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PERFORMANCE SUPPORT AND USABILITY:
AN EXPERIMENTAL STUDY OF
ELECTRONIC PERFORMANCE SUPPORT INTERFACES

by

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ABSTRACT

This study evaluated the usability of two types of performance-support interfaces that were designed using informational and experiential approaches. The experiment sought to determine whether there is a relationship between usability and the informational and experiential approaches.

The general population under study was undergraduate education major students from the University of Central Florida. From the general population of three educational technology instructor-led classes, 83 students were solicited to participate in the study by completing a class activity. From the general population, a total of 63 students participated in the study. By participating in the study, the students completed a task and a questionnaire. Students were predominantly English-speaking Caucasian female education majors between the ages of 19 and 20; most of them were sophomores or juniors working part time. They possessed moderately low to high computer skills and most considered themselves to have intermediate or expert Internet skills.

An experimental posttest-only comparison group research design was used to test the hypotheses posited for this study. The participants were randomly assigned to either the informational interface group \(X_1\) or the experiential interface group \(X_2\), and the experiment was conducted electronically via a Web-based Content Management System (CMS). The observed data consisted of five outcome measures: efficiency, errors, intuitiveness, satisfaction, and student performance.
Two instruments—a checklist and an online usability questionnaire—were used to measure the five dependent variables: efficiency, intuitiveness, errors, satisfaction, and student performance. The CMS was used as the vehicle to distribute and randomize the two interfaces, obtain informed consent, distribute the instructions, distribute the online questionnaire, and collect data.

First, a checklist was used to assess the students’ performance completing their task, which was a copyright issue request letter. The checklist was designed as a performance criterion tool for the researcher, instructor, and participants to use. The researcher and instructor constructed the checklist to grade copyright request letters and determine students’ performance. The participants had the opportunity to use the checklist as a performance criterion to create the task document (copyright request letter). The checklist consisted of ten basic yet critical sections of a successful copyright request letter.

Second, an online usability questionnaire was constructed based on the Purdue Usability Testing Questionnaire (PUTQ) questions to measure interface efficiency, intuitiveness, errors, and satisfaction. While these test items have been deemed important for testing the usability of a particular system, for purposes of this study, test items were modified, deleted, and added to ensure content validity. The new survey, University of Central Florida Usability Questionnaire (UCFUQ), consisting of 20 items, was implemented in a pilot study to ensure reliability and content validity. Changes to the PUTQ were modified to fulfill a blueprint. A pilot study of the instrument yielded a reliability coefficient of .9450, and the final online usability instrument yielded a reliability coefficient of .9321.
This study tested two approaches to user interface design for the Electronic Performance Support (EPS) using two HTML interface templates and the information from an existing training module. There were two interventions consisting of two interface types: informational and experiential.

The SPSS Graduate Pack 10.0 for Windows was used for data analysis and statistical reporting in this study. A t test was conducted to determine if a difference existed between the two interface means. ANOVA was conducted to determine if there was an interaction between the interface group means and the demographic data factored among the five dependent variables.

Results of this study indicated that students at the University of Central Florida reported no differences between the two interface types. It was postulated that the informational interface would yield a higher mean score because of its implementation of HCI guidelines, conventions, and standards. However, it was concluded that the informational interface may not be a more usable interface. Users may be as inclined to use the experiential interface as the informational interface.
This dissertation is dedicated to the people in my life who made it happen.

Jennifer Rawls
Lamar and Peggy Rawls
Amy Reese
Lawrence and Barbara Brown

Jennifer Rawls – Your love, support, and encouragement helped me throughout the entire process and I couldn’t have completed this degree without you.

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LIST OF ABBREVIATIONS

Computer Based Training - CBT
Content Management System – CMS
Electronic Classroom of Tomorrow (ECOT)
Electronic Performance Support - EPS
Electronic Performance Support System – EPSS
Graphical User Interface (GUI)
Human-Computer Interaction (HCI)
Learning Content Management Systems (LCMSs),
Learning Management Systems (LMSs)
Analyses Of Variance (ANOVA)
Purdue Usability Testing Questionnaire (PUTQ)
User-Centered Design (UCD)
University of Central Florida Usability Questionnaire (UCFUQ)
What You See Is What You Get (WYSIWYG)
CHAPTER ONE

INTRODUCTION

In the last decade, companies have begun to shift from training employees in the classroom and with stand-alone computer-based training (CBT), to offering employees training or support on the job (Brown, 1996). The concept of providing people pertinent information at the time of need is performance support. When this support is provided on the job in an electronic environment, it is referred to as electronic performance support (EPS).

Gery (1991) first coined the term Electronic Performance Support System (EPSS) in 1989, which has since been defined by Raybould (1995) as an electronic infrastructure that captures, stores, and distributes knowledge throughout an organization via tools to enable it to learn faster. While there are many terms that have the same meaning or are closely related to EPSS, for the remainder of this document, EPSS and other software applications designed to capture, store, and distribute information and performance support on a just-in-time basis will be referred to as EPS. In addition, the terms “employee(s),” “participant(s),” “user(s),” and “learner(s),” will be interchangeable throughout the document.

Corporations have experienced problems with conventional training, which include inefficacy, high costs, and resources. Training programs, while potentially effective, have proven to be somewhat inefficient because only a limited portion of what
is learned in the classroom is actually remembered by the participant. An even greater loss of information is found when a delay occurs between instruction and actual application on the job (Puterbaugh, 1990). It is estimated that more than 80% of critical job-related learning happens on the job (Lawton, 1999). Corporations view training programs in terms of their impact on their bottom line, which only results in short-term learning. The absence of meaningful long-term retention is serious, because it transforms itself from an instructional problem into a business problem, which could be detrimental to the corporation. Training costs are also becoming prohibitive due to increasing costs for instructors, travel to and from training events, and lost employee work time for formal classroom sessions and complicated course structures (Horn, 1989). Furthermore, it is difficult to design training programs that emulate job situations, because many tasks overlap and usually are performed in a more complex environment.

Due to the high demand for information and ubiquitous delivery methods, the same problems that have begun to plague corporations are now entering the K12 school systems (Branson & Hirumi, 1994). Traditional methods for teacher training and professional development have become inefficient and ineffective (Hirumi, 2003). The negative effects are prevalent in teacher workshops, generally consisting of information dumps resulting in learning devoid of richness. Even Web and computer-based methods are not useful, because teachers are not able to utilize the collective knowledge from the organization.

The aforementioned educational problems have been documented at a virtual K12 school in Ohio (Hirumi, 2003). To assuage these problems, an online training and professional development system is being developed for educators as part of the
Educational Classroom of Tomorrow (ECOT). Included in this system will be an EPS providing educators with the tools, training, and information necessary to complete critical job functions in a just-in-time manner.

With new technologies today, organizations are moving towards EPS as a means to improve the performance of users. There are many reasons why organizations are shifting their views from traditional training methods to performance support, which include decreasing time to competency, increasing performer competency, decentralizing decision making, and increasing customer satisfaction (Brown, 1996). While it may take new employees one to two years to become competent at their jobs, an EPS can provide neophytes with expert advice, allowing them to perform above their current level of knowledge. An EPS also automates redesigned work processes to streamline the task, allowing a user to be more efficient. With organizations empowering their users to make their own decisions, a well-designed EPS supports this goal by providing the resources for better decision-making. Providing the employee with tools ultimately yields a better product, thereby increasing customer satisfaction. Does this mean that training in the classroom should be discarded? Hardly, but because of these compelling reasons, the EPS approach is being used more often to provide on-the-job tools during critical times of need.

An EPS consists of performance-support tools that may or may not include wizards, coaches, advisors, and intelligent tutors. While organizing these tools may appear easy, making them accessible is not. Designing the system and tools to be accessible is critical, because if they are not designed appropriately, the users may not be
able to readily access or navigate to them, thus causing cognitive overload. Usable software products should be designed from a user-centered design (UCD) approach.

Designing products from a UCD approach increases their overall usability or, simply, makes them easier to use. Products, in this case, refer to the user interface, which contains the content, human factors, design guidelines, and interaction styles (Hix & Hartson, 1993). Equally important is the process by which the product is designed. The process involves the life cycle, methods, techniques, and tools used in designing an interface. Using an integrated process, three important activities ensure a disciplined, integrated, customer-based product (Vredenburg, Isensee, & Righi, 2002). The first activity is to understand users in their environment, which also includes understanding tasks users perform frequently and the tasks they may perform in the future. The second activity consists of designing and evaluating iterative prototypes with users. Finally, the last activity is assessing competitor designs. Implementing an integrated process ensures a higher degree of usability because it focuses on users, solutions, teamwork, external designs, user experience, competition, user measurement, and the future customer, as opposed to traditional approaches that focus on technology, components, limited cooperation, internal architecture, limited competition, limited user measurement, and current customers. Designing an EPS from a UCD approach is critical in providing the foundation for a highly usable interface.

The user interface is important in an electronic environment when instructional designers attempt to design accessible software programs. If designed appropriately, the user interface engages users by inviting them to browse or work through software
interface programs. If designed inappropriately, the user interface can lead to user confusion, frustration, and cognitive overload.

**Statement of the Problem**

Relatively little research guides the design of performance-support user interfaces. User interface design remains the least-researched component of knowledge-based systems (McGraw, 1992). Lawton (1999) stated that there are no recognized or universal design templates for developing EPS. The present study evaluates the usability of two types of performance support interfaces that have been designed using informational and experiential approaches. The experiment sought to determine whether there is a relationship between usability and the informational and experiential approaches.

**Hypotheses**

In this study, there are five hypotheses and one null hypothesis:

1. The EPS interface developed using the informational approach will possess a higher degree of usability than the interface developed from the experiential approach based on a measure of efficiency.

2. The EPS interface developed using the informational approach will possess a higher degree of usability than the interface developed from the experiential approach based on a measure of intuitiveness.

3. The EPS interface developed using the informational approach will possess a higher degree of usability than the interface developed from the experiential approach based on a measure of errors.
4. The EPS interface developed using the informational approach will possess a higher degree of usability than the interface developed from the experiential approach based on a measure of satisfaction.

5. The EPS interface developed using the informational approach will possess a higher degree of usability than the interface developed from the experiential approach based on a measure of student performance.

The null hypothesis is the same for all five dependent variables and states there is no statistically significant difference between the experiential interface student mean scores and the informational interface student mean scores.

**Operational Definitions**

Operational definitions are provided for each of the key terms and variables presented in the hypotheses:

1. **Efficiency** – The level of effectiveness achieved in relation to the quantity of resources expended (Common Industry Format, 2001). Efficiency was measured by the online usability questionnaire.

2. **Electronic Performance Support (EPS)** – An electronic infrastructure that, “captures, stores and distributes knowledge throughout an organization to enable it to learn faster individuals to achieve required levels of performance in the fastest possible time and with a minimum of support from other people” (Raybould, 1995, p.10).

3. **Errors** – Instances where test participants did not complete the task successfully, or had to attempt portions of the task more than once (Common
Industry Format, 2001). In this study, errors were measured by the online usability questionnaire.

4. Experiential Interface – A type of user interface that contains an expressive refinement of interface objects and interaction mechanisms to generate a memorable custom experience (Seo, 2002).

5. Informational Interface – A type of user interface that emphasizes functionality and usability with the goal of the clear reception and efficient manipulation of information by the user (Seo, 2002).

6. Intuitiveness – Relates the goals of using a product to measure the accuracy and completeness with which these goals can be achieved. It does not take into account how the task goals were achieved, only the extent to which they were achieved. Efficiency relates the level of intuitiveness achieved to the quantity of resources expended (Common Industry Format, 2001). In this study, intuitiveness was measured by an online usability questionnaire.

7. Satisfaction – Describes a user’s subjective response when using the product (Common Industry Format, 2001). In this study, ease of use and the overall reaction of the interface were measured by an online usability questionnaire.

8. Student performance – describes how well the student performed the copyright letter task as measured by a checklist. The output of assessing student’s performance by the checklist was a grade.

9. Usability – A measurable characteristic that is present to a greater or lesser degree that describes how effectively a user can interact with a product. It can
also be thought of as how easy a product is to learn and how easy it is to use
(Axup, 2002).

10. User Interface Design – The art of combining scientific knowledge about
human behavior to the portion of a product's interactive design (Axup, 2002).

**Significance of the Study**

This study is significant for instructional designers tasked with creating EPS. The
results of this study will provide a solid, research-based, and usable foundation for
designers as they develop an EPS interface. The data from this study may determine the
guidelines and standards for EPS interface design and usability. This in turn should
benefit professionals in general, allowing them to design and develop more efficient and
effective interfaces for users.
CHAPTER TWO
LITERATURE REVIEW

Electronic Performance Support

The use of electronic performance support (EPS) has emerged as an effective way to improve human performance within the workplace. An EPS system is a software environment that provides a context within which tasks are performed. All of the tools (e.g., job aids, information, coaches, wizards, software, expert advice, and guidance) needed to complete specified tasks are integrated into the system and made readily accessible, resulting in performance improvement with minimal assistance from others (Brown, 1996).

Many software applications may be viewed as an EPS, including a range of support tools that assist structuring or executing tasks and decision-making. Gery (1991) listed possible types of software as advisory or expert systems, interactive productivity software, help systems, interactive training sequences, assessment systems, monitoring, and feedback systems. Advisory or expert systems, such as the Amdahl advisor, are common components of an EPS and used for problem structuring, decision support and analysis, and diagnosis. These systems are important because they support complex and difficult-to-perform tasks. The interactivity productivity software includes spreadsheets, text processors, and task-specific interactive job aids. The Dow Total Quality Management System used interactivity productivity software in their EPS to allow users
who are working through processes to call upon both embedded software utilities and
tools, such as flow-charting and graphics tools. In addition, the Navy is currently using
interactive job performance aids to assist artisans with procedural assemblies and
disassemblies of aircraft systems such as F-18 and Fuel Oil Purifier. The procedures are
documented during a knowledge-capture session via digital video cameras and provided
as vignettes in a Web-based EPS. An important aspect of the knowledge capture session
involves capturing tacit knowledge, which can be invaluable to novice artisans. Help
systems, such as Microsoft Word Help, are constructed as either user- or system initiated,
context-sensitive and inquiry based, or intelligent, including explanations,
demonstrations, and advice. Interactive training sequences, for example LaserMedia
products, are typically built-in permit, self-directed, or structured learning experiences
that are task related. They may be task specific but also experienced as a comprehensive
traditional computer-based program. For example, Assessment Systems Incorporated’s
(ASI) Pilot Assessment Tool permits evaluation of knowledge, skill, or competence
before job task performance. Monitoring and feedback systems, such as learning
management systems (LMSs) and learning content management systems (LCMSs), use
simple tracking features that observe users’ actions and prompt users based on context,
activity, and time factors. LMSs, such as ThinQ, and LCMSs, such as Force Ten, have
been implemented in EPS to increase overall human performance productivity. These
software support applications provide useful capabilities and functions and have emerged
as an alternative to conventional training development methods. While conventional
training can be effective, there are many problems associated it.
Problems Associated With Conventional Training

EPS has evolved to address many of the shortcomings associated with conventional training methods. One major shortcoming with conventional training is that it doesn’t usually coincide with when the performers actually perform the work, typically occurring before or after the information is needed (Brown, 1996). An EPS addresses this shortcoming by developing the skills necessary to complete a task at the time of need during the job performance. Also, the best methods by which employees learn do not match the methods the training programs implement. Research indicates that learning is most effective when performed in the context of actual work (Raybould, 1995). The assumption is that if an employee or learner can access information in context, then that person is more inclined to learn the task. “Many organizations report that 85–90% of a person’s job knowledge is learned on the job, and only 10–15% is learned in formal training events” (p. 8). An EPS can improve human performance by facilitating learning in context that may result in long-term learning. Another shortcoming of training is cost. Companies are looking for alternate solutions to replace the increased costs of classroom training. EPS design and development may appear to be costly, but traditional training has many hidden costs. Brown listed some of these costs, which include the cost incurred while staff wait to be trained, time lost from performing normal duties, and “in house” training expenses. When designed properly, an EPS can address many of the shortcomings associated with conventional training. It can also provide the user with pertinent information at the time of need in context while reducing numerous hidden costs. However, there are also many challenges associated with designing an appropriate EPS.
Design Challenges Associated With EPS

When interacting with an EPS, the interface must guide users to and through informational events. Gery (1991) suggested that the user interface may be the single most important element of an EPS. The user interface should provide user-defined access to all of its components in a straightforward and consistent manner, permitting the integration of relevant components so the user has a meaningful and contextual environment with which to work. All available options should be made to the user in a clear way, including functions such as tracking and navigation.

When navigating an EPS, the user has two learning requirements. The user must learn to navigate the interface and to complete specified tasks—two interdependent aspects of the system that work simultaneously, exhausting cognitive resources (Parlangeli, Marchigiani, & Bagnara, 1999). Even if the information is rich and meaningful, the interface may be difficult to use, jeopardizing task performance. For example, Parlangeli et al. determined that maintaining hypertexts could in some cases be detrimental to the learning process, thus decreasing the efficacy of the hypermedia systems. Results from Parlangeli et al.’s study suggested that obscure structure can lead to cognitive overload, even more so if the user is unfamiliar with the content. If hypertexts aren’t properly designed with a high degree of usability, users could and will get lost within the interface. Once the user loses confidence in navigating the interface, the user will most likely become frustrated and quit the program. Parlangeli et al.’s study underscored the importance of adhering to usability engineering processes and user interface design principles.
Usability, if unaccounted for, can cause severe user frustration. Human-Computer Interaction (HCI) techniques can increase usability and decrease user frustration. The techniques help ensure the product is designed with a high degree of usability and are essential to the design of an EPS and its tools (Stevens & Stevens, 1995). In this study, two interface approaches, informational and experiential, were investigated to determine if one has a higher degree of usability than the other. HCI involves more than designing the Graphical User Interface (GUI); it encapsulates input devices, conceptual and visual metaphors, interaction sequence, system feedback, mnemonics, and other elements of the interface.

Stevens and Stevens (1995) drew a distinction between graphical guidelines and system usability. They stated that a usable interface is more complex than creating a global standard for screen design; it is also necessary to design an interface that is ideally accessible to the intended user. A GUI design expert may not be adequate for EPS development projects; an expert in HCI design techniques may also be necessary. McGraw (1995) and Stevens (1995) agreed that human-computer interactions require more complex skills than quotidian screen design. McGraw stated that an intuitive interface includes careful selection of commands, labels, text for data displays, and icons, to ensure they are recognized and understood easily by the user. The screen sections, tabbing order, and interactive elements should lead the user through workflow that is consistent.

Adhering to HCI guidelines helps engage users by inviting them to browse or work through software programs. If users can’t navigate successfully through the software, they may become irritated and quit the program. Poor usability can have
negative effects, leading to two types of difficulties: disorientation and cognitive overhead (Park & Kim, 2002). Disorientation is the “tendency to lose one’s sense of location and direction in a nonlinear document” (Conklin, 1987, p. 40). Cognitive overhead is described as “the additional effort and concentration necessary to maintain several tasks or trails at one time” (p. 40). While HCI techniques, including user interface design to increase usability, are effective, many EPS products are poorly designed, leading to user confusion, frustration, and cognitive load.

The best way to support the user of a complex system is to ensure that the user’s means of communication with the EPS is clear, consistent, and error-free (McGraw, 1995). McGraw suggested that the best way to do this is by designing a user interface adhering to a process known as performer-centric design that requires the designer’s analysis to reach beyond the user’s characteristics and include analysis of the mental model and work processes being performed. The mental model and work processes can and do lead to the development of intelligent interfaces that can be delivered in layers. For example, layer one may be a simple GUI, yet layer three may be more complex and extensive, adapting itself to the user’s profile. While developing multi-layer interfaces may sound intriguing, implementing and maintaining them may constitute a higher cost, due to the complex functionality. McGraw’s research on the use of clear and communicative menu structures as a means to designing an effective interface could have been the important usability factor that was absent in Parlangeli et al.’s study (1999). The more usability is factored into the user interface design, the less performance support may be required.
Barker and Banerji (1995) proposed a multi-layer architecture process to designing an EPS (see Figure 1). At the top level is the human-computer interface that is designed from a user-centered approach. The top-level interface is flexible, allowing different styles and modes of interaction available. The top-level is the only level of the architecture that deals with the user interface. The next level is concerned with the generic components or tools, which may or may not include help system, documentation, intelligent agents, and simulation tools. This breakdown differs from McGraw’s (1995), in that the generic components are not really a part of the human-computer interface. McGraw argued that layers of the interface can be embedded in the different components or tools. Barker and Banerji’s third level is the level of application-oriented toolsets that handles the design of special-purpose tools within the target domain. Finally, the bottom level is concerned with the application domain itself. They describe the levels from an object-oriented approach because of the re-usability of resources it can sustain. The multi-layer architecture process approach may have an increased efficiency from a development standpoint, but there is doubt as to whether it is usable from a user interface design approach.
This study was designed to test the hypothesis that an EPS interface developed using the informational approach possesses a higher degree of usability than the interface developed from the experiential approach, based on measures of efficiency, intuitiveness, errors, and satisfaction. The purpose of this literature review is to synthesize literature related to each of the major variables specified in the hypotheses and to illustrate how the literature review served as a foundation for designing the study and related interventions.

The beginning of this literature review provided a brief overview of EPS concepts and approaches as they pertain to HCI and interface design. The remainder of this review discusses HCI in detail and is divided into two major sections. First, HCI literature is reviewed to delineate the relationship between the human user and the computer system.
Second, informational and experiential approaches to interface design are detailed as a rationale for the hypotheses that were tested in the study. In addition, Usability Engineering and Constructivism are also explored to determine an appropriate method for measuring the effectiveness of user interface design. Refer to Figure 2 for a diagram of the EPS interface design process.

Figure 2. EPS Interface Design Process.

**Human-Computer Interaction**

Human-Computer Interaction (HCI) is the study of the relationship that exists when a human user and computer interact to perform tasks. While there are many terms used to discuss HCI, such as human-computer interface, human-machine interface, man-machine interface, and computer interface machine, for the remainder of this document, all types of human-computer interaction will be referred to as human-computer
interaction or HCI. HCI attempts to provide an understanding of both the human user and the computer system to ensure the interactions between the two are more satisfying, with the emphasis always on the user (Faulkner, 1998). As a field, HCI includes user interface hardware and software, user and system modeling, cognitive and behavioral science, human factors, empirical studies, methodology, techniques, and tools (Hix & Hartson, 1993). According to Faulkner, the goal of HCI is to produce a system that is both natural and transparent and to provide the user with a high degree of usability. When designing HCI interfaces, it is important to implement a solid development process.

There are two main parts of the HCI user interface development process: interaction development and interface software development (Hix & Hartson, 1993). The interaction component is concerned with the interface look and feel and user behavior in response to how a user interacts with the computer. The interface software component is concerned with how the interface is programmed and how the code initializes the interaction component. The interaction component looks at the interface from the user’s perspective, while the interface software component looks at the interface from the software engineer’s perspective. Software engineers and programmers have often designed the interaction component, resulting in interfaces of varying quality and usability. Too many times, the distinction between interaction development and interface software development has not been established. When designing the two interfaces in this study, recognizing these differences is paramount, because if they are not planned for and designed appropriately, there could be numerous usability errors.

To distinguish the differences between interaction development and interface software development processes, the terms behavioral domain and constructional domain
will be used to refer to the people who design the interaction component of user interfaces and the people who design the user interface software (see Table 1). Interaction in the behavioral domain is described abstractly, independent of the software in terms of user behavior and the interface as they interact with one another (Hix & Hartson, 1993) and typically involves human factors guidelines, human cognitive limitations, graphic design, usability specifications, rapid prototyping, and evaluation with human users. In the constructional domain, software engineers and programmers develop the software that implements the behavioral design and typically involves algorithms, procedure libraries, event handlers, object-oriented representations, and user interface description language (see Table 1). HCI recognizes the distinction between the two domains and works toward new approaches to user interface development in an attempt to increase quality and usability. The focus of this study deals with the interaction component, more specifically the human cognitive behavior processes and its relationship to EPS usability. Approaching user interface development from a behavioral domain approach (user’s view) should result in a higher degree of usability as compared to the constructional domain (software engineer’s view). However, both domains are important to development and necessary to the overall process.
Table 1

Comparing the Behavioral and Constructional Domains

<table>
<thead>
<tr>
<th></th>
<th>Behavioral</th>
<th>Constructional</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is being developed</td>
<td>Interaction component</td>
<td>Interface software (to support interaction)</td>
</tr>
<tr>
<td>What is the view</td>
<td>View of the user</td>
<td>View of the system</td>
</tr>
<tr>
<td>What is described</td>
<td>User actions, perceptions, and tasks</td>
<td>System actions in response to what the user does</td>
</tr>
<tr>
<td>What is involved</td>
<td>Human factors, scenarios, usability specifications, evaluation</td>
<td>Algorithms, programming</td>
</tr>
<tr>
<td>The locale</td>
<td>Where interaction designers and evaluators do their work</td>
<td>Where interface software implementers do their work</td>
</tr>
<tr>
<td>The test</td>
<td>Procedures performed by the user</td>
<td>Procedures performed by the system</td>
</tr>
</tbody>
</table>

Source: Hix & Hartson, 1993, p. 7

As stated above, HCI attempts to provide an understanding of the human user and the computer system to create a satisfying experience between the two. The goal of HCI is to produce a system that is both natural and transparent, providing a user interface with a high degree of usability. There are two main parts of the HCI user interface development process: interaction development and interface software development (Hix & Hartson, 1993). The behavioral domain is critical in determining user behavior and user interaction with the interface, and the constructional domain is critical in the software development process. Software engineers develop the interface from the architecture designed during the interaction (behavioral) domain process. While the intent
of this study was to focus on the behavioral domain, the interface software development process was not ignored, because it is an important part of the interface development process. The need to recognize and design to both behavioral and constructional domains at the appropriate time was important when designing the interfaces in this study. While HCI is the overall paradigm, there are theoretical foundations used in the design of user interfaces. Since HCI has been discussed as the overarching theoretical construct, the next section will discuss interface design approaches.

**Interface Design**

The interface is a critical component of the design process and vital to the success of the system. As previously discussed, the interface design doesn’t pertain only to the graphical user interface, but to the environment as a whole, which includes not only the display of the menus, hyperlinks, and commands, but also the selection process of these display features. The user interface is highly dependent on these critical behavioral and software coding factors.

The significance of the interface is the impact it has while the user interacts with digital information (Seo, 2002). To better understand this impact, S. Johnson (1997) eloquently stated,

>We live in a society that is increasingly shaped by events in cyberspace, and yet cyberspace remains, for all practical purposes, invisible, outside our perceptual grasp. Our only access to this parallel universe of zeros and ones runs through the conduit of the computer interface, which means that the most dynamic and innovative region of the modern world reveals itself to us only through the anonymous middlemen of interface design. (p. 38)

The interface is a way for designers to map this new territory, preventing users from becoming lost. The most general principle to follow in user interface design is to create
an interface that is transparent (User Interface Design, n.d.), becoming almost an extension of the user.

The evolution of user interface design has produced two different schools of thought: informational and experiential (Seo, 2002). The schools are different, yet they can and do interact with one another. The main purpose of the informational approach is to provide the user with the most efficient interface, minimizing error and confusion. One example of the informational approach is the What You See Is What You Get (WYSIWYG) model. This model presents information to the user in a consistent manner. An example of the WYSIWYG model is Macromedia’s DreamWeaver HTML editing program, which displays information in a consistent visual form for all users. The informational interface is more concerned with structure and functionality versus flexibility and flashiness. The main purpose of the experiential approach is to provide the user with a custom user experience in which the user can explore the system. The experiential interface is typically designed for video games, allowing the designer more artistic freedom. These two schools of thought are important when designing the interface and will be discussed in more detail as basis for the hypotheses that were tested in this study.

First, the informational approach will be discussed in detail, including discussion of the usability engineering process. In addition, the experiential approach will be discussed in detail, including Constructivism and its relevance to custom user experience. Both approaches are discussed in detail for the hypotheses that have been tested in this study.
Informational Approach

In the next two sections, informational approach principles and the usability engineering process will be discussed.

Informational Approach Principles

The informational approach is used to design user interfaces that clearly communicate information to the user. The goal of the informational approach is to allow the user to access content as efficiently as possible. The informational approach is inspired by traditional print and graphic design (Seo, 2002). Because there is a significant static component to interactive displays, the same principles of print media are used in electronic media and include elegance, simplicity, consistency, harmony, and communicability. These print-media design principles can be directly applicable when designing visual interactive interfaces. Applying these principles to electronic media allows the user to be more efficient when accessing content within the interface.

Constructing an informational interface involves the use of conventions and standards, inevitably leading to reduced confusion and thus a shorter learning curve. This approach improves the functionality of the interface to focus the user’s attention on the information, for example, including fewer graphics for optimal Web page download time. The informational approach is the dominant approach for desktop and Web software interface design (Seo, 2002). Implementing conventions and standards can greatly reduce user frustration and confusion while increasing usability. While HCI is the overall philosophy and implementing it at a macro level is important, a usability engineering process should be followed at a micro level to create an effective informational interface.
Usability Engineering Process

When designing a user interface, it is important to design it with a high degree of usability. Following HCI methods, the designer can increase interface usability. Usability is a measurable characteristic that is present to a greater or lesser degree and describes how effectively a user can interact with a product (Axup, 2002). It can also be thought of as how easy a product is to learn and how easy it is to use. Mayhew (1999) expanded the definition of usability to include how easy the user interface is to learn for novice users and how easy it is to use for proficient users after they have mastered the initial learning of the interface. Nielsen (1993) stated that it is important to realize that interface usability is not a single component but has multiple components associated with four attributes, which include efficiency, intuitiveness, errors, and satisfaction. Efficiency refers to the expert user’s steady state level of performance at the time when the learning curve of navigating the user interface flattens out. Intuitiveness can be explained through learnability and memorability. Learnability is the most fundamental usability attribute, simply because the system needs to be easy to learn. Memorability refers to how the casual user learns to use the system. However, the user is not learning the system from the beginning but rather learning how to use it based on previous learning. Therefore, the interface should be easy to use based on previous experience. A product with a high degree of usability should also be free of errors. An error is any action that does not accomplish the desired goal. Finally, satisfaction refers to how pleasant the user interface was to use. The EPS interfaces in this study were measured using Nielsen’s four usability attributes. The attributes were assessed using an online usability questionnaire that was administered to the participants after they completed a series of tasks. While
usability is critical to designing an effective informational user interface that is easy to use, it is also important to follow a set of structured tasks before initial design work begins.

The usability engineering lifecycle (Mayhew, 1999) consists of several tasks, which include structured usability requirements analysis tasks, usability goal setting from requirements analysis data, tasks supporting a structured top-down approach to user interface design, and objective usability evaluation tasks for iterating design toward usability goals. The lifecycle model emphasizes that usability engineers should not move straight into design (Nielsen, 1993), but rather determine the usability requirements, tasks, and goals. Mayhew asserted that requirements analysis is important because it provides a description of the specific user characteristics relevant to user interface design and typically includes a user profile and a contextual task analysis. At a minimum, designers should visit the user environment to obtain a better idea of how the product will be used. From the requirements analysis, specific qualitative and quantitative goals are set to define minimal acceptable user performance and satisfaction criteria. Once the goals are set, iterative design and prototypes begin. A conceptual model of the user interface is designed and evaluated, providing feedback that drives the user interface design. After these tasks have been implemented, it is important to produce a baseline for the design and evaluation of the interface. When designing the architecture for the EPS interfaces, a requirements analysis is used to map the cognitive skills of the user and build a conceptual model of the user interface. This process determines the HCI behavioral domain elements (see Table 1) for the design architecture. After the
architecture is complete, then the software engineer will program the interface (the HCI constructional domain, see Table 1).

Usability heuristics are used as a basis to design and evaluate user interface usability and include the following precepts: simple and natural dialogue, speaking the users’ language, minimizing user memory load, consistency, feedback, clearly marked exits, shortcuts, good error messages, prevention of errors, help and documentation, and heuristic evaluation (Nielsen, 1993). However, for the purpose of this study, only simple and natural dialogue, speaking the users’ language, minimizing user memory load, consistency, feedback, clearly marked exits, good error messages, and heuristic evaluation were used as a basis for design of the informational interface. Shortcuts were not relevant since users were not experts. Also, preventing errors was not relevant because user testing was not conducted for redesign purposes in this study. Finally, help and documentation was not relevant, since users completed test tasks at a broad level. Some of these heuristics were not applicable to the experiential interface, because they would be seen as hindering the user’s experience. For example, experiential designers would argue that designing the interface with metaphor menus (consistency and reducing memory load) would confuse the user because it is not possible to know what metaphor sufficiently identifies with the user. This rationale will be discussed further in the Experiential Approach section.

Simple and Natural Dialogue

User interfaces should be simplified, since there is a learning curve involved. They should also match the users’ task in a natural way (Nielsen, 1993), such that the mapping between computer concepts and user concepts becomes as simple as possible
and the users’ navigation through the interface is minimized. The user interface should also reflect the users’ task syntax and semantics, designed such that it is in a natural language for the task involved and structured with the task (Faulkner, 1998). Finally, the user interface should express itself in simple terms with less technical jargon, unless it is a necessary part of the users’ language.

Graphic design layout is an important element in achieving natural dialogue. Prototyping screen layouts using “mumble screens” (Nielsen, 1993), which replace the content with an arbitrary letter such as an “m,” can abstract away the content and focus on layout issues. Screen layouts should use gestalt rules for human perception to increase the users’ understanding of the system relationships. Gestalt rules state that things are seen as belonging together, as a group or as a unit, if they are close together, are enclosed by lines or boxes, move or change together, or resemble one another with respect to shape, color, size, or typography. These principles of graphic design layout should be used to assist users with navigating and understanding the interface in simple terms.

Another important factor that has a direct impact on usability is typography. Typography is the visual treatment of written language and is used to enrich visual communication (Matthews, 1999). Emotional qualities and tones of voice can be communicated through typographic forms such as typeface, weight, and color. There are many different typefaces and some are more appropriate than others depending on the medium. Serif and sans serif are the two major classes of typeface. Numerous studies have been conducted in attempts to determine which one of the two classes is more readable and both have been found to be equally pleasing. The use of increased weight, as in the form of boldness, and italicized typeface typically signify emphasis and should
be used sparingly. Using weighted typefaces in large amounts can reduce legibility and interface appeal.

Colors are also important and typically convey different meanings in different cultures. For example, red in the United States is generally associated with danger, as compared to red in China, which is generally associated with happiness (Matthews, 1999). The best example of extreme color associations between the United States and China is the color white. In the United States, white is associated with purity, while in China it is associated with death. In addition, different colors work well together, making the overall appearance much more pleasing to the eye. Combinations such as blue or purple and yellow, red, and green have high contrast and work well together. However, blue can cause eye fatigue. The eye absorbs twice the amount of blue light than other colors like yellow and red. In order for the lens to focus, it must change shape and refocus, causing the muscle to work overtime. Adhering to usability guidelines and factors such as typography and color is a vital aspect of the EPS design and must not be overlooked. Applying the simple and natural dialogue principle to user interface design may increase usability.

Speak the Users’ Language

The terminology in the user interface should be based on the users’ language and not on system-oriented terms (Nielsen, 1993). It is important that the user interface include all common words, as well as specialized terminology for its domain.

A more general way of approaching dialogue is to aim at a good mapping between the computer display information and the users’ conceptual model of the
information (Nielsen, 1993). Using a model, the users’ language can become simplified. Examples of common user models are (User Interface Design, n.d.)

- Editing options – scissors, paste pot, and clipboard
- Computer desktop – contains objects that can be moved around
- Audio/Video controller – mimics Web-based controllers
- Applying the users’ language principle to user interface design may increase usability.

Minimize User Memory Load

Computers are much better than humans at remembering things. In general, users have an easier time recognizing something that is shown to them rather than having to recall the same information from memory without help (Nielsen, 1993). One way to help them recall is by designing display dialogue elements for users, allowing them to choose from items generated by the computer, which can be done via menus.

Menus offer a multitude of possible inputs, saving the novice user the task of trying to work out different values (Faulkner, 1998). The menu is the basis for organizing the information identified from the task analysis. Faulkner described examples of menus that include but are not limited to:

- Bar
- Block
- Button
- Scroll bar
- Full screen
• Pop-up, Pop-down, Pull-down, Drop-down

• Tear-off

• Walking menus (cascade menus)

Menus can be supportive, but they don’t always provide flexibility. For example, the user can make only one selection at a time (Faulkner, 1998). When deciding on how many menu items to include in the menu, the magic number seven plus or minus two is generally considered. If more menu items are needed, then the items should be subdivided into more menu entries.

Hochheiser and Schneiderman (2000) proposed the existence of two strategies to support navigation and desired information resources: hierarchical or sequential menus and query-based menus. Sequential menus are most appropriate for situations requiring context-dependent menu choices, such as choosing a continent first and then a country. However, sequential menus tend be rigid, particularly when explorations and comparisons among the results of multiple selections are required, potentially causing the user to backtrack.

Query-based, form fill-in interfaces are frequently used to provide for searches of nonhierarchical data sets typically used as power searches on search engines (Hochheiser & Schneiderman, 2000). Examples include airline reservation sites and online automobile sales. These forms are particular useful when users must select options from a range of alternatives presented as drop-down menus. Query-based interfaces can have serialization problems associated with sequential menus in that searching is often provided in a batch mode where the search is submitted, results are displayed, and the user must return to the search screen to make another search. As a result, comparison between results of searches
may be awkward. Hochheiser and Schneiderman’s study revealed that sequential menus are faster when subjects are performing simple tasks that don’t require comparisons between multiple result sets.

Mayes, Draper, Mcgregor, and Oatley conducted a series of experimental studies to assess users’ knowledge of Macintosh application menus (Wright, Fields, & Harrison, 2000). The results of the study suggested that users could not recall the menu names, but did not have difficulty using the menus when performing tasks. This finding led Mayes et al. to postulate that the users didn’t commit the menu names to memory, but instead relied on cues to trigger the right menu selections. The study suggests that user interface design has an important central role in controlling interactions during system navigation.

Another important feature is reducing cognitive load for user input. Nielsen (1993) recommended the system should describe the format, as well as provide an example of legal and sensible input, such as a default value. One example of this is date input. An even more effective dialogue design would provide a default value example in the input field, allowing the user to edit the date rather than having to input it.

Finally, to minimize the user’s memory load, the system should be based on a small number of rules that apply throughout the interface. Using a superfluous amount of rules to determine the behavior of the system would be cumbersome for the user. Conversely, using generic commands is one way to let rules govern a system (Nielsen, 1993). Generic commands enable similar items to happen in different circumstances, thus making it possible for the user to learn a few commands while working with many different types of data.
Consistency

Consistency is one of the most basic yet most important usability principles. By providing consistency, designers enable users to be more confident navigating the interface (Nielsen, 1993). One important way to maintain consistency throughout the interface is to present the information in the same location on all screens, menus, and dialogue boxes. For example, if presenting content with multimedia, keep the content separate from the multimedia and have them always appearing in the same areas on the screen. As a result, users becomes trained to find content, multimedia, navigation, and dialogue boxes in the same place throughout the interface, reinforcing their expectations. The interface should reinforce the user’s expectations from previous interaction with the interface and not introduce surprises (Faulkner, 1998).

Following design guidelines and standards can increase consistency. Smith and Mosier developed the most famous set of guidelines for the Mitre Corporation, known as the Smith and Mosier guidelines (C. Johnson, 1997). They include several thousand rules that have been adapted by the United States military and NASA. While guidelines can assist designers with identifying positive and negative options for the user interface, they can also be difficult to apply and are only as effective as the person using them.

Feedback

The system should continuously provide feedback about what it is doing and how it is interpreting the user’s input (Nielsen, 1993). System feedback should restate the user’s input through the use of dialogue boxes. A good example of this is prompting the user before overwriting a file. Again, the design document should include guidelines and standards for developing these types of messages.
Clearly Marked Exits

Users should always have the option to exit or cancel a program or task. For example, the interface should have an exit button visible to users at all times. In Web-based applications, including the exit button in the top right corner of the interface relates to the users’ experience of exiting most browser windows. When creating dialogue boxes, designers should include a cancel button. Implementing these techniques gives users a feeling of control and ultimately more confidence in using the interface.

Good Error Messages

Error messages are critical to usability for two main purposes. First, error messages represent situations in which users are in trouble and potentially will not be able to use the interface, and second, they present opportunities for helping the user understand the system better (Nielsen, 1993). Shneiderman (1982) asserted that error messages should basically follow four simple rules. First, error messages should be phrased in clear language and avoid obscure codes. Second, error messages should be precise rather than ambiguous. Third, error messages should constructively assist the user with solving the problem. Finally, error messages should be polite and should not intimidate the user.

Heuristic Evaluation

A heuristic evaluation is performed by reviewing the interface in order to detect positive and negative features within the interface. In a perfect world, designers would follow a set of rules, such as those listed in typical guideline documents. Unfortunately, most designers conduct the evaluation using their intuition or common sense. Nielsen
(1993) described a heuristic evaluation as a “systematic inspection of a user interface design for usability” with the goal “to find the usability problems in a user interface design so that they can be attended to as part of an iterative design process” (p. 155). The heuristic evaluation employs a small group of evaluators to examine the interface and judge its compliance with recognized usability principles.

An individual can perform a heuristic evaluation; however, research (Nielsen, 1993) indicates that a single evaluator will miss most of the usability problems in an interface. In fact, Nielsen stated that single evaluators tend to find about 35% of the errors associated with the interface. Nielsen recommended that heuristic evaluations consist of about five examiners with no fewer than three. The exact number should be determined from a cost–benefit analysis.

Typically, a heuristic evaluation session lasts one to two hours (Nielsen, 1993). During the session, the evaluator has individuals explore the interface several times, emphasizing different aspects. While the evaluator decides how many times the user navigates through the interface, Nielsen recommended that the user navigate through the interface at least twice, so the user gets a feel for the system.

The output of the heuristic evaluation should yield a list of referenced interface usability problems. While this list does not provide a systematic way to generate fixes or to assess the probable quality of redesign issues, it does aim at explaining each observed usability problem referenced to established usability principles (Nielsen, 1993). Therefore, the list will often make the process easier for redesigning the interface based on violated principles. Heuristic evaluation is considered “discount usability engineering” (p. 17), and user testing with real users is the most fundamental usability method.
User testing provides direct information about how individuals use computers and the exact issues encountered when using the interface. There are many issues to consider such as reliability, validity, test goals, user target audience, and test tasks. Reliability refers to whether the usability test was consistent, and validity refers to whether the usability test actually tested for the correct usability issues. Implementing a test goal with plans is important, because the purpose should be clearly articulated and the plans should be documented describing the criteria for conducting the test. The rule for selecting test users is that they should be as close to a representative sample of the users as possible, and the basic rule for test tasks is that they should be selected to be as representative as possible to the types of tasks that would be performed in the actual environment (Nielsen, 1993). The stages of a test typically include preparation, introduction, the test, and debriefing. Test tasks are important because if incorrect tasks are selected, the design of the interface may not be suitable to the user. All of these issues are critical in user testing, but additional methods may be required.

Other usability assessment methods may be useful, including observation, questionnaires and interviews, and focus groups. Observation is one of the simplest usability methods and involves visiting users on site and recording their actions through the use of note taking or even videotaping. One advantage of observing users is that issues are discovered that were not originally tested for in the design. Experimenters must also be aware of one major disadvantage, the Hawthorne Effect, which states that people being watched act in a different way because of the presence of the observer (Faulkner, 1998).
Questionnaires and interviews are considered indirect methods, since they don’t actually study the user interface itself but only the user’s opinions about the user interface (Nielsen, 1993). Experimenters must be careful about trusting the user’s answers, because people have a tendency to give answers they think they should give. Questionnaires do have the advantage that once produced, they can provide a vast body of information (Faulkner, 1998). An online usability questionnaire was used to gather data on the EPS interfaces in this study.

Focus groups are an informal technique used to assess user needs and feelings before and after the user interface design. Focus groups have the advantage of allowing group dynamics and organizational issues to arise spontaneously, giving insight into new design ideas (Nielsen, 1993). Using these alternative usability assessment methods can supplement user testing, providing a better user interface design or redesign.

In conclusion, applying HCI techniques can increase the usability of a user interface. Usability engineering is a discipline that provides structured methods for achieving usability through user interface design (Mayhew, 1999), yet it is mostly focused on design and evaluation during product development. Usability is not a single component but includes multiple components associated with four attributes. This study focused on implementing the usability engineering life cycle to design the user interface, as well as apply the usability attributes as measures to assess the informational interface usability.
Experiential Approach

While the informational approach is concerned with user interface efficiency, the experiential approach is concerned with user interface experience. In the following two sections, experiential approach principles and Constructivism are discussed.

Experiential Approach Principles

The experiential approach to interface design emphasizes the custom user experience generated by the interface (Seo, 2002). While the manipulation of data is important, the experiential approach is more concerned with aesthetics. The experiential approach, also referred to as the expressive approach, attempts to satisfy functional, but more importantly, visual stimulating needs of the user. The drawbacks to experiential interfaces typically include larger file size, longer download times, and more computing power to run custom elements. Still many organizations, as well as gaming companies, are beginning to experiment with the experiential interface focusing on the user experience.

One major problem with the traditional view of interface design (the informational approach) is that it views metaphors as the communication vehicle between the designer and the user (Lund & Waterworth, n.d.). The experiential approach does not implement metaphors because they may cause problems for the user. The problem occurs in that the designer may not select the most relevant metaphor that the user will identify with, rendering the metaphor ineffective. Communicating with the user through metaphor may not be effective, causing cognitive load and frustration.
Lund and Waterworth (n.d.) argued that meaning is objective and can be captured in a fixed correspondence between aspects of the world and some system of representation. In other words, communication depends on what is relevant in a situation and not what is passed along through the interface. Communication depends on “ostension,” which are acts that produce experiences in the user by virtue of being performed in context.

An approach based on experiential meaning, rather than the traditional informational approach, is based on the premise that to design HCI is to design for potential users’ experiences (Lund & Waterworth, n.d.). While the informational approach is largely based on metaphors, there is no need for metaphors from the experiential view, simply because the metaphor is ubiquitous. From an experiential perspective, interface design suggests that a meaningful interface is one that is experienced in a way that supports the metaphoric projection of image schemata. The user making an unconscious projection of bodily image schemata can accomplish this type of experiential support. Ultimately, the user produces unconscious reactions to the structures provided. The designer can’t possibly predict how to design the interface for the user, so the user must “experience” it. The experiential designer is a developer of user experiences, and the informational designer is a developer of mental models consisting of metaphors.

Leo and Budd (n.d.) argued that emotion drives the human experience, and the user interface has the potential to be a powerful tool for creating an emotive experience. An important part of creating an emotional relationship with the user is storytelling. Stories are a way of thinking, an information organizer, and the consciousness of people.
in general. Telling a story can also assist users with understanding and remembering. Including a narrative within the story can be powerful, which, combined with the capabilities of an electronic environment, can produce a richer, more interactive experience. Designing an emotive and engaging interface is essential, and designing the interface for usability alone is insufficient. The insufficiency of usability-only design is significant because it is in stark contrast to the informational approach, which considers the usability engineering process to be vital to the success of the informational interface and interfaces in general.

Leo and Budd (n.d.) described their work as an intuitive approach to interface design that has been described as transparent. Transparency aims to immerse the user within the interface, facilitating the feeling of being lost in a story. While both the informational and experiential approaches attempt to design transparent interfaces, their design interpretations are very different. The informational approach attempts to design for transparency by making the interface an extension of the user and increasing the usability through the effective use of metaphors, menus, and commands. In contrast, the experiential approach attempts to design a transparent interface through the absence of usability and the inclusion of emotional relationship development. Bolter and Grusin (1999), professors at the Georgia Institute of Technology, asserted that designers have expressed the need for “interfaceless” interfaces in which users interact with objects naturally as they would in the real world. The “interfaceless” interface would not include structure such as buttons, windows, and icons, but would seek to erase the technology by becoming transparent. In effect, the user would be oblivious to the transparent interface. While a requirements analysis from the usability engineering lifecycle was used to create
a conceptual model, a constructivist approach was followed to design the experiential interface in the present study.

**Constructivism**

Constructivist theories of human cognition (Perkins, 1986) assume users interactively refine their understanding of an area to construct their own knowledge representations. These representations are important to experiential-approach designers, because the desire is for users to relate relevant information to their interface experience. Constructivism stresses the experience between the user and the interface, which is a personal idiosyncratic process characterized by users’ developing knowledge and understanding by forming new concepts based on previously refined concepts (Squires, 1999). From a constructivist approach, users are expected to take responsibility for their experience with the interface. Users are navigating within an unstructured environment and welcomed to discover the interface through exploration. This interaction should provide the user with a meaningful experience. While the constructivist approach becomes more important when increasing task efficiency within the EPS, user visual and conceptual representations can be supported by the user interface (Robson, 2000).

Constructivism stresses the experience between the user and the interface, which is significant to this study because the designer is attempting to increase the user experience through the use of the experiential intervention. The interface is intended to become a part of the user, encouraging the user to explore areas without trepidation. It was postulated that if the user became comfortable navigating a particular section of the program, the user would subsequently navigate to other sections of the program feeling
confident. However, it was postulated that the experiential interface would yield a lesser degree of usability as measured by the online usability questionnaire when compared to the informational interface.

The literature on interface design has produced two interface design schools of thought or approaches (Seo, 2002). The informational approach is used to provide the user with the most efficient interface and the experiential approach is more concerned with aesthetics and a custom user experience. When designing interface navigation and functionality, it is good practice to include both approaches. It is important to present information functionally with a clean look and feel, not becoming overzealous with distracting flashy animations. Too often designers feel it is important to include flashy programs, not realizing the negative impact it can have on users. Conversely, it is equally important that the interface not be overly rigid in striving to engage the user in an enjoyable experience. The balance between these two interfaces is delicate.

Summary

While designers have detailed numerous aspects of EPS, generally interface design has not been of the highest priority. Unfortunately and often inconsistently, many designers have developed EPS without adhering to HCI techniques. Distributing pertinent information to the user in an accessible manner is critical, especially when the user is attempting to complete a task. A usability engineering process must be followed in order to improve performance, and it is vital to the success of informational interface design. In contrast, an experiential approach does not require the rigors of usability engineering and relies more on a constructivist approach to enhance the user experience.
This study tested these two types of approaches, using the usability engineering process as a basis to design both types of interfaces. The constructivist approach was the design focus for the experiential interface. The four attributes were used to evaluate which interface approach had a higher degree of usability. Adhering to usability principles is critical to the informational approach, and it was postulated that the participants would determine it to be more usable, thereby indicating the type of design approach that should be used in EPS development.

A designer may have all the information needed to develop an EPS, yet without proper user testing and evaluation, the designer could be developing a product that is inaccessible and consequently unusable. HCI and, more specifically, usability engineering processes are important to the design of an effective EPS.
CHAPTER THREE

METHOD

Chapter Three describes the methods used to test the hypotheses posited for this study, including participants, research design, instrument, intervention, data collection, data analysis, and limitations.

Participants

The general population under study was undergraduate education major students enrolled in three educational-technology instructor-led classes at the University of Central Florida. From the general population, 83 students were solicited to participate in the study by completing a class activity. A total of 63 students participated in the study. By participating in the study, the students completed a task and a questionnaire. Students were predominantly English speaking Caucasian female education majors between the ages of 19 and 20. Most of them were sophomores or juniors working part time. They possessed moderately low to high computer skills and most of them considered themselves to have intermediate or expert Internet skills.

Students’ last names were collected in order to match their task document with their questionnaire. After the items were matched, the names were replaced with numbers and discarded. The participants were randomly assigned to the treatment and control groups based on their access to the study. The usability software randomly assigned 36
participants to the experiential interface and 47 to the informational interface. However, because six participants of the experiential interface didn’t turn in task documents, they were excluded from the study. In addition, 14 students assigned to the informational interface didn’t turn in task documents and were excluded. Due to the exclusions, the study yielded 63 total participants.

Research Design

An experimental posttest-only comparison group research design was used to test the hypotheses posited for this study. Two instruments, a checklist and an online usability questionnaire, were used to measure the dependent variables. Figure 3 provides a diagram of the design method. R indicates the participants were randomly assigned to a group. X indicates the intervention administered to the participants. O indicates the data observed and collected.

![Diagram of Posttest-Only Comparison Group](image)

Figure 3. Diagram of Posttest-Only Comparison Group.
The participants were randomly assigned to either the informational interface group (X1) or the experiential interface group (X2), and the experiment was conducted electronically via a Web-based Content Management System (CMS). The observed data consists of five outcome measures: efficiency, errors, intuitiveness, satisfaction, and student performance.

**Instruments**

Two instruments were used to measure the dependent variables. The CMS was used as the vehicle to distribute and randomize the Web interfaces, obtain informed consent, distribute the instructions, distribute the online questionnaire, and collect data. First, a checklist (see Appendix D) was used to assess the quality of the participant’s final product, which is the copyright issue request letter. The checklist was designed as a performance criterion tool for the researcher, instructor, and participants to use. The researcher and instructor constructed the checklist to grade copyright letters for errors. The participants had the opportunity to use the checklist as a performance-criterion as well as a performance-support tool to create the task document (copyright letter). The checklist consisted of ten basic and critical sections of a successful copyright request letter. The checklist consisted of expert content validity but was not test for reliability.

As part of the task, the participant had to write and upload a copyright issue request letter using applicable performance support tools. The participant’s document was compared against the checklist and grades, which was an important tool for measuring student performance.
Second, an online usability questionnaire was constructed based on the Purdue Usability Testing Questionnaire (PUTQ) questions (see Appendix G). The new online usability questionnaire is the University of Central Florida Usability Questionnaire (UCFUQ) (see Appendix E). A Task List (see Appendix B) was included in the Web “home” page and was instrumental in determining what navigation processes the participants engaged in while interacting with the interface. The UCFUQ was used as the testing instrument.

The PUTQ is a 100-item test that has been established to rate the usability of a particular system. The PUTQ was developed by Lin and Salvendy in 1997 for the purpose of comparing the relative usability of different software systems. The questionnaire views usability as determined by eight different sections (1) compatibility, (2) consistency, (3) flexibility, (4) learnability, (5) minimal action, (6) minimal memory load, (7) perceptual limitation, and (8) user guidance. Lin, Choong, and Salvendy (1997) stated that PUTQ has good construct validity and content validity since it is derived from an experimental and theoretical base and its items were selected from numerous user interface guidelines and questionnaire items. Lin et al. (1997) conducted an experiment to test PUTQ’s reliability and criterion based validity. The Cronbach Alpha values ranged from 0.59 to 0.81 with an average reliability of .70, indicating that its criterion-based validity and reliability were good in their experiment. While these test items have been deemed important for testing the usability of a particular system, for purposes of this study, test items were modified, deleted, and added to ensure content validity. The new survey, UCFUQ (see Appendix E), consisting of 20 items, was implemented in the pilot
study to ensure reliability and content validity. The PUTQ was used to construct the UCFUQ, which was required to fulfill the Blueprint (see Appendix C).

A pilot study was conducted using 45 participants from two educational technology online classes. The data were used to validate and test the reliability of the modified UCFUQ online survey instrument. Respondent ratings of different usability factors obtained from the usability questionnaire were judged to be highly reliable for undergraduate students to whom it was administered during the pilot study, with a reliability coefficient of .9450. A review of the corrected item-total correlations suggested that the variables Q5 and Q6 correlate negatively. Both of these items were in the “Errors” category of the questionnaire blueprint. Eliminating these two variables was unwarranted on the basis that removing them did not necessarily ensure a more reliable coefficient. Removing items Q5 and Q6 increased the reliability coefficient only to .9583 and .9589, respectively. Therefore, these two items were left in the study.

Also, lessons learned were gathered, documented, and implemented into the study. These improvements were deemed important, ensuring data were accurately collected.

The final online usability questionnaire had an $n$ of 63 and yielded a reliability coefficient of .9321, suggesting the questionnaire instrument to be reliable. Question 6 correlated negatively again. However, Question 5 did not, perhaps due to the larger sample size.

To ensure the validity of the informational and experiential interface types and the prototypes used in this experiment, an expert in the field reviewed them and provided comments. A performance technologist with an Orlando-based performance support and
training company, who has been designing and developing complex performance support and computer-based solutions for the past ten years, reviewed the two interfaces and stated,

The goal of the experiential interface appears to create a memorable experience rather than functionality and usability. It creates a satisfying user experience and promotes deeper engagement of the user. The three-dimensional icons make a distinct impression on the user. The alluring background and expressive qualities of the interface enhances the overall interaction process, which promotes deeper engagement of the user. Exploration, discovery, and surprise are all parts of this experiential interface. The informational interface is undoubtedly informational because of its emphasis on functionality and usability. The goal of the informational interface seems to be clear reception and efficient manipulation by the user.

These two interfaces were validated as experiential and informational, respectively, by an experienced performance technologist.

**Intervention**

This study tested two approaches to user interface design for the EPS using two HTML interface templates and the information from an existing Electronic Classroom of Tomorrow (ECOT) training module. There were two interventions consisting of two interface types: informational and experiential. The two types of user interfaces were similar in some respects, yet different in many others. The interfaces were similar in that they contained the same hyperlinks and paths. However, they were different in how they were presented to the user and perceived by the user. The informational interface features were crisp, the colors subtle, and the information structured and straightforward, adhering strictly to the usability principles detailed in Chapter Two (Figure 4).
More specifically, the performance support tools were arranged in a menu structure along the left area of the interface, allowing them to be highly visible and structured. Adhering to usability principles, the content was presented from top to bottom and chunked. Titles were bolded where appropriate to provide the user with a consistent visual cue. When the user clicked a secondary page, for example templates, the information again was structured and consistent (see Figure 5).
In the template section, the pertinent information was highlighted in red to focus the users’ attention to that area. The menu structure again appeared in the left area and Performance Support Tools was labeled as a header to inform users that they had navigated to this section. There was also a return to copyright hyperlink that linked the user back to the “home” page. Again, this design was straightforward and detailed with information communicating user models. When navigating the informational interface, the user will be more efficient and effective when performing tasks.
Conversely, the experiential interface features were not as obvious, and the information and navigation were unstructured, adhering to the constructivist approach detailed in Chapter Two (see Figure 6).

More specifically, the performance support tool links were arranged in 3D image schemata, giving the interface more depth based less on metaphors. While this interface was a prototype, the focus was to tap into the user’s unconscious daily schemata, creating a meaningful user experience.

In the template section, the pertinent information moved from the right to the left area of the interface. The menu structure also moved to the right area, and the Performance Support Tool menu was not visible; only the template image schema was visible (see Figure 7). Labeled headers weren’t visible to the user, and the “x” image in the background was the hyperlink back to the “home” page. This link was not labeled,
allowing the user to explore and experience the interface. This design was not as straightforward and detailed as the informational design. However, the user was in a discovery mode while experiencing the interface. This setup may ultimately cause the user to become disoriented, lost, and frustrated. The data gathered from this study can assist in building interfaces with a higher degree of usability for performance support interfaces.

Figure 7. Template Screenshot of the Experiential Interface.

**Data Collection**

The participants were randomly assigned to either the informational or experiential interface on clicking a Web address as part of their lab activity. During the lab session, participants opened their browsers and navigated to the Web site. After
clicking the URL, the participants were administered the Informed Consent Form (see Appendix A). After reading the form, the participants clicked the “Accept” button to participate in the study. Clicking “Accept” constituted their electronic signature and their agreement to participate in the study. After clicking the “Accept” button, the participants were directed to the demographic survey (see Appendix F). After they filled out the survey, the content management system (CMS) randomly assigned them to an interface. The participants read the directions on the “home” page and completed the task (see Appendix B). After completing the task, the participant was administered the UCFUQ (see Appendix E) via the CMS. Data collection procedures were as follows:

1. The participants opened their browsers and navigated to the study Web site and then were administered the Informed Consent Form (see Appendix A). After reading the form, the participants clicked the “Accept” button to participate in the study. Clicking “Accept” constituted their electronic signature and their agreement to participate in the study. After clicking the “Accept” button, the CMS directed participants to the demographic survey.

2. After the participant answered all of the questions in the demographic survey, the CMS randomly assigned the user to an interface.

3. The participant then read the directions on the “home” Web page and had the capability to print it.

4. The participant navigated a series of Web pages based on the task (see Appendix B). The participant was given as much time as needed during the lab, yet it should not have taken more than approximately twenty to thirty minutes to complete the task.
5. Once participants finished navigating the interface and completing the task, they answered the UCFUQ (see Appendix E). Again, participants were given as much time as needed to complete the questionnaire; however, it should not have taken more than approximately twenty minutes to complete it.

**Data Analysis**

The SPSS Graduate Pack 10.0 for Windows was used for data analysis and statistical reporting in this study. A $t$ test was conducted to determine if a difference existed between the two interface means. A ANOVA was conducted to determine if there was an interaction between the interface group means and the demographic data factored among the five dependent variables.

**Limitations**

Limitations of the study include

1. The sample used for the study consisted of undergraduate students ages 18–23 from the University of Central Florida; therefore, the results of the study should not be generalized beyond the scope of this study.

2. The UCFUQ was administered to undergraduate education major students, and the results may not be generalizable outside populations used in this study.

3. The checklist didn’t include reliability testing and therefore should not be assumed a reliable instrument.
CHAPTER FOUR
RESULTS

Chapter Four describes the results of the study for the primary five hypotheses and also the post hoc analyses. First, hypotheses data are reported using $t$ tests for the five dependent variables. Second, the post hoc analysis is reported using ANOVA analyses to determine if there were interactions between the independent variable, the dependent variables, and the demographic data.

Hypotheses Data

A $t$ test was conducted to determine if there was a mean difference between the experiential and informational interfaces. Specifically $t$ tests were run to determine if there were mean differences between interface type and the five dependent variables: efficiency, intuitiveness, errors, satisfaction, and student performance. The following reports include interactions that were significant.

$t$-Test Results With Respect to Efficiency

The EPS interface developed using the informational approach will possess a higher degree of usability than the interface developed from the experiential approach based on a measure of efficiency. The mean experiential interface usability scores do not
exceed the mean informational interface usability scores (see Table 2) to a statistically
significant degree for efficiency \( t(.350) = .728, p > .05 \) (see Table 3).

Table 2

\( t \)-Test Group Statistics Results With Respect to Usability Domain Variables: Efficiency,
Intuitiveness, Errors, and Satisfaction

<table>
<thead>
<tr>
<th>Interface</th>
<th>N</th>
<th>Mean</th>
<th>Std. deviation</th>
<th>Std. error mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface Efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiential</td>
<td>30</td>
<td>7.20</td>
<td>3.06</td>
<td>.56</td>
</tr>
<tr>
<td>Informational</td>
<td>33</td>
<td>6.94</td>
<td>2.86</td>
<td>.50</td>
</tr>
<tr>
<td>Interface Errors</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiential</td>
<td>30</td>
<td>11.67</td>
<td>2.77</td>
<td>.51</td>
</tr>
<tr>
<td>Informational</td>
<td>33</td>
<td>11.09</td>
<td>2.98</td>
<td>.52</td>
</tr>
<tr>
<td>Interface Intuitiveness</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiential</td>
<td>30</td>
<td>13.97</td>
<td>5.43</td>
<td>.99</td>
</tr>
<tr>
<td>Informational</td>
<td>33</td>
<td>13.12</td>
<td>4.94</td>
<td>.86</td>
</tr>
<tr>
<td>Interface Satisfaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiential</td>
<td>30</td>
<td>10.07</td>
<td>4.70</td>
<td>.86</td>
</tr>
<tr>
<td>Informational</td>
<td>33</td>
<td>9.45</td>
<td>4.72</td>
<td>.82</td>
</tr>
</tbody>
</table>
Table 3

$t$-Test Independent Samples Test Results With Respect to Usability Domain Variables: Efficiency, Errors, Intuitiveness, and Satisfaction

<table>
<thead>
<tr>
<th></th>
<th>Levene's test for equality of variances</th>
<th>$t$ test for equality of means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$F$</td>
<td>Sig.</td>
</tr>
<tr>
<td><strong>Interface Efficiency</strong></td>
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<td></td>
</tr>
<tr>
<td>Equal variances assumed</td>
<td>.001</td>
<td>.972</td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>.348</td>
<td>.59</td>
</tr>
<tr>
<td><strong>Interface Errors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equal variances assumed</td>
<td>.123</td>
<td>.727</td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>.794</td>
<td>.522</td>
</tr>
<tr>
<td><strong>Interface Intuitiveness</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equal variances assumed</td>
<td>.038</td>
<td>.846</td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>.644</td>
<td>.522</td>
</tr>
<tr>
<td><strong>Interface Satisfaction</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equal variances assumed</td>
<td>.466</td>
<td>.497</td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>.515</td>
<td>.608</td>
</tr>
</tbody>
</table>

$t$-Test Results With Respect to Intuitiveness

The EPS interface developed using the informational approach will possess a higher degree of usability than the interface developed from the experiential approach based on a measure of intuitiveness. The mean experiential interface usability scores do
not exceed the mean informational interface usability scores (see Table 2) to a statistically significant degree for intuitiveness $t(.647) = .520, p > .05$ (see Table 3).

$t$-Test Results With Respect to Errors

The EPS interface developed using the informational approach will possess a higher degree of usability than the interface developed from the experiential approach based on a measure of errors. The mean experiential interface usability scores do not exceed the mean informational interface usability scores (see Table 2) to a statistically significant degree for errors $t(.791) = .432, p > .05$ (see Table 3).

$t$-Test Results With Respect to Satisfaction

The EPS interface developed using the informational approach will possess a higher degree of usability than the interface developed from the experiential approach based on a measure of satisfaction. The mean experiential interface usability scores do not exceed the mean informational interface usability scores (see Table 2) to a statistically significant degree for satisfaction $t(.515) = .608, p > .05$ (see Table 3).

$t$-Test Results With Respect to Student Performance

The EPS interface developed using the informational approach will possess a higher degree of usability than the interface developed from the experiential approach based on a measure of student performance. The mean experiential interface student performance scores (see Table 4) do not exceed the mean informational interface...
performance scores to a statistically significant degree, \( t(-1.566) = .124, p > .05 \) (see Table 5).

Table 4

\( t \)-Test Group Statistics Results With Respect to Student Performance

<table>
<thead>
<tr>
<th>Interface</th>
<th>N</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Std.error mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>TASKGRAD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiential</td>
<td>30</td>
<td>88.33</td>
<td>12.62</td>
<td>2.30</td>
</tr>
<tr>
<td>Informational</td>
<td>33</td>
<td>92.42</td>
<td>7.08</td>
<td>1.23</td>
</tr>
</tbody>
</table>
Table 5

*t*-Test Independent Samples Test Results With Respect to Student Performance

| TASKGRAD          | Levene's test for equality of variances |  |  |  |  |  |  |
|------------------|----------------------------------------|---|---|---|---|---|
|                  | Levene's test | Levene's test | Levene's test | Levene's test | Levene's test | Levene's test | Levene's test |
|                  | for equality of | for equality of | for equality of | for equality of | for equality of | for equality of | for equality of |
|                  | variances      | variances      | variances      | variances      | variances      | variances      | variances      |
| Equal variances assumed | 4.55 | .037 | -1.61 | 61 | .114 | -4.09 | 2.55 | -9.19 | 1.00 |
| Equal variances not assumed | -1.57 | 45 | .124 | -4.09 | 2.61 | -9.35 | 1.17 |
Post Hoc Data

A series of post hoc analyses were conducted to determine if there were interactions between the treatment and subject demographics. First, ANOVA were run to determine if there were interactions between interface and demographics: gender, age, computer skills, Internet skills, and occupation. Second, a reliability analysis was conducted on the UCFUQ to determine negatively correlated items. The following reports include interactions that were significant.

ANOVA Results With Respect to Interface and Age

Given that the assumption of equal variances was met, ANOVA was deemed a suitable procedure for these data.

A statistically significant difference between the age and interface satisfaction group means was found (see Table 6), suggesting the assumption that the data are unlikely, assuming that the null hypothesis is true, $F(5, 51) = 2.560, p = .038$. We therefore reject the null hypothesis in favor of the alternative, which states that a difference exists among the group means in population.
Table 6

ANOVA Results With Respect to Interface and Age

<table>
<thead>
<tr>
<th>Source</th>
<th>Dependent variable</th>
<th>Type III sum of squares</th>
<th>df</th>
<th>Mean square</th>
<th>F</th>
<th>Sig.</th>
<th>Eta squared</th>
<th>Noncent. parameter</th>
<th>Observed power a</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE</td>
<td>Interface Satisfaction b</td>
<td>261.69</td>
<td>5</td>
<td>52.34</td>
<td>2.56</td>
<td>.038</td>
<td>.20</td>
<td>12.80</td>
<td>.75</td>
</tr>
<tr>
<td>Error</td>
<td>Interface Satisfaction</td>
<td>1042.66</td>
<td>51</td>
<td>20.44</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a Computed using alpha = .05
b $R^2 = .233$ (Adjusted $R^2 = .068$)

Overall, the model fits well. An examination of the effect size ($R^2 = .233$) reveals that the statistical difference among the group means is trivial. This result suggests that the independent variable explains only 23.3% of the variation in dependent variable’s scores.

ANOVA Results With Respect to Interface and Occupation

Given that the assumption of equal variances was met, ANOVA was deemed a suitable procedure for these data.

Efficiency

A statistically significant difference between the interface and interface efficiency group means was found (see Table 7), suggesting the assumption that the data are unlikely, assuming that the null hypothesis is true, $F (2, 57) = 5.498, p = .007$. We therefore reject the null hypothesis in favor of the alternative, which states that a difference exists among the group means in population.
Table 7

ANOVA Results With Respect to Interface and Occupation

<table>
<thead>
<tr>
<th>Source</th>
<th>Dependent variable</th>
<th>Type III sum of squares</th>
<th>df</th>
<th>Mean square</th>
<th>F</th>
<th>Sig.</th>
<th>Eta squared</th>
<th>Non-cent. param.</th>
<th>Observed power</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Interface Efficiency</td>
<td>83.63</td>
<td>2</td>
<td>41.81</td>
<td>5.50</td>
<td>.007</td>
<td>.16</td>
<td>11.00</td>
<td>.83</td>
</tr>
<tr>
<td></td>
<td>Interface Intuitiveness</td>
<td>208.19</td>
<td>2</td>
<td>104.10</td>
<td>4.42</td>
<td>.016</td>
<td>.13</td>
<td>8.84</td>
<td>.74</td>
</tr>
<tr>
<td></td>
<td>Interface Satisfaction</td>
<td>191.54</td>
<td>2</td>
<td>95.77</td>
<td>4.76</td>
<td>.012</td>
<td>.14</td>
<td>9.51</td>
<td>.77</td>
</tr>
<tr>
<td>OCCUPATI TASKGRAD</td>
<td>164.64</td>
<td>2</td>
<td>82.32</td>
<td>.79</td>
<td>.461</td>
<td>.03</td>
<td>1.57</td>
<td>.18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interface Efficiency</td>
<td>433.51</td>
<td>57</td>
<td>7.61</td>
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<tr>
<td></td>
<td>Interface Intuitiveness</td>
<td>1342.85</td>
<td>57</td>
<td>23.56</td>
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<tr>
<td></td>
<td>Interface Satisfaction</td>
<td>1148.04</td>
<td>57</td>
<td>20.14</td>
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<tr>
<td>Error</td>
<td>TASKGRAD</td>
<td>5973.93</td>
<td>57</td>
<td>104.81</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R² = .188 (Adjusted R² = .117)

Overall, the model fits modestly well. An examination of the effect size (R² = .188) reveals that the statistical difference among the group means is trivial. This result suggests that the independent variable explains only 18.8% of the variation in dependent variable’s scores.

Intuitiveness

A statistically significant difference between the interface and interface intuitiveness group means was found (see Table 7), suggesting the assumption that the
data are unlikely, assuming that the null hypothesis is true, $F(2, 57) = 4.419, p = .016$. We therefore reject the null hypothesis in favor of the alternative, which states that a difference exists among the group means in population.

Overall, the model fits modestly well. An examination of the effect size ($R^2 = .188$) reveals that the statistical difference among the group means is trivial. This result suggests that the independent variable explains only 18.8% of the variation in dependent variable’s scores.

**Satisfaction**

A statistically significant difference between the interface and interface satisfaction group means was found (see Table 7), suggesting the assumption that the data are unlikely, assuming that the null hypothesis is true, $F(2, 57) = 4.755, p = .012$. We therefore reject the null hypothesis in favor of the alternative, which states that a difference exists among the group means in population.

Overall, the model fits modestly well. An examination of the effect size ($R^2 = .156$) reveals that the statistical difference among the group means is trivial. This result suggests that the independent variable explains only 15.6% of the variation in dependent variable’s scores.

**UCFUQ Reliability Analysis**

Respondent ratings of different usability factors obtained from the usability questionnaire were judged to be highly reliable for undergraduate students to whom it was administered, with a reliability coefficient of .9321. A review of the corrected item-
total correlations suggests that the variable Question 5 is very low and Question 6 is negatively correlated (see Table 8), .0498 and -.1209 respectively.

Table 8

Reliability Item Analysis

<table>
<thead>
<tr>
<th>Item number</th>
<th>Scale mean if item deleted</th>
<th>Scale variance if item deleted</th>
<th>Corrected item-total correlation</th>
<th>Alpha if item deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>39.76</td>
<td>156.25</td>
<td>.7176</td>
<td>.9271</td>
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<td>2</td>
<td>39.95</td>
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<td>3</td>
<td>40.03</td>
<td>160.87</td>
<td>.6242</td>
<td>.9291</td>
</tr>
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<td>39.98</td>
<td>156.76</td>
<td>.6695</td>
<td>.9279</td>
</tr>
<tr>
<td>5</td>
<td>37.98</td>
<td>169.44</td>
<td>.0498</td>
<td>.9427</td>
</tr>
<tr>
<td>6</td>
<td>38.08</td>
<td>175.27</td>
<td>-.1209</td>
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Reliability coefficients:
N of cases = 63.0
N of items = 20
Alpha = .9321
Both of these items were in the “Errors” usability subdomain of the questionnaire blueprint. Eliminating these two variables is warranted on the basis that reducing the scale to only relevant items would make for a better, more parsimonious scale. It turns out that removing the items may further be motivated by the anticipated increase in the reliability coefficient. To examine the impact of removing both items, Questions 5 and 6 were removed, yielding a reliability coefficient of .9603 (see Table 9).
Table 9

Reliability Item Analysis Without Questions 5 and 6

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Reliability coefficients:
N of cases = 63.0
N of items = 18
Alpha = .9603
CHAPTER FIVE

CONCLUSIONS

Chapter Five discusses the results reported in Chapter Four. The results of this study are discussed with respect to the specific research hypotheses addressed: The EPS interface developed using the informational approach will possess a higher degree of usability than the interface developed from the experiential approach based on measures of efficiency, intuitiveness, errors, satisfaction, and student performance. Major findings and conclusions based on the research are presented. First, the hypotheses data will be discussed, and then the post hoc data will be discussed. The chapter concludes with a summary and recommendations for further study.

Hypotheses Data

A t test was conducted to determine if there was a mean difference between the experiential and informational interfaces. Specifically, t tests were run to determine if there were mean differences between interface type and the five dependent variables: efficiency, intuitiveness, errors, satisfaction, and student performance. The following discusses the dependent variable t-test results.
Efficiency

Comparing the mean scores from the UCFUQ responses for differences with respect to efficiency did not yield statistically significance differences, therefore suggesting null hypothesis acceptance. Efficiency refers to the expert user’s steady-state level of performance at the time when the learning curve of navigating the user interface flattens out. The results indicate that using the experiential interface was as efficient as using the informational interface. This support for the null hypothesis could be due to the fact that the navigation learning curve was low (Nielsen, 1993), since this was a prototype and the users could navigate fewer than three Web pages to retrieve information regarding their task. Based on responses, there was no difference in usability between the two interfaces with regard to efficiency. This result could be due to the fact that the user completed the task, indicating that completing the task may result in a higher degree of usability efficiency.

Intuitiveness

Comparing the mean scores from the UCFUQ responses for differences with respect to intuitiveness did not yield statistically significance differences, therefore suggesting null hypothesis acceptance. Intuitiveness can be explained through learnability and memorability. Learnability (Nielsen, 1993) is the most fundamental usability attribute, simply because the system needs to be easy to learn. From the results of the study, both interfaces were easy to learn. Again, this could be due to the fact that the interventions were part of a prototype and not part of a larger system. Memorability refers to how the casual user learns to use the system. However, the user is not learning
the system from the beginning but rather learning how to use it based on previous
teaching. Therefore, the interface should be easy to use based on previous experience.
This attribute may not have as much of an effect on this study because the users
shaped the Web pages once and for the first time. However, if they did spend extra
navigation time, they may have had a chance to remember it. Based on the results of the
study, neither interface was more memorable than the other. This result could be due to
the fact that the user completed the task, indicating that completing the task may result in
a higher degree of usability intuitiveness.

Errors

Comparing the mean scores from the UCFUQ responses for differences with
respect to errors did not yield statistically significance differences, therefore suggesting
null hypothesis acceptance. A product with a high degree of usability should be free of
errors. An error is any action that does not accomplish the desired goal (Nielsen, 1993).
However, because errors were not documented as the user performed the task, the
response scores could be due to the fact that since users completed the task, they didn’t
report making many errors when responding to the questionnaire.

Satisfaction

Comparing the mean scores from the UCFUQ responses for differences with
respect to satisfaction did not yield statistically significance differences, therefore
suggesting null hypothesis acceptance. Satisfaction refers to how pleasant the user
interface was to use (Nielsen, 1993). While individual responses are subjective, multiple
responses can result in an objective measure of the interface’s pleasantness. However, based on the results of the study, one interface was no more pleasant than the other. This result could be due to the fact that the user completed the task, indicating that completing the task may result in a higher degree of usability satisfaction.

Student Performance

Comparing the mean scores of the copyright letter task grades for differences with respect to student performance did not yield statistically significance differences, therefore suggesting null hypothesis acceptance. The checklist was used as the instrument to measure the user’s interface performance in completing the task. While there wasn’t a statistical difference, the informational interface users did have a higher grade when completing the task at 92% compared to the experiential interface scores that averaged 88%.

How can no differences between the two interface mean scores be explained? Perhaps the informational interface did not reduce cognitive overload as compared to the experiential. Perhaps the use of HCI techniques and guidelines are not as important as the literature proclaims or the experiential approach is at as effective in providing usable interfaces. Stevens and Stevens (1995) reported that HCI techniques help ensure that the product is designed with a higher degree of usability and are essential to the design of EPS tools. Parlangeli et al.’s (1999) study determined that cognitive overload can be reduced, among other factors, by adhering to usability engineering process and user interface design principles, specifically when performing tasks. Does adhering to these processes and principles greatly reduce cognitive overload by allowing the user to
complete the task more efficiently and effectively? Perhaps they do, but the differences were not determined by this study.

The use of metaphors rather than the projection of image schemata (Lund & Waterworth, 2004) have also been suggested as a method for designing an intuitive interface with a higher degree of usability. However, the use of metaphors in this study did not result in a higher degree of usability. An intuitive interface includes careful selection of commands, labels, text for data displays, and icons to ensure they are recognized and understood easily by the user (McGraw, 1995). McGraw stated that the best way to support the user is to ensure that the user’s means of communication with the EPS is clear, consistent, and error-free, which was the goal of the informational interface design. Perhaps an intuitive interface does not possess careful selection of commands and labels, but rather more exploratory and expressive elements. Lund and Waterworth (n.d.) stated that one major problem with the traditional view of interface design (the informational approach) is that it views metaphors as the communication vehicle between the designer and the user. The experiential approach does not implement metaphors because they may cause problems for the user. The problem occurs in that the designer may not select the most relevant metaphor that the user will identify with, rendering the metaphor ineffective. Communicating with the user through metaphors may not be effective, causing cognitive load and frustration, which contradicts Parlangeli et al’s research (1999).

An approach based on experiential meaning, rather than the traditional informational approach, is predicated on the premise that to design HCI is to design for potential users’ experiences (Lund & Waterworth, n.d.). The designer cannot possibly
predict how to design the interface for the user, so the user must “experience” it. The experiential designer is a developer of user experiences, and the informational designer is a developer of mental models consisting of metaphors. While the informational approach is largely based on metaphors, there is no need for metaphors from the experiential view, simply because the metaphor is ubiquitous. It is possible that both approaches are equally usable as indicated by the results of this study.

The results of student performance grades could also be due to a ceiling effect. A ceiling effect can occur when a test or task fails to identify the performance of the most competent user because of a limited number of difficult test items (Harris & Hodges, 1995). However, the task was to create a copyright issue request letter with either no assistance or by using any one of the performance support tools provided within the interface. There were four performance support tools that could possibly assist users in completing their task: checklist, example, information, and template. The checklist performance support tool was also used by the researcher to grade the copyright issue request letter. After grading the copyright letters, it was apparent that most participants consulted the performance support checklist as a guide when writing their copyright letter. In fact, a few of them even copied the example from the example performance support tool. The example included all of the elements of the checklist while also providing descriptions for each element, making it easier for the participant to obtain a higher score. These observations would explain the reason for high mean scores for both interfaces and a possible ceiling effect.

Now that hypotheses data have been discussed, the next section discusses post hoc data.
Post Hoc Data

A series of post hoc analyses were conducted to determine if there were interactions between the treatment and subject demographics. Specifically ANOVA were run to determine if there were interactions between interface and demographics: gender, age, computer skills, Internet skills, and occupation. Also, a reliability item analysis was conducted on the UCFUQ. The following reports include interactions and analyses that were significant.

Interface and Age

The Interface and Age analysis did not produce significant findings among the variables except when age was analyzed with interface satisfaction. A statistical significance was found, suggesting that age did have an effect on satisfaction response scores. Age was somewhat evenly dispersed, although ages 18 and 19 were heavily populated responses, accounting for almost one-third of the sample. It was interesting that the over-23 demographic was the next-most-populated demographic. The reason for no significant difference (except for satisfaction) could be due to the fact that this sample is young and its members are more familiar with the expressive approach, which emphasizes the custom user experience generated by the interface (Seo, 2002). These types of interfaces are popular with video games and the explosion of animations and online games. Therefore, the experiential interface was not unusual and did not present as a factor difference.

However, the fact that there was a statistical significance with age and satisfaction perhaps indicated that users were not satisfied with the experiential interface. For reasons
stated above, the presentation was not as engaging as typical video games, animations, and online games. It is also interesting to note that there was not a statistical significance found with satisfaction alone, only when an analysis was run with age, thus indicating that age does have an effect on satisfaction in regard to the interfaces. Perhaps the younger age users were not satisfied with the experiential interface and were expecting it to be more dynamic and engaging.

**Interface and Occupation**

Finally, interface and occupation were factored and analyzed. The results were different in this demographic, specifically in regard to occupation and interface efficiency, intuitiveness, and satisfaction. Interface efficiency and satisfaction were significant, explaining 18.8% and 15.6% of the variance, respectively. The groupings within this demographic were more evenly split, with 20 users answering that they were students only, 31 answering they were students and working part time, and 12 answering they were students and working full time. Perhaps students who work are more inclined to expect a different type of interface. This could be due to the fact that workers are more familiar with informational type interfaces and students are more familiar with the experiential interface, especially students interacting with computer-based learning modules or playing video games. Many software applications, such as Microsoft Word, may be viewed as informational type interfaces, thereby providing working students with previous knowledge of informational interfaces. Perhaps the full-time students related to the experiential projection of image schemata (Lund & Waterworth, n.d.) within the interface to expressive types of interfaces such as video games. They were able to
connect with the emotive experience of the interface (Leo & Budd, n.d.). Again, these types of interfaces generally emphasize the custom user experience generated by the interface (Seo, 2002). This interaction sets up an interesting discussion and should be investigated further.

UCFUQ Reliability Analysis

Both of these items were in the “Errors” usability subdomain of the questionnaire blueprint. Since one item was negatively correlated and another was close to being negatively correlated, it could be that the question evokes a negative response. Therefore, reversing the responses may alleviate part of this problem. It is still postulated that eliminating the “Errors” subdomain as a variable from the blueprint and combining the remaining subdomain variables (efficiency, intuitiveness, and satisfaction) into one variable would be recommended for further studies.

Summary

The purpose of this study was to determine whether there is a difference between experiential and informational interface usability. Does designing with one interface rather than another result in a higher degree of usability, thus allowing the user to complete tasks with less difficulty?

Results of this study indicated that students at the University of Central Florida reported no differences between the two interface types. It was postulated that the informational interface would yield a higher mean score because of its implementation of HCI guidelines, conventions, and standards. However, it was concluded that the
informational interface may not be a more usable interface. Users may be as inclined to use the experiential interface as the informational interface.

**Recommendations for Further Research**

Several recommendations can be made in regards to the method.

1. The instruments should be retested on other populations, specifically with novice computer- and Internet-skilled participants.
2. Further validation studies should be conducted.
   Several additional studies should be conducted in various educational settings in order to determine the construct validity of these instruments. The instruments, if used on another population, should be sufficiently stable to produce results that measure the four domains of usability and student performance identified from the literature review.
3. The interventions should be further tested to ensure validity.
4. Additional testing should be conducted with a wider range of ages and an even gender group. The population consisted of mostly 18-to-20-year-old female students; thus including a wider range of ages and a more evenly split gender group may provide different results.
5. Additional testing should be conducted with novice-to-intermediate participants in regard to computer and Internet skills. Most of the participants possessed intermediate-to-expert computer and Internet skills.
6. Additional usability testing should be conducted documenting efficiency by time on task while the user is completing the task. This type of measure may provide more conclusive data than using a self-report measure.

7. Additional usability testing should be conducted documenting errors by determining navigation errors while the user is completing the task. This type of measure may provide more conclusive data than using a self-report measure.

8. Additional usability testing should be conducted documenting intuitiveness by time on task and navigation errors while the user is completing the task. This type of measure may provide more conclusive data on interface memorability and learnability.

9. Additional usability testing should be conducted investigating the interaction between age and satisfaction to try to gain a better understanding of why satisfaction was significant versus the other factors.

10. Additional usability testing should be conducted investigating the interaction between interface and occupation. This interaction had the most instances of significance and could provide more insight into the usability of performance-support interfaces.
APPENDIX A

INFORMED CONSENT FORM
Informed Consent Form

Please read this consent document carefully before you decide to participate in this study.

Project title:
Performance Support and Usability: An Experimental Study of Electronic Performance Support Interfaces

Purpose of the research study:
The purpose of this study is to examine the effects of usability on performance support interfaces.

What you will be asked to do in the study:

You will access a Website from the desktop of your computer. After you navigate to the site, you will read the welcome/instructions, read and print out the Task List, navigate the interface, and fill out the questionnaire. Data collection procedures are as follows:
1. You will open their browser and navigate to the website in which you will be assigned to an interface – A or B.
2. After reaching and reading the study intro Webpage, you will then be administered the Informed Consent Form (see Appendix A). After reading the form, you will click the “Accept” button to participate in the study. This is their electronic signature and agreement to participate in the study.
3. You will then be administered a Demographic Survey.
4. After completing the Demographic Survey, you will then be randomly assigned to an interface.
5. You will read the directions on the main Web page and will have the capability to print it.
6. You will navigate a series of Web pages based on the task (see Appendix B). You will be given as much time as needed during the lab, yet it should not take more than approximately twenty to thirty minutes to complete the task.
7. Once you are finished navigating the interface, you will answer the questionnaire. Again, you will be given as much time as needed to complete the questionnaire, however, it should not take more than approximately twenty minutes to complete it.

Time required:
Approximately 40 – 50 minutes.

Risks:
There are no known potential risks or side effects associated with this study. You will be navigating an interface completing tasks on the computer.
Benefits / Compensation:

The present study will help teachers as well as designers with creating EPS interfaces. The results of this study may benefit teachers at two levels. First, there is a general benefit of having access to the EPS. Teachers will have many resources available to them. The second benefit is the optimization of the interface with an increased degree of usability.

The results of this study will also provide a solid, research based, and usable foundation for designers as they develop an EPS interface. The data from this study may determine the guidelines and standards for EPS interface design and usability. This in turn should benefit all teachers and professionals using this system, allowing them to be more efficient and effective users.

There is no compensation for this study.

Confidentiality:
Your identity will be kept confidential. Your information will be assigned a code number. The list connecting your name to this number will be kept in a locked file in my office. When the study is completed and the data have been analyzed, the list will be destroyed. Your name will not be used in any report.

Voluntary participation:
Your participation in this study is voluntary. There is no penalty for not participating.

Right to withdraw from the study:
You have the right to withdraw from the study at any time without consequence.

Whom to contact if you have questions about the study:

Chad Rawls
Doctoral Candidate
University of Central Florida.
Phone number - 321.663.1309
E-mail - nolesknite01@yahoo.com

Dr. Hirumi
Faculty Supervisor
College of Education
University of Central Florida
Whom to contact about your rights in the study:
UCFIRB Office, University of Central Florida Office of Research, Orlando Tech Center,
12443 Research Parkway, Suite 302, Orlando, FL 32826. The phone number is (407)
823-2901.

By checking the following boxes and clicking the “ACCEPT” button, you agree to
the terms of the study.

☐ I have read the procedure described above.
☐ I voluntarily agree to participate in the procedure.

☐ I would like to receive a copy of the final "interview" manuscript submitted to the
instructor.

Print name here: ______________________________
Sign name here: ______________________________ Date _____________
APPENDIX B

TASK LIST
Task List

Welcome again! For the purposes of this study, you are going to write a fictitious copyright letter requesting permission to use copyrighted information. You only have to write one letter and you are provided with the tools to assist you with completing this task. Please follow the directions below.

Directions
1. Open Microsoft Word – there should be an icon on the desktop.

2. Write a copyright letter requesting the publisher to use their information.

Note: If you already know how to address copyright issues, write the necessary letter to obtain permission. If you are not sure how to write such a letter, you may access Performance Support Tools, which contain information regarding performance criteria needed to complete the letter, a template for completing your letter, an example of a written copyright letter, and information regarding writing copyright letters. These tools provide you with additional information that can assist you with completing this task.

Important: When writing your copyright letter, be sure to include your name in the document.

3. After writing the copyright letter and saving in a Word document format, save it to your computer.

4. Then click the "browse" button located at the bottom of this page to upload an attached copy.

5. After sending the copyright letter, click the below link to take the questionnaire.
APPENDIX C
BLUEPRINT
Blueprint

Purpose
The prime purpose in which the Online Usability Questionnaire will be used is to measure the usability of two interface types: informational and experiential.

Domains
- Efficiency – System should be efficient to use.
- Intuitiveness – System should be intuitive to use.
- Errors – System should have a low error rate.
- Satisfaction – System should be pleasant to use.

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<tr>
<td>Intuitiveness</td>
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<tr>
<td>Errors</td>
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<tr>
<td>Satisfaction</td>
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<tr>
<td>Total</td>
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APPENDIX D

CHECKLIST
Use the performance checklist to ensure you include all the necessary criteria for completing the copyright letter. The criteria will help you complete a satisfactory copyright letter. The checklist will be used to evaluate your copyright letter.

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<td>No</td>
</tr>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>2. Includes Material Permission Department Contact Information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Includes Your Contact Information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Includes Salutation (e.g., Dear)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. States Purpose of Request</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Identifies Material Sought for Permission Reproduction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Describes the Material Format and Nature of Use</td>
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<td></td>
</tr>
<tr>
<td>8. Indicates Number of Copies and Who gets the Money if Sold</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Includes Closing – with Name</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Includes Section for Permission Granted</td>
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<td></td>
</tr>
</tbody>
</table>
APPENDIX E

UNIVERSITY OF CENTRAL FLORIDA USABILITY QUESTIONNAIRE (UCFUQ)
Online Usability Questionnaire

INSTRUCTIONS
Please indicate your satisfaction or dissatisfaction regarding each of the following 46 items, with 1 being Strongly Disagree and 5 being Strongly Agree.

QUESTIONS

1. The menu structure allowed me to navigate efficiently.
   1. Strongly Disagree
   2. Somewhat Disagree
   3. Neither Agree or Disagree
   4. Somewhat Agree
   5. Strongly Agree

2. I was able to complete my task efficiently.
   1. Strongly Disagree
   2. Somewhat Disagree
   3. Neither Agree or Disagree
   4. Somewhat Agree
   5. Strongly Agree

3. The display format is consistent.
   1. Strongly Disagree
   2. Somewhat Disagree
   3. Neither Agree or Disagree
   4. Somewhat Agree
   5. Strongly Agree

4. The labeling itself is consistent.
   1. Strongly Disagree
   2. Somewhat Disagree
   3. Neither Agree or Disagree
   4. Somewhat Agree
   5. Strongly Agree
5. Errors were encountered within the interface.
   1. Strongly Disagree
   2. Somewhat Disagree
   3. Neither Agree or Disagree
   4. Somewhat Agree
   5. Strongly Agree

6. Errors were encountered within the menu structure.
   1. Strongly Disagree
   2. Somewhat Disagree
   3. Neither Agree or Disagree
   4. Somewhat Agree
   5. Strongly Agree

7. I was able to complete my task without errors.
   1. Strongly Disagree
   2. Somewhat Disagree
   3. Neither Agree or Disagree
   4. Somewhat Agree
   5. Strongly Agree

8. The menu structure was easy to use.
   1. Strongly Disagree
   2. Somewhat Disagree
   3. Neither Agree or Disagree
   4. Somewhat Agree
   5. Strongly Agree

9. The interface provided clarity of wording.
   1. Strongly Disagree
   2. Somewhat Disagree
   3. Neither Agree or Disagree
   4. Somewhat Agree
   5. Strongly Agree
10. The data grouping is reasonable for easy learning.

   1. Strongly Disagree
   2. Somewhat Disagree
   3. Neither Agree or Disagree
   4. Somewhat Agree
   5. Strongly Agree

11. The grouping of menu options is logical.

   1. Strongly Disagree
   2. Somewhat Disagree
   3. Neither Agree or Disagree
   4. Somewhat Agree
   5. Strongly Agree

12. The ordering of menu options is logical.

   1. Strongly Disagree
   2. Somewhat Disagree
   3. Neither Agree or Disagree
   4. Somewhat Agree
   5. Strongly Agree

13. The hyperlink names are meaningful.

   1. Strongly Disagree
   2. Somewhat Disagree
   3. Neither Agree or Disagree
   4. Somewhat Agree
   5. Strongly Agree

14. The symbols for graphic data are standard.

   1. Strongly Disagree
   2. Somewhat Disagree
   3. Neither Agree or Disagree
   4. Somewhat Agree
   5. Strongly Agree
15. The interface provides easily distinguished colors.

1. Strongly Disagree
2. Somewhat Disagree
3. Neither Agree or Disagree
4. Somewhat Agree
5. Strongly Agree

16. I would recommend using this interface design.

1. Strongly Disagree
2. Somewhat Disagree
3. Neither Agree or Disagree
4. Somewhat Agree
5. Strongly Agree

17. The overall design of the interface was pleasing.

1. Strongly Disagree
2. Somewhat Disagree
3. Neither Agree or Disagree
4. Somewhat Agree
5. Strongly Agree

18. Using the interface improved my task performance.

1. Strongly Disagree
2. Somewhat Disagree
3. Neither Agree or Disagree
4. Somewhat Agree
5. Strongly Agree

19. I found the interface easy to use.

1. Strongly Disagree
2. Somewhat Disagree
3. Neither Agree or Disagree
4. Somewhat Agree
5. Strongly Agree
20. My interaction with the interface was clear and understandable.

1. Strongly Disagree
2. Somewhat Disagree
3. Neither Agree or Disagree
4. Somewhat Agree
5. Strongly Agree

Thank you for completing this questionnaire.

If you have any suggestions or comments that you feel would be useful, please feel free to type them in the area provided below. After you are done, click the “SUBMIT” button and your responses will be e-mailed to the researcher.
APPENDIX F

DEMOGRAPHIC SURVEY
The Demographic Survey was administered after accepting to participate in the study.

1. Please type your last name below.

2. What is your major?

3. What is your age?
   _ 18 _ 19 _ 20 _ 21 _ 22 _ 23 and older

4. What is your gender?
   __ Male  __ Female

5. What is your education level?
   __ Freshman  __ Sophomore  __ Junior  __ Senior  __ Graduate

6. What is your ethnic background
   __ African American  __ Asian  __ Caucasian  __ Hispanic  __ Other

7. What is your native language
   _ Chinese  __ English  __ Spanish  __ Other

8. What are your computer skills (before this study)?
   __ None (never used software)
   __ Low (used one - two software applications)
   __ Moderately low (learned and used 3 - 10 different software applications)
   __ Moderately high (used more than 10 software applications but never programmed)
   __ High (used many different software applications and have some programming skills)

9. What are your Internet skills (before this study)?
   _ Novice – spends 1 hour a day (checks E-mail)
   _ Intermediate – spends 2-3 hours a day (checks E-mail, surfs Web)
_ Expert – Spends 4 plus hours a day (checks E-mail, surfs Web, online gaming, online shopping, instant messaging)

10. What is your occupation?
   __ Student
   __ Student and working part time
   _ Student and working full time
APPENDIX G

PURDUE USABILITY TESTING QUESTIONNAIRE (ORIGINAL)
Purdue Usability Testing Questionnaire


Compatibility
Is the control of cursor compatible with movement?
Are the results of control entry compatible with user expectations?
Is the control matched to user skill?
Are the coding compatible with familiar conventions?
Is the wording familiar

Consistency
Is the assignment of colour codes conventional?
Is the coding consistent across displays, menu options?
Is the cursor placement consistent?
Is the display format consistent?
Is the feedback consistent?
Is the format within data fields consistent?
Is the label format consistent?
Is the labelling itself consistent?
Is the display orientation consistent? -- panning vs. scrolling.
Are the user actions required consistent?
Is the wording consistent across displays?
Is the data display consistent with entry requirements?
Is the data display consistent with user conventions?
Are symbols for graphic data standard?
Is the option wording consistent with command language?
Is the wording consistent with user guidance?

Flexibility
Does it have by-passing menu selection with command entry?
Does it have direct manipulation capability?
Is the design for data entry flexible?
Can the display be controlled by user flexibly?
Does it provide good training for different users?
Are users allowed to customize windows?
Can user name displays and elements according to their needs?
Does it provide good training for different users?
Are users allowed to customize windows?
Can users assign command names?
Does it provide user selection of data for display?
Does it handle user-specified windows?
Does it provide zooming for display expansion?
Learnability
Does it provide clarity of wording?
Is the data grouping reasonable for easy learning?
Is the command language layered?
Is the grouping of menu options logical?
Is the ordering of menu options logical?
Are the command names meaningful?
Does it provide no-penalty learning?

Minimal Action
Does it provide combined entry of related data?
Will the required data be entered only once?
Does it provide default values?
Is the shifting among windows easy?
Does it provide function keys for frequent control entries?
Does it provide global search and replace capability?
Is the menu selection by pointing? -- primary means of sequence control.
Is the menu selection by keyed entry? -- secondary means of control entry.
Does it require minimal cursor positioning?
Does it require minimal steps in sequential menu selection?
Does it require minimal user control actions?
Is the return to higher-level menus required only one simple key action?
Is the return to general menu required only one simple key action?

Minimal Memory Load
How are abbreviations and acronyms used?
Does it provide aids for entering hierarchic data?
Is the guidance information always available?
Does it provide hierarchic menus for sequential selection?
Are selected data highlighted?
Does it provide index of commands?
Does it provide index of data?
Does it indicate current position in menu structure?
Are data items kept short?
Are the letter codes for menu selection designed carefully?
Are long data items partitioned?
Are prior answers recapitulated?
Are upper and lower case equivalent?
Are upper and lower case equivalent?
Does it use short codes rather than long ones?
Does it provide supplementary verbal labels for icons?

Perceptual Limitation
Does it provide coding by data category?
Is the abbreviation distinctive?
Is the cursor distinctive?
Are display elements distinctive?
Is the format for user guidance distinctive?
Do the commands have distinctive meanings?
Is the spelling distinctive for commands?
Does it provide easily distinguished colours?
Is the active window indicated?
Are items paired for direct comparison?
Is the number of spoken messages limited?
Does it provide lists for related items?
Are menus distinct from other displayed information?
Is the colour coding redundant?
Does it provide visually distinctive data fields?
Are groups of information demarcated?
Is the screen density reasonable?

User Guidance
System feedback: How helpful is the error message?
Does it provide CANCEL option?
Are erroneous entries displayed?
Does it provide explicit entry of corrections?
Does it provide feedback for control entries?
Is HELP provided?
Is completion of processing indicated?
Are repeated errors indicated?
Are error messages non-disruptive/informative?
Does it provide RESTART option?
Does it provide UNDO to reverse control actions?
Is the sequence control user initiated?

Both the questionnaire and answer sheets are reproducible without permission provided this footnote is included in all copies used. Reproduced by permission from Han X. Lin, Yee-Yin Choong, and Gravriel Salvendy. A proposed index of usability: A method for comparing the relative usability of different software systems, Behaviour & Informational Technology, 1997, Oct., pp. 267-278.
APPENDIX H

IRB DOCUMENTS
August 17, 2005

Charles Rawls
14408 Stamford Circle
Orlando, FL 32826

Dear Mr. Rawls:

With reference to your protocol #05-2792 entitled, "Performance Support and Usability: An Experimental Study of Electronic Performance Support Interfaces" I am enclosing for your records the approved, expedited document of the UCFIRB Form you had submitted to our office. This study was approved by the Chairman on 8/15/05. The expiration date for this study will be 8/14/06. Should there be a need to extend this study, a Continuing Review form must be submitted to the IRB Office for review by the Chairman or full IRB at least one month prior to the expiration date. This is the responsibility of the investigator. Please notify the IRB when you have completed this study.

Please be advised that this approval is given for one year. Should there be any addendums or administrative changes to the already approved protocol, they must also be submitted to the Board through use of the Addendum/Modification Request form. Changes should not be initiated until written IRB approval is received. Adverse events should be reported to the IRB as they occur.

Should you have any questions, please do not hesitate to call me at 407-823-2901.

Please accept our best wishes for the success of your endeavors.

Cordially,

Barbara Ward, CIM
IRB Coordinator

Copy: IRB file
Atsushi Hirumi, Ph.D.

BW jm
THE UNIVERSITY OF CENTRAL FLORIDA
INSTITUTIONAL REVIEW BOARD (IRB)

IRB Committee Approval Form

PRINCIPAL INVESTIGATOR(S):  Charles Rawls  IRB #: 05-2792

PROJECT TITLE: Performance Support and Usability: An Experimental Study of Electronic Performance Support Interfaces

[  ] New project submission
[  ] Continuing review of lapsed project #
[X] Study expired: 8/1/05  [  ] Continuing review of #
[  ] Initial submission was approved by expedited review
[  ] Initial submission was approved by full board review but continuing review can be expedited
[  ] Suspension of enrollment email sent to PI, entered on spreadsheet, administration notified

Chair
[X] Expedited Approval
   Dated: 8/15/05
   Cite how qualifies for expedited review: minimal risk and
   Complete reverse side of expedited or exempt form

IRB Co-Chairs:

Signed:  
Dr. Sophia Delogu

[  ] Exempt
   Dated:
   Cite how qualifies for exempt status: minimal risk and

[X] Expiration
   Date: 8/14/06

NOTES FROM IRB CHAIR (IF APPLICABLE): First review minor clarification to sample needed. 
Analyzed on August 14, 2005
LIST OF REFERENCES


