and standard deviations were reported in Table 6. For task number 2 the homogeneity of slope assumption was evaluated and the interaction of treatment and proposals per year was not significant $F(2,44) = 3.13$, $p = .053$. See Table 7 for the full results. The ANCOVA results show that the null hypothesis, that the adjusted means are equal, should be rejected $F(2,46) = 7.69$, $p = < .01$. The partial $\eta 2$ of .25 suggests a strong relationship between the treatment and the time spent on task 2 controlling for the proposals per year submitted by the participant. The adjusted mean time in minutes to complete task 2 for the dynamic integrated, dynamic non-integrated, and non-dynamic non-integrated treatments were 23.87 (N=18), 15.25 (N=17), and 32.56 (N=15). A Fisher's LSD test shows that the comparison of the dynamic integrated group with the non-dynamic non-integrated group was significant ($p = .03$), as was the comparison of the dynamic non-integrated with the non-dynamic non-integrated ($p < .01$). Adjusted means and standard deviations were reported in Table 8. For task number 3 the homogeneity of slope assumption was evaluated and the interaction of treatment and proposals per year was not significant $F(2,41) = 1.82$, $p = .18$. See Table 9 for the full results. The ANCOVA results show that the null hypothesis, that the adjusted means are equal, cannot be rejected $F(2,43) = .11$, $p = .9$. Means and standard deviations were reported in Table 10.

A Subsequent exploratory question on the possible interaction of efficiency and treatment group when controlling for years of employment was similar to the previous analysis controlling for proposals submitted per year in that task 1 and task 3 were not significant, task 1 $F(2, 47) = 2.96$, $p = .06$, and task 3 $F(2, 43) = .11$, $p = .9$. Task 2 was again significant with years of employment covariate $F(2, 46) = 7.42$, $p < .01$.

Cognitive Load Analysis

The NASA TLX mean score for the dynamic integrated, dynamic non-integrated, and non-dynamic non-integrated treatments were 35.56 (N = 19), 41.11 (N = 20), and 30.65 (N = 17) respectively. Minimum, maximum and standard deviations were reported in Table 11. A one-way between subjects ANCOVA was conducted to evaluate the potential effects of the form of instructional guidance on cognitive load as measured by the NASA TLX measure. To protect against the possibility that previous experience had an impact on their cognitive load results the proposals sent per year was used as a covariate in the analysis. The homogeneity of slope assumption was evaluated and the interaction of treatment and proposals per year was not significant $F(2,50) = .49$, $p = .61$. The ANCOVA results show that the null hypothesis that the adjusted means are equal cannot be rejected $F(2, 52) = 1.37$, $p = .26$. Adjusted means and standard deviations were reported in Table 12. Some exploratory analysis was also conducted to look for any other covariates that might aid in an analysis of the cognitive load data collected via the NASA TLX measure. Controlling for other recorded possible covariates like learner attitude score $F(2, 52) = 1.1$, $p = .34$, years of experience $F(2, 52) = 1.36$, $p = .27$, and pre-test score $F(2, 54) = 1.23$, $p = .3$, also failed to result in statistical significance.

Learner Attitude Analysis

A one-way between-subjects ANCOVA was conducted on the IMMS scores to evaluate the potential effects of the form of instructional guidance on learner attitude. Pre-test scores were used as a covariate to control for the potential effects of prior knowledge. The results of the Instructional Materials Motivation Survey were first checked for homogeneity of slopes. The interaction of the covariate pre-test score with the treatment was not significant $F(2, 49) = .1.04$, $p = .36$. Based on this non-significant result the requirement of homogeneity of slopes has been met. See Table 13 for the full results.

The ANCOVA results were not statistically significant $F(2, 49) = .68$, $p = .51$. No further post analysis is justified with a non-significant result. Means and standard deviations were reported in Table 14. Controlling for other recorded possible covariates like proposals submitted per year $F(2, 52) = 1.37$, $p = .26$, learner attitude score $F(2, 52) = 1.1$, $p = .34$, and years of experience $F(2, 53) = .49$, $p = .61$, also failed to result in statistical significance.

Chapter 4

Discussion

Research Questions

What is the impact of different forms of guidance (i.e. dynamic & integrated, dynamic & non-integrated, non-dynamic & non-integrated) used in a computer-based training module on learning as measured by scores on a learning measure? One of the significant findings of the study was that participants in the dynamic integrated method and those in the non-dynamic non-integrated method each had a larger increase in their post test scores than those in the dynamic non-integrated method. The mean post test score for the dynamic integrated group was the highest of the three but was not significantly higher the non-dynamic non-integrated group. It could be speculated that two of the three treatment methods each have their benefits. The dynamic integrated approach may be easy to follow and may allow the learner to focus more on what is being taught rather than the mechanics of following along. Alternatively, the non-dynamic non-integrated approach may have required a mental concentration to track application elements and their associated instructions, which in turn forced a repetition which aided in retention for better results on the post test. Perhaps the in-between method had neither of these benefits. This would suggest that mental repetition of instructional steps aids in retention and searching for on screen elements does not aid, or even inhibits retention. It is also possible that with a larger sample size or fewer outliers greater comparisons could be made between the dynamic integrated and non-dynamic non-integrated methods and their impact on instruction.

What is the impact of different forms of guidance (i.e. dynamic & integrated, dynamic & non-integrated, non-dynamic & non-integrated) used in a computer-based

training module on efficiency as measured by time to complete a computer based training? The fact that the testing environment consisted of the participants' normal work desk with all the interruptions, distractions, and complications they have made an efficiency conclusion challenging. There were simply too many uncontrolled variables for such a small sample size (task 1 N = 57, task 2 N = 50, task 3 N = 57) when examining total time to complete all three tasks. The time to complete task #2 alone was the one significant finding (p = .05). It is worth noting the adjusted mean time to complete for the dynamic non-integrated (N= 17) group was 15.25 minutes, which is far lower than the other two groups (dynamic integrated = 23.87, N = 18, non-dynamic non-integrated = 32.56, N = 15). This fastest group also scored the lowest on the post test. Why they spent the least amount of time in the training cannot be conclusively determined but it could be theorized that it was not more efficient, per se, indicated by the lower test scores. It is noteworthy that on task 2 the dynamic integrated group was significantly faster than the non-dynamic non-integrated group.

What is the impact of different forms of guidance (i.e. dynamic & integrated, dynamic & non-integrated, non-dynamic & non-integrated) used in a computer-based training module on cognitive load? No conclusions could be made regarding cognitive load. It is unclear why the measurements did not find a significant result despite the very different methods of instruction. The answer as to why may lie in the information that was being taught itself. John Sweller noted:

> It is suggested that extraneous cognitive load that interferes with learning only is a problem under conditions of high cognitive load caused by high element interactivity. Under conditions of low element interactivity, re-designing instruction to reduce extraneous cognitive load may have no appreciable consequences (Sweller, 1994).

The subject matter is described as one having a great deal of element interactivity by experts in the field of research administration, however, it could be said that the information covered in the training for this study was not yet at a sophisticated enough level to experience that interactivity.

What is the impact of different forms of guidance (i.e. dynamic integrated, dynamic & non-integrated, non-dynamic & non-integrated) used in a computer-based training module on learner attitude toward the instructional material? Comments from all three groups recorded great appreciation for the training regardless of the assigned treatment. Perhaps the participants felt such a demand for the instructional content and felt a strong intrinsic desire to learn that the effects of split attention on cognitive load were tempered. The subjects had experienced a distinct lack of instructional content for over a year despite the expectation that they would be familiar with the subject matter. If there were a sufficient number newly hired employees at a given time for a similar study, there might be more clear findings for cognitive load from such a sample population.

Observations

It is notable that for the three treatments the difference in time to complete tasks 1 and 3 were not significant but the difference between treatments for task 2 was. The reason for this difference may be in the nature of the tasks themselves. The reason these particular tasks were selected was they represent required elements for all subsequent knowledge of the system and could be addressed in about an hour of training. New employees would not be able to perform other functions without this baseline knowledge. The first task was to complete several web based forms making what is known as a basic proposal in the research administration system. This process is very

linear, the user is presented a form and must process elements on that form from top to bottom, and then move on to the next form. They repeat the top to bottom completion process for 14 forms. The scope of decisions the user makes during this task are each isolated to an individual field, one at a time. This is also the case for the third task, which was to route the proposal for approval to designated management staff. Choices made previous to task 3 had no impact on it and the routing process is also very linear. That is to say, there is low element interactivity in both task 1 and task 3. The opposite is true for the second assigned task which is to create and modify a budget to go along with the proposal that was made in the first task. The budget creation process is more open in the research administration system and not strictly sequential. Also, its details depend on the proposal information entered previously and therefore has some degree of element interactivity with previous choices and instructions. The input screens themselves do not follow the top to bottom processing path, they have elements that must be located and used in various places on the screen. The arguably more complex budget work might have exposed the learner to extraneous cognitive load in some of the treatment conditions, which the previously cited John Sweller said was caused by the instructional format (Sweller and Chandler, 1994). The nature of the tasks themselves might explain why efficiency results for task 2 were significant and the other task results were not. Additional more complex tasks that build on those used in this study might show significant differences between the conditions.

At the end of the study participants were invited to leave any comments as feedback. Of the 67 that completed the study 33 elected to do so. The majority of the comments expressed gratitude for the new training made available to them by virtue of this study. The participants normally had access to an occasionally scheduled instructor led training session, to recordings of previous instructor led sessions, or to reference

websites with limited instructions. The change from having limited on demand information to having a designed course with guided tasks teaching the foundational aspects of using the research enterprise system may have influenced their answers on the learner attitude assessment as well as made for a dominating topic in their comments. One particular comment that can be considered when evaluating the three treatments said:

> My biggest frustration with this lesson was picking out the information about the proposal from the lesson. The forms themselves were easy to use. If the proposal information was all together, separate from the actual instructions on how to complete it, I would have finished much faster and with less frustration.

This participant was in the non-dynamic non-integrated treatment and did indeed have to locate all the proposal information in the instructions and locate where to put it in the system manually. Participants in the dynamic conditions were provided the needed information just in time with when they were needed and those in the integrated condition were prompted where to enter that proposal data.

Implications

The purpose of the current study was to investigate the impacts of three different instructional presentation styles in self-paced online learning. The results revealed that one of the three methods tested was not significantly better in any way reliably measured in this study. The dynamic non-integrated treatment group had the least improvement in test scores. It did result in a faster mean time to complete than the other groups but the lower average test scores could counter any true efficiency claims and may point to a "just click next" effect on participants. Participants in this group spent the least amount of time in the training despite the constant need to locate features in the web application

themselves. This design may not be a wise choice for instructional designers especially when the highest learning result is the primary objective.

The dynamic integrated group had the highest mean score on the post-test controlling for the pre-test score. While the result was only statistically significant when compared with the dynamic non-integrated group this is a result that can guide instructional designers in how they develop instruction. In this study the dynamic integrated and non-dynamic non-integrated were equally effective in learning as measured by a pre/post-test and so both can be considered when selecting a training design. The significant result of a faster time to complete may influence instructional designers to consider dynamic imbedded methods for their next development project. This study could help the field of instructional design further embrace this style of instruction and make it more commonplace for everyday applications. As noted previously, some of the largest software companies in the world have experimented with but not yet implemented it as a standard method. With empirical evidence showing some of its benefits it is time to embrace it.

Limitations and Future Research

The impact of the learning environment and its inherent interruptions and freedom to stop and start the treatment was drastic. With so many participants seemingly exercising this freedom, the time to complete results were not indicative of the time actually spent in the treatment. Artificially long times were not detectible outliers since so many participants responded in the same way. A time to complete measure is likely not feasible when the participant has no barrier to intermittent participation and the treatment mechanism is not able to detect actual participation. The detailed methods of detecting outliers as they applied to different measures resulted in an ever

changing sample size for each analysis. The high number of participants that did not complete the study resulted in a much lower sample size. Had more of the original 158 participants completed there may have been more statistically significant results.

There are several opportunities for subsequent research. The developers of the research administration system that served as the subject matter for this study have expressed interest in co-developing additional training materials following the dynamic imbedded style. Up to this point they have generally produced videos for training, which they feel are effective teaching tools, but not adaptable to software customizations that research institutions make to their products. The embedded dynamic instructions, on the other hand, can be modified easily to cope with changes. A logical next study would be to compare the impacts of learning from their existing videos with those of learning from dynamic integrated content. When a learner watches a video on a topic it is an unavoidably passive activity. Would they experience a split-attention affect or other negative impacts?

By embedding the learning material in with the subject application an instructional designer might gain access to tools that are not normally available. For example, in the case of the research administration system used in this study the learner is expected to log in with a unique username. The system already adapts itself to them by the information it displays, showing existing records they have worked on or are associated with, indicating any important status updates, and delivering options based on their role in the application. What if the training materials adapted in much the same way? Starting simply with referring to the person by name, then providing guidance on how to respond to a recent status change associated with their work, followed by offering guidance on the other program features available to their role especially focusing on new or updated features. Would leveraging these tools result in a better overall experience?

Would both status updates and new features of the application both benefit from the same type of intervention? A study might look at how often any passively available instruction is invoked, how effective it is, and how well it is received by users when it leverages data from the system like these examples vs traditional instruction that does not adapt in this way.

Accepting for the moment the idea that an embedded instructional offering on a new feature of enterprise application is beneficial to users, how might that visual effect best be designed? A study looking at the size, manner and timing of solicitation would be needed to avoid frustrating users. There are several ways to alert a user of something ranging from the very subtle to a required acknowledgement. An instructional designer might go the very passive route and create an interface that never changes or calls attention to itself, but when invoked displays the customized assistance. Another might be comparatively more invasive by using animation and sound to call attention to customized assistance. The size and volume of the animation and sound that wold work best is not known. A study dedicated to a user's moment of decision to get help and how that interface is best designed is merited.

With both the dynamic integrated and non-dynamic non-integrated scoring significantly better than dynamic non-integrated group on the post-test controlling for pre-test, a follow up study with only the two treatments should be run. By eliminating the least desirable condition, a greater sample size is likely and that might help distinguish the remaining two. Another clear opportunity for another study would be one that better controlled the learning environment and did not attempt to approximate a real world situation that includes interruptions and uncounted distractions. Also, interviewing participants might gain more insights into their attitudes toward the instruction by getting past their opinions of the research administration system itself.

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APPENDIX A

TABLES

Table 2 Measure of Learning Pilot - Split Half Method

Student	Score	Even	Odd
1	4	2	2
2	6	3	3
3	6	3	3
4	6	3	3
5	5	2	3
6	6	3	3
7	12	6	6
8	4	2	2
9	7	3	4

Spearman-Brown coefficient 0.966

Table 3 Pre/Post Test Means Min Max and Standard Deviation

Descriptive Statistics

Treatment		N	Minimum	Maximum	Mean	Std. Deviation
D_I	PreScore	19	2	12	6.16	2.478
	PostScore	19	6	12	8.74	1.485
	TestScoreDifference	19	-1	6	2.58	1.742
	Valid N (listwise)	19				
D_NI	PreScore	20	3	10	6.55	1.986
	PostScore	21	5	11	7.76	1.640
	TestScoreDifference	20	-1	3	1.20	1.281
	Valid N (listwise)	20				
ND_NI	PreScore	16	4	10	6.69	1.662
	PostScore	17	6	11	8.59	1.121
	TestScoreDifference	16	-1	4	2.00	1.414
	Valid N (listwise)	16				

Table 4 Post-test adjusted Means and Significance

Estimates

Dependent Variable: PostScore

Treatment	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
D_I	8.882[a]	.243	8.395	9.369
D_NI	7.703[a]	.236	7.230	8.176
ND_NI	8.574[a]	.264	8.044	9.103

a. Covariates appearing in the model are evaluated at the following values: PreScore = 6.45.

Pairwise Comparisons

Dependent Variable: PostScore

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
D_I	D_NI	1.179*	.339	.001	.499	1.858
	ND_NI	.308	.359	.395	-.413	1.030
D_NI	D_I	-1.179*	.339	.001	-1.858	-.499
	ND_NI	-.870*	.353	.017	-1.580	-.161
ND_NI	D_I	-.308	.359	.395	-1.030	.413
	D_NI	.870*	.353	.017	.161	1.580

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Univariate Tests

Dependent Variable: PostScore

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Contrast	14.479	2	7.240	6.524	.003	.204
Error	56.596	51	1.110			

The F tests the effect of Treatment. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

Tests of Between-Subjects Effects

Dependent Variable: PostScore

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	66.131[a]	3	22.044	19.864	.000	.539
Intercept	135.019	1	135.019	121.669	.000	.705
PreScore	54.276	1	54.276	48.909	.000	.490
Treatment	14.479	2	7.240	6.524	.003	.204
Error	56.596	51	1.110			
Total	3970.000	55				
Corrected Total	122.727	54				

a. R Squared = .539 (Adjusted R Squared = .512)

Table 5 Task 1 Homogeneity of Slope

Tests of Between-Subjects Effects

Dependent Variable: Task 1

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2693.600[a]	5	538.720	1.996	.098	.181
Intercept	28395.003	1	28395.003	105.187	.000	.700
Treatment	1208.338	2	604.169	2.238	.118	.090
Proposals_Per_Year	860.823	1	860.823	3.189	.081	.066
Treatment * Proposals_Per_Year	218.252	2	109.126	.404	.670	.018
Error	12147.622	45	269.947			
Total	62103.856	51				
Corrected Total	14841.223	50				

a. R Squared = .181 (Adjusted R Squared = .091)

Table 6 Task 1 Adjusted Means and Significance

Tests of Between-Subjects Effects

Dependent Variable: Task 1

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2475.349[a]	3	825.116	3.136	.034	.167
Intercept	29985.091	1	29985.091	113.967	.000	.708
Proposals_Per_Year	939.540	1	939.540	3.571	.065	.071
Treatment	1211.406	2	605.703	2.302	.111	.089
Error	12365.874	47	263.104			
Total	62103.856	51				
Corrected Total	14841.223	50				

a. R Squared = .167 (Adjusted R Squared = .114)

Descriptive Statistics

Dependent Variable: Task 1

Treatment	Mean	Std. Deviation	N
D_I	37.7110	20.83101	17
D_NI	28.7774	15.39664	20
ND_NI	23.9936	11.95648	14
Total	30.4420	17.22859	51

Pairwise Comparisons

Dependent Variable: Task 1

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
D_I	D_NI	7.759	5.387	.156	-3.078	18.596
	ND_NI	12.373*	5.897	.041	.510	24.236
D_NI	D_I	-7.759	5.387	.156	-18.596	3.078
	ND_NI	4.614	5.653	.419	-6.759	15.986

ND_NI	D_I	-12.373*	5.897	.041	-24.236	-.510
	D_NI	-4.614	5.653	.419	-15.986	6.759

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Table 7 Task 2 homogeneity of slope

Tests of Between-Subjects Effects

Dependent Variable: Task 2

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4157.133[a]	5	831.427	6.244	.000	.415
Intercept	20622.306	1	20622.306	154.861	.000	.779
Treatment	2893.783	2	1446.892	10.865	.000	.331
Proposals_Per_Year	1139.773	1	1139.773	8.559	.005	.163
Treatment * Proposals_Per_Year	834.430	2	417.215	3.133	.053	.125
Error	5859.331	44	133.167			
Total	37741.045	50				
Corrected Total	10016.464	49				

a. R Squared = .415 (Adjusted R Squared = .349)

Table 8 Task 2 Adjusted Means and Significance

Tests of Between-Subjects Effects

Dependent Variable: Task 2

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3322.702[a]	3	1107.567	7.611	.000	.332
Intercept	20123.658	1	20123.658	138.291	.000	.750
Proposals_Per_Year	929.991	1	929.991	6.391	.015	.122
Treatment	2238.387	2	1119.193	7.691	.001	.251
Error	6693.762	46	145.517			
Total	37741.045	50				
Corrected Total	10016.464	49				

a. R Squared = .332 (Adjusted R Squared = .288)

Descriptive Statistics

Dependent Variable: Task 2

Treatment	Mean	Std. Deviation	N
D_I	23.8735	11.67861	18
D_NI	15.2469	6.54275	17
ND_NI	32.5642	18.16630	15
Total	23.5476	14.29747	50

Estimates

Dependent Variable: Task 2

			95% Confidence Interval	
Treatment	Mean	Std. Error	Lower Bound	Upper Bound
D_I	22.984[a]	2.865	17.217	28.751
D_NI	16.017[a]	2.942	10.096	21.938
ND_NI	32.759[a]	3.116	26.488	39.030

a. Covariates appearing in the model are evaluated at the following values: Proposals_Per_Year = 35.04.

Pairwise Comparisons

Dependent Variable: Task 2

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
D_I	D_NI	6.966	4.132	.099	-1.351	15.284
	ND_NI	-9.775*	4.239	.026	-18.308	-1.243
D_NI	D_I	-6.966	4.132	.099	-15.284	1.351
	ND_NI	-16.742*	4.279	.000	-25.356	-8.128
ND_NI	D_I	9.775*	4.239	.026	1.243	18.308
	D_NI	16.742*	4.279	.000	8.128	25.356

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Table 9 Task 3 Homogeneity of Slope

Tests of Between-Subjects Effects

Dependent Variable: Task 3

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	34.989[a]	5	6.998	.777	.572	.087
Intercept	1393.124	1	1393.124	154.648	.000	.790
Treatment	16.074	2	8.037	.892	.418	.042
Proposals_Per_Year	.708	1	.708	.079	.781	.002
Treatment * Proposals_Per_Year	32.698	2	16.349	1.815	.176	.081
Error	369.342	41	9.008			
Total	3012.661	47				
Corrected Total	404.331	46				

a. R Squared = .087 (Adjusted R Squared = -.025)

Table 10 Task 3 Adjusted Means and Significance

Tests of Between-Subjects Effects

Dependent Variable: Task 3

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2.291[a]	3	.764	.082	.970	.006
Intercept	1450.619	1	1450.619	155.150	.000	.783
Proposals_Per_Year	.091	1	.091	.010	.922	.000
Treatment	2.029	2	1.015	.109	.897	.005
Error	402.040	43	9.350			
Total	3012.661	47				
Corrected Total	404.331	46				

a. R Squared = .006 (Adjusted R Squared = -.064)

Descriptive Statistics

Dependent Variable: Task 3 Min

Treatment	Mean	Std. Deviation	N
D_I	10.0279	6.40075	19
D_NI	11.9446	12.39850	21
ND_NI	14.9222	20.89802	17
Total	12.1937	14.02583	57

Pairwise Comparisons

Dependent Variable: Task 3

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a] Lower Bound	Upper Bound
D_I	D_NI	.498	1.078	.646	-1.675	2.672
	ND_NI	.208	1.133	.855	-2.078	2.494
D_NI	D_I	-.498	1.078	.646	-2.672	1.675
	ND_NI	-.290	1.104	.794	-2.516	1.935
ND_NI	D_I	-.208	1.133	.855	-2.494	2.078

D_NI	.290	1.104	.794	-1.935	2.516

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Table 11 NASA TLX Means Min Max and Standard Deviation

Descriptive Statistics

Treatment		N	Minimum	Maximum	Mean	Std. Deviation
D_I	Overall TLX	19	7.33333	67.00000	35.5614035	17.31981404
	Valid N (listwise)	19				
D_NI	Overall TLX	20	6.33333	81.66667	41.1166667	20.73172414
	Valid N (listwise)	20				
ND_NI	Overall TLX	17	7.00000	83.33333	30.6470588	19.27810740
	Valid N (listwise)	17				

Table 12 NASA TLX Adjusted Means and Significance

Tests of Between-Subjects Effects

Dependent Variable: Overall TLX

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1683.482[a]	5	336.696	.893	.493	.082
Intercept	42669.853	1	42669.853	113.225	.000	.694
Treatment	418.228	2	209.114	.555	.578	.022
Proposals_Per_Year	240.845	1	240.845	.639	.428	.013
Treatment * Proposals_Per_Year	370.777	2	185.388	.492	.614	.019
Error	18842.912	50	376.858			
Total	93318.556	56				
Corrected Total	20526.395	55				

a. R Squared = .082 (Adjusted R Squared = -.010)

Descriptive Statistics

Dependent Variable: Overall TLX

Treatment	Mean	Std. Deviation	N
D_I	35.5614035	17.31981404	19
D_NI	41.1166667	20.73172414	20
ND_NI	30.6470588	19.27810740	17
Total	36.0535714	19.31857083	56

Tests of Between-Subjects Effects

Dependent Variable: Overall TLX

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1312.706[a]	3	437.569	1.184	.325	.064
Intercept	43186.751	1	43186.751	116.881	.000	.692
Proposals_Per_Year	298.488	1	298.488	.808	.373	.015
Treatment	1012.990	2	506.495	1.371	.263	.050
Error	19213.689	52	369.494			
Total	93318.556	56				
Corrected Total	20526.395	55				

a. R Squared = .064 (Adjusted R Squared = .010)

Table 13 IMMS Homogeneity of Slope

Tests of Between-Subjects Effects

Dependent Variable: IMMS Total

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1940.697[a]	5	388.139	.704	.623	.067
Intercept	74493.419	1	74493.419	135.191	.000	.734
Treatment	1214.808	2	607.404	1.102	.340	.043
PreScore	26.043	1	26.043	.047	.829	.001
Treatment * PreScore	1149.305	2	574.652	1.043	.360	.041
Error	27000.212	49	551.025			
Total	1050305.000	55				
Corrected Total	28940.909	54				

a. R Squared = .067 (Adjusted R Squared = -.028)

Table 14 IMMS Adjusted Means and Significance

Tests of Between-Subjects Effects

Dependent Variable: IMMS Total

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	791.393[a]	3	263.798	.478	.699	.027
Intercept	95753.484	1	95753.484	173.482	.000	.773
PreScore	39.326	1	39.326	.071	.791	.001
Treatment	751.411	2	375.706	.681	.511	.026
Error	28149.517	51	551.951			
Total	1050305.000	55				
Corrected Total	28940.909	54				

a. R Squared = .027 (Adjusted R Squared = -.030)

Descriptive Statistics

Dependent Variable: IMMS Total

Treatment	Mean	Std. Deviation	N
D_I	137.6842	20.42888	19
D_NI	131.6000	28.83784	20
ND_NI	140.4375	18.02949	16
Total	136.2727	23.15044	55

Pairwise Comparisons

Dependent Variable: IMMS Total

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a] Lower Bound	Upper Bound
D_I	D_NI	5.921	7.551	.437	-9.239	21.081
	ND_NI	-2.974	8.014	.712	-19.063	13.116
D_NI	D_I	-5.921	7.551	.437	-21.081	9.239
	ND_NI	-8.895	7.883	.264	-24.720	6.931
ND_NI	D_I	2.974	8.014	.712	-13.116	19.063
	D_NI	8.895	7.883	.264	-6.931	24.720

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

APPENDIX B

IRB APPROVAL

From: research.integrity@asu.edu
To: Drew Brown
Subject: STUDY00004526 has been approved
Date: Thursday, June 23, 2016 8:11:36 AM

Template:IRB_T_Post-Review_Approved

Notification of Approval

To: Andrew Brown

Link: STUDY00004526

P.I.: Brian Nelson

Title: A Case Study of Modern Instruction in an Enterprise Environment

Description: This submission has been approved. You can access the correspondence letter using the following link:

Correspondence_for_STUDY00004526.pdf(0.01)

To review additional details, click the link above to access the project workspace.

APPENDIX C

CONCENT TO PARTICIPATE

Informed Consent Form

Research Study Title: A Case Study of Modern Instruction in an Enterprise Environment
Investigator: Andrew Brown

Introduction
This research study attempts to discover the best type of instructional design for teaching how to use the ASU Enterprise Research Administration system (ERA).

Procedures
You will be asked to complete a short questionnaire as well as a pre-test before beginning the training. Following the training you will be asked to complete a post-test and some survey questions. The pre and post test simply help us learn if the instructional material was able to convey information in a memorable way.

Benefits
There are no direct benefits for participants. However, it is hoped that through your participation we will learn more about how to teach subsequent lessons and other research administrators how to use ERA. Your time will improve our processes and help the university. The first 50 participants will be given a $25 Amazon gift card distributed via email within 4 weeks of completion.

Alternative training options
You may also learn more about using ERA using information posted on the researchadmin.asu.edu website. Videos and tutorials are posted that cover many of the same ERA topics found in this study.

Anonymity
Your responses will be anonymous. Data obtained from participants will only be reported in an aggregate format (by reporting only combined results and never reporting individual ones). Only the email address for the gift card delivery will be collected separately from the study responses.

Participation
You must be 18 or older to participate. Participation in this research study is completely voluntary and expected to take about 90 minutes. About 75 people will participate. You have the right to withdraw at any time or refuse to participate entirely without jeopardy to your standing with the university or employment if applicable. If you desire to withdraw, please close your internet browser and notify the principal investigator via email: drew.brown@asu.edu.

Questions about the Research
If you have questions regarding this study, you may contact the principal

investigator Brian Nelson at 480-965-0383, or Drew Brown at 480-965-6596. This study has been reviewed and approved by the Arizona State University Institutional Review Board. If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788.

APPENDIX D

PRE-SURVEY

Thank you for your participation! First just a few questions about you and your experience with ERA.

How would you rate your own ability to learn a new business application on the computer?

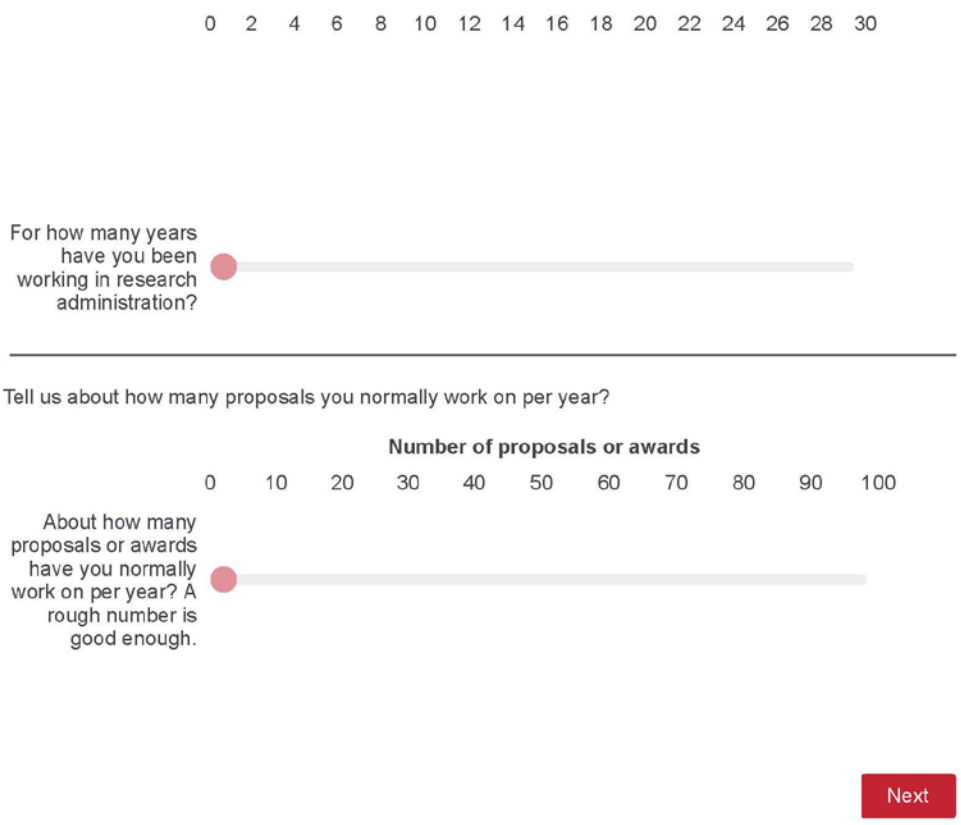
	Poor	Fair	Neutral	Good	Excellent
	0	1	2	3	4	5
How would you rate your own ability to learn a new business application on the computer?						

What is your primary role with regard to the Enterprise Research Administration (ERA) system?

- I work with researchers to enter or submit proposals
- I review proposals entered by others for submission
- I work on contracts once an award has been received
- I provide administrative or technical support to others who use it
- Other (please specify)

Tell us how long you have been working in research administration.

Brand new or N/A	**Years**	30 years or more


0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
For how many years have you been working in research administration?
Tell us about how many proposals you normally work on per year?
Number of proposals or awards
0 10 20 30 40 50 60 70 80 90 100
About how many proposals or awards have you normally work on per year? A rough number is good enough.
Next

APPENDIX E

PRE/POST TEST

Q1 Which items are required in a proposal to get a proposal number? (Choose all that apply.)

- ❑ Proposal Title (1)
- ❑ Principal Investigator (2)
- ❑ Funding Announcement Number (3)
- ❑ Budget (4)
- ❑ RA Contact (5)
- ❑ Sponsor (6)

Q2 When dividing recognition between multiple investigators

- ❍ the recognition total must be equal to 100% (1)
- ❍ all personnel must be from the same unit (2)
- ❍ the recognition total must account for the applied interest rate (3)
- ❍ at least three investigators are required (4)

Q3 In an ERA sponsor search field, entering in %NSF would show you which of the following results? (Choose all that apply.)

- ❑ National Science Foundation (NSF) (1)
- ❑ Addiction Technology Transfer Center (2)

- ❑ Technology Assessment & Transfer (3)
- ❑ National Aeronautics Space Administration (NASA) (4)

Q4 Which of the following would prevent a proposal from moving past a draft state? (Choose all that apply.)

- ❑ No budget or a $0 budget (1)
- ❑ A sponsor of TBD (2)
- ❑ A Co-Investigator of TBD (3)
- ❑ A Graduate Student of TBD (4)

Q5 What inflation rate is used by ASU unless one is required by the sponsor?

- ❍ 3% (1)
- ❍ 5% (2)
- ❍ 2.5% (3)
- ❍ 7% (4)

Q6 When budgeting salary information for a faculty member on a multi year proposal

- ❍ ERA will increase the salary by the inflation rate (1)
- ❍ ERA will increase the salary and ERE by 3% (2)

- ERA will assume a no-cost extension for the final year (3)
- ERA will allow adjustments to the ERE (4)

Q7 When budgeting for academic year graduate students what is required when entering their salary?

- Multiply by 2, divide by 9, multiply by 12 to get their full time annual equivalent salary (1)
- divide by 2 since they only work up to 20 hours per week (2)
- enter 2 graduate students together as though they were 1 full time person (3)
- replace any TBD entries with real names before submitting for approval (4)

Q8 When budgeting travel costs, which of the following is true regarding lodging rates

- ASU budgets a standardized lodging rate for all research travel (1)
- ERA calculates lodging rates based on the destination (2)
- You are required to look up lodging rates on a travel website (3)
- Lodging rates are based off the total budget amount (4)

Q9 When submitting a proposal for departmental review, the Department Hierarchical method will

- ❍ contact all investigators first (1)
- ❍ contact the College Approver first (2)
- ❍ contact all approvers simultaneously (4)
- ❍ contact departments in order as they were added to the proposal (3)

Q10 Once a proposal has been submitted for department review

- ❍ the funding proposal is locked and no editing is permitted until department reviews are completed (1)
- ❍ only minor budget changes are permitted based on feedback from the first reviewer (2)
- ❍ the submission deadline is no longer a concern (3)
- ❍ changes are automatically sent to approvers (4)

Q11 Once a department review has begun, you can learn who has completed their review by

- ❍ using the Dept Reviewers tab on the proposal workspace (1)
- ❍ contacting the ERA Helpdesk during business hours (2)
- ❍ editing the proposal to see the error displayed indicating who still needs to review (3)
- ❍ asking each reviewer for an update (4)

Q12 Which documents must be attached to a proposal before it can be submitted for department approval? (Choose all that apply.)

- ❑ The Project Summary / Abstract (1)
- ❑ The Budget Justification (2)
- ❑ The References Cited (3)
- ❑ The Sponsor Bundle (4)

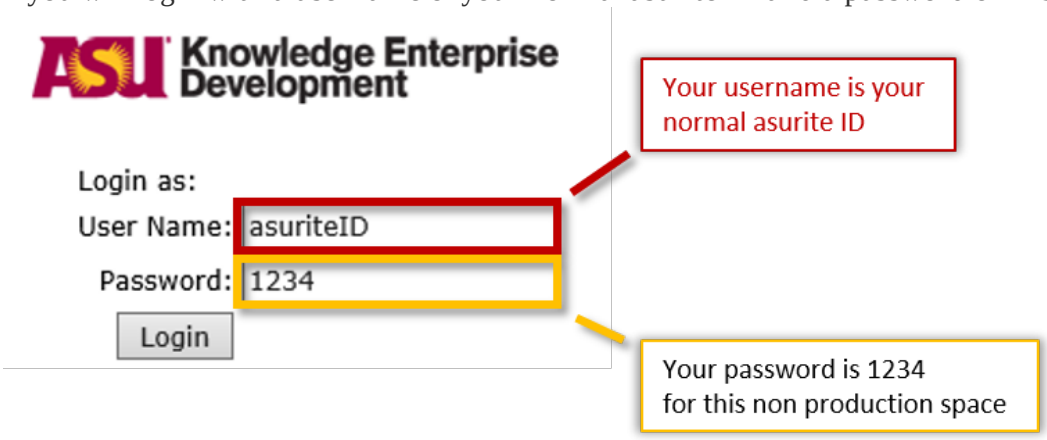
APPENDIX F

LOGIN INSTRUCTIONS

Training Login Information
The instructional section is about to begin. It is strongly recommended that you use a desktop monitor rather than a smaller laptop screen.

This training will take place on a non production ERA server. This means that your actions will not initiate contact with sponsors or other ASU employees. It also means that you will login with a temporary account.

Soon you will login with a username of your normal asurite ID and a password of **1234**.



APPENDIX G

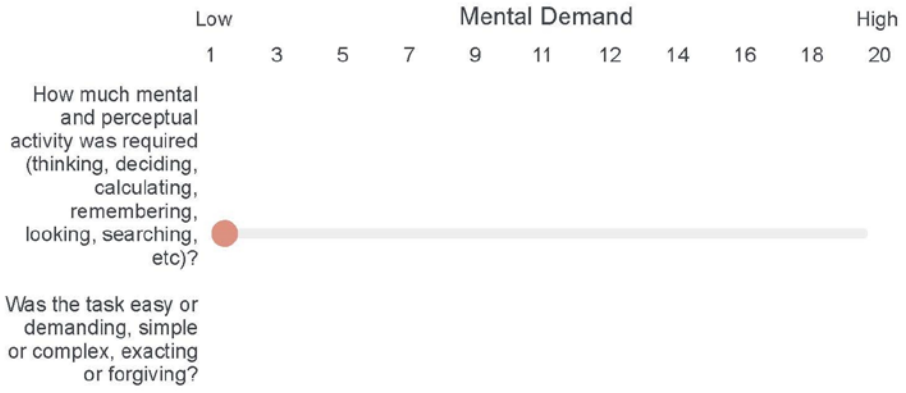
COGNITIVE LOAD ASSESSMENT NASA TLX

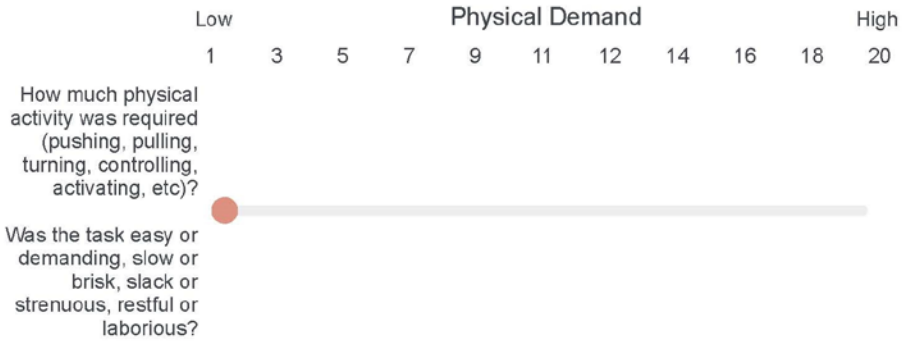
Workload

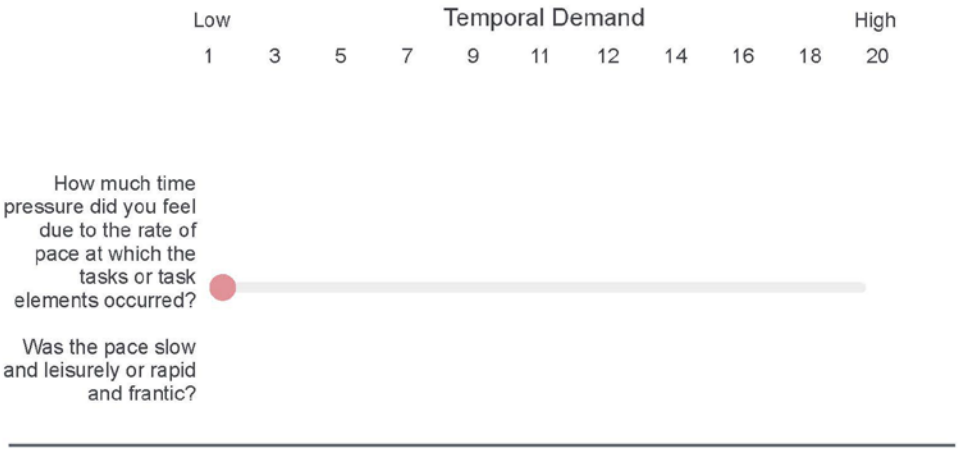
That's it for the lesson topics. Now we'd like to know more about how that went. Please answer the following questions.

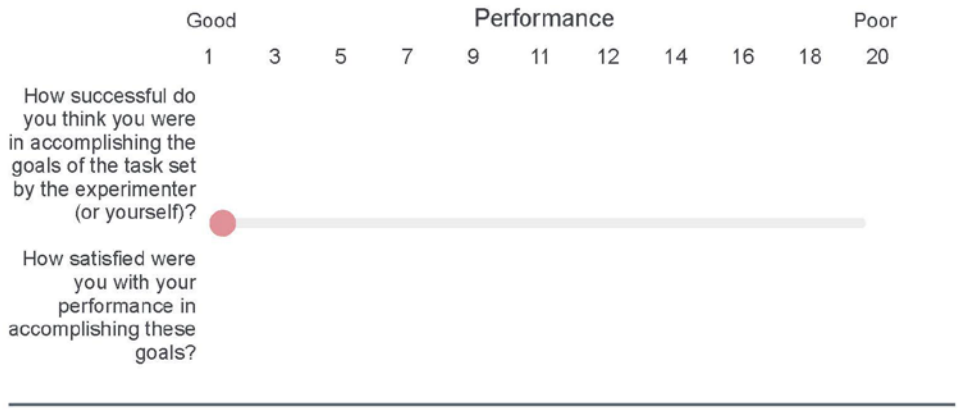
Task Questionnaire - Part 1

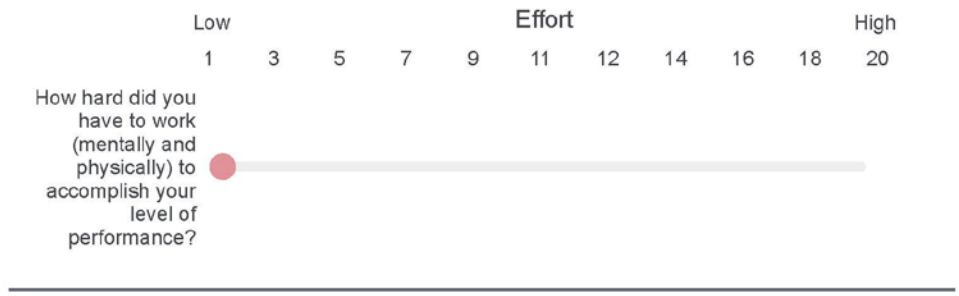
Click on each scale at the point that best indicates your experience of the task

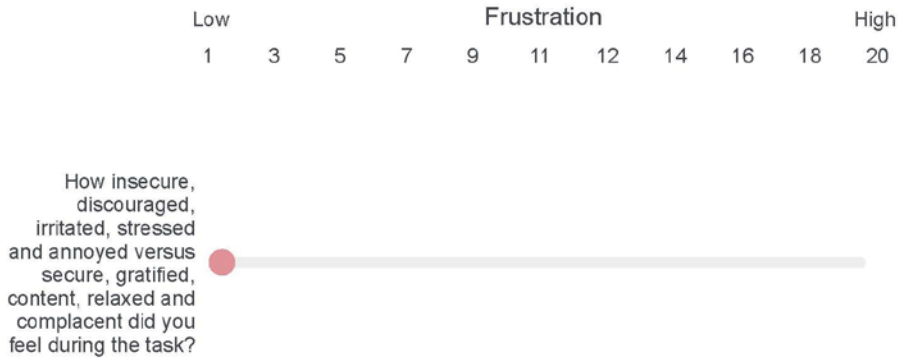





Low
Temporal Demand
High
1 3 5 7 9 11 12 14 16 18 20
How much time pressure did you feel due to the rate of pace at which the tasks or task elements occurred?
Was the pace slow and leisurely or rapid and frantic?


Good
Performance
Poor
1 3 5 7 9 11 12 14 16 18 20
How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)?
How satisfied were you with your performance in accomplishing these goals?


Low
Effort
High
1 3 5 7 9 11 12 14 16 18 20
How hard did you have to work (mentally and physically) to accomplish your level of performance?



Next

Click on the factor that represents the more important contributor to workload for the task

Effort

How hard did you have to work (mentally and physically) to accomplish your level of performance?

Performance

How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)? How satisfied were you with your performance in accomplishing these goals?

Next

Click on the factor that represents the more important contributor to workload for the task

Temporal Demand

How much time pressure did you feel due to the rate of pace at which the tasks or task elements occurred? Was the pace slow and leisurely or rapid and frantic?

Frustration

How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?

Previous Next

Click on the factor that represents the more important contributor to workload for the task

Temporal Demand

How much time pressure did you feel due to the rate of pace at which the tasks or task elements occurred? Was the pace slow and leisurely or rapid and frantic?

Effort

How hard did you have to work (mentally and physically) to accomplish your level of performance?

Previous Next

Click on the factor that represents the more important contributor to workload for the task

Physical Demand

How much physical activity was required (e.g. pushing, pulling, turning, controlling, activating, etc)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?

Frustration

How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?

Previous Next

Click on the factor that represents the more important contributor to workload for the task

Performance

How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)? How satisfied were you with your performance in accomplishing these goals?

Frustration

How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?

Previous Next

Click on the factor that represents the more important contributor to workload for the task

Physical Demand

How much physical activity was required (e.g. pushing, pulling, turning, controlling, activating, etc)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?

Temporal Demand

How much time pressure did you feel due to the rate of pace at which the tasks or task elements occurred? Was the pace slow and leisurely or rapid and frantic?

Previous Next

Click on the factor that represents the more important contributor to workload for the task

Physical Demand

How much physical activity was required (e.g. pushing, pulling, turning, controlling, activating, etc)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?

Performance

How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)? How satisfied were you with your performance in accomplishing these goals?

Previous Next

Click on the factor that represents the more important contributor to workload for the task

Temporal Demand

How much time pressure did you feel due to the rate of pace at which the tasks or task elements occurred? Was the pace slow and leisurely or rapid and frantic?

Mental Demand

How much mental and perceptual activity was required (e.g. thinking, deciding, calculating, remembering, looking, searching, etc)? Was the task easy or demanding, simple or complex, exacting or forgiving?

Previous Next

Click on the factor that represents the more important contributor to workload for the task

Frustration

How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?

Effort

How hard did you have to work (mentally and physically) to accomplish your level of performance?

Previous Next

Click on the factor that represents the more important contributor to workload for the task

Performance

How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)? How satisfied were you with your performance in accomplishing these goals?

Mental Demand

How much mental and perceptual activity was required (e.g. thinking, deciding, calculating, remembering, looking, searching, etc)? Was the task easy or demanding, simple or complex, exacting or forgiving?

Previous Next

Click on the factor that represents the more important contributor to workload for the task

Performance

How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)? How satisfied were you with your performance in accomplishing these goals?

Temporal Demand

How much time pressure did you feel due to the rate of pace at which the tasks or task elements occurred? Was the pace slow and leisurely or rapid and frantic?

Previous Next

Click on the factor that represents the more important contributor to workload for the task

Mental Demand

How much mental and perceptual activity was required (e.g. thinking, deciding, calculating, remembering, looking, searching, etc)? Was the task easy or demanding, simple or complex, exacting or forgiving?

Effort

How hard did you have to work (mentally and physically) to accomplish your level of performance?

Previous Next

Click on the factor that represents the more important contributor to workload for the task

Mental Demand

How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?

Physical Demand

How much physical activity was required (e.g. pushing, pulling, turning, controlling, activating, etc)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?

Previous Next

Click on the factor that represents the more important contributor to workload for the task

Effort

How hard did you have to work (mentally and physically) to accomplish your level of performance?

Physical Demand

How much physical activity was required (e.g. pushing, pulling, turning, controlling, activating, etc)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?

Previous Next

Click on the factor that represents the more important contributor to workload for the task

Frustration

How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?

Mental Demand

How much mental and perceptual activity was required (e.g. thinking, deciding, calculating, remembering, looking, searching, etc)? Was the task easy or demanding, simple or complex, exacting or forgiving?

Previous Next

Response	Q1 - How much mental and perceptual activity was required (thinking, deciding, c...	Q21 - How much physical activity was required (pushing, pulling, turning, control...	Q3 - How much time pressure did you feel due to the rate of pace at which the ta...	Q4 - How successful do you think you were in accomplishing the goals of the task...	Q5 - How hard did you have to work (mentally and physically) to accomplish your...	Q6 - How insecure, discouraged, irritated, stressed and annoyed versus secure, g...
1	13	1	10	18	17	8
2	6	0	15	18	3	13
3	17	1	3	2	12	12
4	12	0	7	13	5	11
5	15	6	2	2	15	10
6	13	2	8	2	14	3
7	13	0	2	18	10	3
8	12	12	11	4	5	7
9	8	4	6	9	5	7
10	1	0	0	20	0	0
11	7	14	5	3	3	0
12	9	2	4	2	3	6
13	4	2	2	15	2	1
14	9	0	7	0	7	0
15	11	0	5	0	3	3
16	6	0	12	0	3	0
17	6	0	1	3	5	1
18	7	1	3	1	1	1
19	2	1	1	1	2	2
20	20	5	5	8	20	18
21	20	0	14	16	17	20
22	9	3	13	14	15	18
23	9	0	4	13	9	18
24	13	0	0	8	4	20
25	8	0	9	12	10	11
26	13	15	6	4	9	11
27	12	10	12	6	0	10
28	17	1	1	2	0	5
29	7	11	2	18	4	2
30	9	5	8	0	9	10
31	6	6	5	16	8	3
32	4	0	5	9	5	12
33	1	1	1	20	1	1

Response	Q1 - How much mental and perceptual activity was required (thinking, deciding, c...	Q21 - How much physical activity was required (pushing, pulling, turning, control...	Q3 - How much time pressure did you feel due to the rate of pace at which the ta...	Q4 - How successful do you think you were in accomplishing the goals of the task...	Q5 - How hard did you have to work (mentally and physically) to accomplish your...	Q6 - How insecure, discouraged, irritated, stressed and annoyed versus secure, g...
34	7	3	3	0	11	3
35	10	0	0	1	12	0
36	6	0	5	0	5	2
37	5	1	2	1	3	1
38	3	1	2	1	2	1
39	3	1	1	1	1	1
40	17	9	17	15	18	16
41	3	1	17	10	3	13
42	10	2	15	3	10	3
43	8	2	4	17	9	1
44	13	6	3	2	11	3
45	7	13	4	1	6	6
46	11	7	6	3	11	3
47	9	3	8	2	5	5
48	6	2	2	7	5	9
49	7	2	6	3	5	5
50	6	6	4	0	11	0
51	9	0	3	3	6	0
52	7	0	0	1	3	1
53	6	2	3	2	2	1
54	7	1	1	0	1	1
55	4	0	0	4	0	0
56	2	0	2	1	1	0

NASA Task Load Index Results

Response	Click on the factor that represents the more important contributor to workl...														
1	Effort	Temporal De	Effort	Frustration	Frustration	Temporal De	Performance	Mental Dem	Effort	Mental Dem	Temporal De	Effort	Mental Dem	Effort	Mental Dem
2	Performance	Temporal De	Temporal De	Frustration	Frustration	Temporal De	Performance	Temporal De	Frustration	Performance	Temporal De	Mental Dem	Mental Dem	Effort	Frustration
3	Effort	Frustration	Effort	Frustration	Frustration	Temporal De	Performance	Mental Dem	Frustration	Mental Dem	Performance	Effort	Mental Dem	Effort	Frustration
4	Performance	Temporal De	Temporal De	Frustration	Performance	Temporal De	Performance	Mental Dem	Effort	Performance	Performance	Mental Dem	Mental Dem	Effort	Mental Dem
5	Effort	Temporal De	Effort	Frustration	Performance	Temporal De	Performance	Mental Dem	Effort	Mental Dem	Performance	Mental Dem	Mental Dem	Effort	Mental Dem
6	Effort	Frustration	Effort	Frustration	Frustration	Temporal De	Performance	Mental Dem	Effort	Mental Dem	Temporal De	Mental Dem	Mental Dem	Effort	Mental Dem
7	Performance	Frustration	Temporal De	Frustration	Frustration	Temporal De	Performance	Mental Dem	Frustration	Mental Dem	Performance	Effort	Mental Dem	Effort	Frustration
8	Effort	Frustration	Effort	Frustration	Frustration	Physical Den	Performance	Mental Dem	Frustration	Mental Dem	Performance	Effort	Mental Dem	Effort	Frustration
9	Effort	Frustration	Temporal De	Frustration	Performance	Temporal De	Performance	Mental Dem	Frustration	Mental Dem	Performance	Mental Dem	Mental Dem	Effort	Frustration
10	Performance	Temporal De	Temporal De	Frustration	Performance	Temporal De	Performance	Mental Dem	Frustration	Mental Dem	Performance	Mental Dem	Mental Dem	Effort	Mental Dem
11	Performance	Temporal De	Temporal De	Physical Den	Performance	Temporal De	Performance	Mental Dem	Effort	Mental Dem	Performance	Mental Dem	Mental Dem	Effort	Mental Dem
12	Performance	Frustration	Temporal De	Frustration	Performance	Temporal De	Performance	Mental Dem	Frustration	Mental Dem	Temporal De	Mental Dem	Mental Dem	Effort	Frustration
13	Performance	Temporal De	Temporal De	Frustration	Performance	Temporal De	Performance	Temporal De	Effort	Performance	Temporal De	Effort	Physical Den	Effort	Frustration
14	Performance	Temporal De	Temporal De	Frustration	Performance	Temporal De	Performance	Temporal De	Effort	Performance	Temporal De	Effort	Mental Dem	Effort	Mental Dem
15	Effort	Frustration	Effort	Frustration	Performance	Temporal De	Performance	Mental Dem	Effort	Mental Dem	Performance	Effort	Mental Dem	Effort	Mental Dem
16	Performance	Temporal De	Temporal De	Frustration	Performance	Temporal De	Performance	Temporal De	Effort	Performance	Performance	Effort	Mental Dem	Effort	Mental Dem
17	Performance	Temporal De	Effort	Frustration	Performance	Temporal De	Performance	Mental Dem	Effort	Performance	Performance	Effort	Mental Dem	Effort	Mental Dem
18	Performance	Temporal De	Effort	Physical Den	Performance	Physical Den	Performance	Mental Dem	Effort	Performance	Performance	Mental Dem	Physical Den	Physical Den	Mental Dem
19	Performance	Temporal De	Effort	Frustration	Performance	Temporal De	Performance	Mental Dem	Effort	Performance	Performance	Effort	Physical Den	Effort	Mental Dem
20	Effort	Frustration	Effort	Frustration	Performance	Physical Den	Performance	Mental Dem	Effort	Mental Dem	Performance	Mental Dem	Mental Dem	Effort	Mental Dem
21	Effort	Frustration	Effort	Frustration	Frustration	Temporal Demand		Mental Dem	Frustration	Mental Dem	Temporal De	Effort			Frustration
22	Performance	Temporal De	Effort	Frustration	Performance	Temporal De	Performance	Mental Dem	Effort	Mental Dem	Temporal De	Mental Dem	Mental Dem	Effort	Mental Dem
23	Performance	Frustration	Effort	Frustration	Performance	Temporal De	Performance	Mental Dem	Frustration	Performance	Performance	Mental Dem	Mental Dem	Effort	Frustration
24	Effort	Frustration	Effort	Frustration	Frustration	Temporal De	Physical Den	Mental Dem	Frustration	Mental Dem	Temporal De	Mental Dem	Mental Dem	Effort	Frustration
25	Performance	Frustration	Temporal De	Frustration	Performance	Temporal De	Performance	Temporal De	Frustration	Performance	Performance	Mental Dem	Mental Dem	Effort	Frustration
26	Effort	Frustration	Effort	Frustration	Frustration	Temporal De	Performance	Mental Dem	Effort	Mental Dem	Performance	Mental Dem	Mental Dem	Effort	Mental Dem
27	Effort	Temporal De	Temporal De	Frustration	Performance	Temporal De	Performance	Mental Dem	Frustration	Mental Dem	Performance	Mental Dem	Mental Dem	Effort	Mental Dem
28	Effort	Frustration	Effort	Frustration	Frustration	Temporal De	Performance	Mental Dem	Frustration	Performance	Performance	Mental Dem	Mental Dem	Effort	Frustration
29	Effort	Frustration	Effort	Physical Den	Performance	Physical Den	Physical Den	Mental Dem	Frustration	Mental Dem	Performance	Mental Dem	Physical Den	Physical Den	Frustration
30	Performance	Frustration	Temporal De	Frustration	Frustration	Temporal De	Physical Den	Temporal De	Frustration	Mental Dem	Temporal De	Effort	Mental Dem	Effort	Frustration
31	Performance	Frustration	Effort	Frustration	Performance	Temporal De	Performance	Mental Dem	Frustration	Mental Dem	Performance	Mental Dem	Mental Dem	Effort	Frustration
32	Performance	Frustration	Temporal De	Frustration	Frustration	Temporal De	Performance	Temporal De	Frustration	Performance	Temporal De	Effort	Mental Dem	Effort	Frustration
33	Performance	Frustration	Temporal De	Frustration	Performance	Temporal De	Performance	Mental Dem	Frustration	Performance	Performance	Mental Dem	Mental Dem	Effort	Mental Dem
34	Effort	Temporal De	Effort	Physical Den	Performance	Physical Den	Performance	Mental Dem	Effort	Mental Dem	Performance	Effort	Mental Dem	Effort	Mental Dem
35	Performance	Frustration	Effort	Frustration	Performance	Temporal De	Performance	Mental Dem	Frustration	Performance	Performance	Mental Dem	Mental Dem	Effort	Mental Dem
36	Performance	Frustration	Temporal De	Frustration	Performance	Temporal De	Performance	Mental Dem	Effort	Performance	Performance	Mental Dem	Mental Dem	Effort	Frustration

NASA Task Load Index Results

Response	Click on the factor that represents the more important contributor to workl...														
37	Performance	Temporal De	Temporal De	Frustration	Performance	Temporal De	Performance	Mental Dem	Effort	Performance	Performance	Mental Dem	Mental Dem	Effort	Mental Dem
38	Performance	Frustration	Effort	Frustration	Performance	Temporal De	Performance	Mental Dem	Effort	Mental Dem	Performance	Effort	Mental Dem	Effort	Mental Dem
39	Performance	Frustration	Temporal De	Frustration	Performance	Temporal De	Performance	Temporal De	Frustration	Performance	Performance	Mental Dem	Mental Dem	Effort	Frustration
40	Effort	Temporal De	Temporal De	Frustration	Performance	Temporal De	Performance	Mental Dem	Frustration	Mental Dem	Performance	Effort	Mental Dem	Effort	Mental Dem
41	Effort	Temporal De	Temporal De	Frustration	Frustration	Temporal De	Performance	Temporal De	Frustration	Performance	Temporal De	Mental Dem	Mental Dem	Effort	Frustration
42	Performance	Temporal De	Temporal De	Frustration	Performance	Temporal De	Performance	Temporal De	Frustration	Performance	Temporal De	Mental Dem	Mental Dem	Effort	Mental Dem
43	Performance	Temporal De	Temporal De	Physical Den	Performance	Physical Den	Performance	Temporal De	Effort	Performance	Performance	Effort	Physical Den	Physical Den	Mental Dem
44	Effort	Frustration	Effort	Frustration	Frustration	Temporal De	Performance	Mental Dem	Frustration	Mental Dem	Performance	Mental Dem	Mental Dem	Effort	Mental Dem
45	Effort	Frustration	Effort	Frustration	Frustration	Physical Den	Physical Den	Mental Dem	Effort	Mental Dem	Temporal De	Mental Dem	Mental Dem	Effort	Mental Dem
46	Performance	Frustration	Effort	Frustration	Performance	Temporal De	Performance	Mental Dem	Frustration	Performance	Performance	Effort	Mental Dem	Effort	Mental Dem
47	Performance	Temporal De	Temporal De	Frustration	Performance	Temporal De	Performance	Mental Dem	Effort	Mental Dem	Performance	Mental Dem	Mental Dem	Effort	Mental Dem
48	Effort	Frustration	Temporal De	Frustration	Frustration	Temporal De	Performance	Mental Dem	Frustration	Mental Dem	Temporal De	Mental Dem	Mental Dem	Effort	Frustration
49	Performance	Frustration	Temporal De	Frustration	Performance	Temporal De	Performance	Mental Dem	Frustration	Performance	Performance	Mental Dem	Mental Dem	Effort	Frustration
50	Performance	Temporal De	Effort	Frustration	Frustration	Temporal De	Performance	Temporal De	Effort	Performance	Temporal De	Effort	Mental Dem	Effort	Frustration
51	Performance	Temporal De	Effort	Physical Den	Performance	Physical Den	Physical Den	Mental Dem	Effort	Mental Dem	Performance	Mental Dem	Mental Demand		
52	Effort	Temporal De	Effort	Frustration	Performance	Temporal De	Performance	Mental Dem	Effort	Mental Dem	Performance	Mental Dem	Mental Dem	Effort	Mental Dem
53	Performance	Temporal De	Effort	Frustration	Performance	Temporal De	Performance	Temporal De	Frustration	Performance	Temporal De	Mental Dem	Mental Dem	Effort	Frustration
54	Performance	Temporal De	Temporal De	Frustration	Performance	Temporal De	Performance	Mental Dem	Effort	Performance	Performance	Mental Dem	Mental Dem	Effort	Mental Dem
55	Performance	Frustration	Temporal De	Frustration	Performance	Temporal De	Performance	Mental Dem	Frustration	Performance	Performance	Mental Dem	Mental Dem	Effort	Frustration
56	Performance	Temporal De	Temporal De	Frustration	Performance	Temporal De	Performance	Mental Dem	Effort	Performance	Performance	Mental Dem	Mental Dem	Effort	Mental Dem

APPENDIX H

INSTRUCTIONAL MATERIALS MOTIVATION SURVEY

There are 36 statements in this questionnaire. Please think about each statement in relation to the instructional materials you have just studied, and indicate how true it is. Give the answer that truly applies to you, and not what you would like to be true, or what you think others want to hear.

Think about each statement by itself and indicate how true it is. Do not be influenced by your answers to other statements.

Thank you.

Indicate the how true each statement is by selecting one of the following answers:

1 = Not true
2 = Slightly true
3 = Moderately true
4 = Mostly true
5 = Very true

1. When I first looked at this lesson, I had the impression that it would be easy for me.
2. There was something interesting at the beginning of this lesson that got my attention.
3. This material was more difficult to understand than I would like for it to be.
4. After reading the introductory information, I felt confident that I knew what I was supposed to learn from this lesson.
5. Completing the exercises in this lesson gave me a satisfying feeling of accomplishment.
6. It is clear to me how the content of this material is related to things I already know.
7. Many of the pages had so much information that it was hard to pick out and remember the important points.

8. These materials are eye-catching.
9. There were stories, pictures, or examples that showed me how this material could be important to some people.
10. Completing this lesson successfully was important to me.
11. The quality of the writing helped to hold my attention.
12. This lesson is so abstract that it was hard to keep my attention on it.
13. As I worked on this lesson, I was confident that I could learn the content.
14. I enjoyed this lesson so much that I would like to know more about this topic.
15. The pages of this lesson look dry and unappealing.
16. The content of this material is relevant to my interests.
17. The way the information is arranged on the pages helped keep my attention.
18. There are explanations or examples of how people use the knowledge in this lesson.
19. The exercises in this lesson were too difficult.
20. This lesson has things that stimulated my curiosity.
21. I really enjoyed studying this lesson.
22. The amount of repetition in this lesson caused me to get bored sometimes.
23. The content and style of writing in this lesson convey the impression that its content is worth knowing.
24. I learned some things that were surprising or unexpected.
25. After working on this lesson for awhile, I was confident that I would be able to pass a test on it.
26. This lesson was not relevant to my needs because I already knew most of it.
27. The wording of feedback after the exercises, or of other comments in this lesson, helped me feel rewarded for my effort.
28. The variety of reading passages, exercises, illustrations, etc., helped keep my attention on the lesson.

29. The style of writing is boring.
30. I could relate the content of this lesson to things I have seen, done, or thought about in my own life.
31. There are so many words on each page that it is irritating.
32. It felt good to successfully complete this lesson.
33. The content of this lesson will be useful to me.
34. I could not really understand quite a bit of the material in this lesson.
35. The good organization of the content helped me be confident that I would learn this material.
36. It was a pleasure to work on such a well-designed lesson.

Instructional Materials Motivation Survey Results

Response	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36
1	5	2	5	3	4	4	2	2	4	2	2	4	5	4	4	4	2	4	5	3	3	3	4	4	5	4	1	2	3	3	4	4	4	4	4	3
2	5	2	5	2	2	4	5	5	1	3	3	5	5	2	4	2	4	1	5	2	2	5	3	1	4	4	2	3	4	2	5	2	3	5	3	3
3	1	1	3	3	2	2	3	1	2	5	2	4	3	1	2	2	3	5	5	1	1	5	4	3	2	5	2	2	3	2	5	5	2	4	3	2
4	4	4	3	2	4	3	3	3	5	4	5	4	4	4	5	4	5	5	5	5	4	3	5	4	3	5	5	4	4	2	4	4	5	3	4	4
5	4	2	5	5	3	4	2	3	2	3	3	5	5	2	3	4	4	5	5	3	3	4	4	3	4	4	3	3	3	5	3	4	5	5	4	4
6	5	4	5	4	4	5	4	4	4	5	3	5	5	4	5	4	4	4	5	2	4	2	4	4	4	3	3	2	4	5	5	4	4	5	3	4
7	3	2	4	4	4	4	2	2	2	4	3	5	5	2	3	3	2	4	5	2	2	3	3	2	4	4	3	3	2	2	4	4	4	2	4	4
8	3	4	4	3	5	4	4	3	4	5	4	5	5	3	4	4	5	4	5	3	3	3	5	4	5	2	4	4	4	4	5	4	4	5	4	4
9	4	4	3	4	3	4	2	3	5	3	4	4	4	2	4	3	4	4	4	3	2	3	3	4	4	3	4	4	4	3	3	3	3	4	3	3
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11	4	3	5	4	4	4	4	4	4	5	5	5	5	4	5	4	5	5	5	2	3	5	4	2	4	5	5	5	5	4	5	5	3	5	5	4
12	5	3	5	5	4	1	5	5	1	4	5	5	4	3	5	2	4	4	5	2	3	5	5	4	4	5	5	4	5	1	5	4	1	5	5	3
13	5	1	5	5	1	5	5	2	4	1	2	5	5	2	3	5	2	3	5	1	1	2	3	1	5	1	2	2	3	2	5	1	3	5	2	3
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Instructional Materials Motivation Survey Results

Response	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36
29	4	2	3	4	5	3	5	2	2	5	2	5	5	3	4	5	3	3	5	2	2	4	2	2	4	5	1	2	4	2	5	5	5	5	3	2
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55	5	3	5	4	3	3	5	5	1	4	5	5	4	1	5	1	5	5	5	1	4	5	5	3	3	5	3	4	5	1	5	4	1	5	4	5

APPENDIX I

FEEDBACK

Feedback

Is there anything you would like to say about the training you received today?

Next

Feedback Results

"Save early, save often" made me smile. :)

"ERA populates travel information (lodging etc...) for locations that are programmed in, if you have to type in a location you must hand look up and enter per diem information.

thank you!

Thank you!

I would like to see more of this type of training.

Even though I am not an RA, knowing this information helps me understand the projects and accounts that I reconcile, track, and project (after they're awarded) in my duties as a BOM. I will check to see if there is financial training in this format as well. That would also be useful.

Excellent training. After going through, I recommended it to my team. Thank you!

Hope this is not the real training bundle

I don't think I received training related to the review process.

I got stuck at the "Generating Approvers" section. I added approvers, but the instructions never updated to allow me to go to the next screen.

I have never entered a proposal in ERA so as a first time user of this module the training was very helpful

I really enjoyed this training and would love to see something like it on the post award side

I seemed to get out of sync between the ERA form and the side training panel quite often.

I thought this training was put together very well, and was informative but not overwhelming. I know there are still pieces that I am not completely comfortable with, but I am confidant that I now know more about the creation of ERA sites.

I wasn't able to complete the last two lessons because the instruction box kept getting stuck on one page. I couldn't move it forward or go back and fix the issue, which got very frustrating. This had more to do with the training itself than the content.

Good for a brief tour, but instructional method does not replace better/other methods of training, such as video presentations, person-to-person. Would recommend creating a set of test proposal pdf packs with funding calls etc.... that folks could enter in to ERA training module, choose a variety of types of funders and award instruments (contract vs grant etc....). "

If I had been an RA new to ASU and ERA, this would be a very helpful tutorial.

"It was helpful to have the icons that triggered an action, like a mouse symbol for clicking or a cursor symbol for typing. It is good to have the information in BOLD that should be entered. Overall, it looked like there was too much going on with the page (large fonts, lots of symbols everywhere) for me to easily follow and see what my next action should be.

It would be helpful to have a short guide at the very beginning of the lessons to introduce the symbols to me so that I could jump through the guide to places I want to read. Going through everything word-by-word and having almost everything large and prominent was not how I wanted to navigate the content and made it harder for me to keep attention and follow along."

My biggest frustration with this lesson was picking out the information about the proposal from the lesson. The forms themselves were easy to use. If the proposal information was all together, separate from the actual instructions on how to complete it, I would have finished much faster and with less frustration.

My training module froze on "generate department approvers" and would not allow me to go further. Kind of frustrating really...

None

Could not get past budget portion to "remove" a period. Could not get department approvers generated.

Not having "tester" as a role made it impossible to do anything, but once I had that role, everything went very smoothly!

"On section 1.4.2 if you don't enter a RFp hyperlink, some weird things can happen.

For me, once I generate department reviewers, the program instructions stopped generating (not good)

Overall, this is a great remedial introduction training, and will be awesome for new RAs, but it could use a bit more refinement. I'm pretty busy, but might be able to allocate some time as to where and how those refinements can be made. "

Other than the type mismatch error it was an excellent lesson.

That was an intense 90 minutes. I constantly wondered if I would survive the onslaught. I will be expecting the Amazon card promptly of course.

The budgeting section of the training is not working correctly

The system did not function properly internally.

"There were a few places in the instructions that needed modifications to match what was intended. They were minor. When on a page it would be nice in the instructions to differentiate between the page and the question #. They both had the same text.

The budget grids could use more explanation on the scrolling of the page verses the grid.

Overall, good instructions to follow."

This is great for new staff; there should be an 'advanced' version for oddball cases (esp cost share and F&A waiver)

This was great and a I learned a lot about ERA that I did not know previously.

Well written but I have extensive experience with this software. Got a bit confused when a lesson ended and it said to close out the lesson. I lost the ERA workspace a few times and had to hunt for it again. I think it should have just stated to leave the workspace open and not close it out after each lesson.

APPENDIX J

INSTRUCTIONAL TASKS

(1) Create a funding proposal from scratch including all required fields.

(2) Create a budget for a Funding Proposal completing the required smartforms for personnel, travel, and direct costs.

(3) Rout a proposal for approval via a workflow identifying who will be asked to approve and how to add/remove approvers.