1-1-2013

Electronic Performance Support Systems: Comparison Of Types Of Integration Levels On Performance Outcomes

Sharon A. Phillips
Wayne State University,

ELECTRONIC PERFORMANCE SUPPORT SYSTEMS: COMPARISON OF TYPES OF INTEGRATION LEVELS ON PERFORMANCE OUTCOMES

by

SHARON A. PHILLIPS

DISSERTATION

Submitted to the Graduate School

of Wayne State University,

Detroit, Michigan

in partial fulfillment of the requirements

for the degree of

DOCTOR OF PHILOSOPHY

2013

MAJOR: INSTRUCTIONAL TECHNOLOGY

Approved by:

____

Advisor Date

____

____

____

DEDICATION

This dissertation is dedicated to my husband, Lynn, and to my children, Mark, Sarah and Michelle for their longstanding encouragement and support.

ACKNOWLEDGEMENTS

I wish to extend my sincere gratitude to the many individuals who have contributed in many ways to making this dissertation possible. I wish to thank my adviser, Dr. James Moseley, for his support, patience and guidance throughout my doctoral program. I also wish to thank my committee members, Drs. Ingrid Guerra Lopez, Timothy Spannaus, and Dian Walster for their valued expertise, insight and encouragement.

I would like to acknowledge the many members of the staff of the Wayne State University Library System for their expertise and assistance with the many phases of this research project. I am grateful to Dr. Sandra Yee, Dean, Wayne State University Library System, for her enthusiastic support and encouragement throughout my doctoral program. I wish to especially acknowledge Shawn McCann, who provided outstanding and critical assistance and expertise with the technical aspects of this study, and with the data collection process. I also wish to give a special acknowledgement to Jill Wurm, who provided key advice and support throughout this study. I wish to recognize the efforts of Veronica Bielat who patiently assisted with my literature review, and who served as a valued sounding board. I am particularly grateful to expert panel members Judith Arnold, Cynthia Krolikowski, and Nancy Wilmes, whose wisdom, experience and expertise guided my methodology and understanding of my results.

Finally, I wish to thank my family, without whose steadfast support and encouragement I could not have completed this work. I am particularly grateful to my husband, Lynn Phillips, for his constant and ongoing support, understanding and good humor.

TABLE OF CONTENTS

LIST OF TABLES

TABLE OF FIGURES

CHAPTER 1

Introduction and Statement of the Problem

Selecting appropriate performance improvement interventions is a critical component of a comprehensive model of performance improvement (Richey, Klein, & Tracey, 2010). According to Wilmouth, Prigmore & Bray (2010), intervention selection is an interconnected process involving analysis of an organization's environment, definition of the performance problem, and identification of a performance gap and identification of causal factors. When the performance gap relates to a lack of knowledge or information on the job, instructional approaches such as training have been traditionally used; however, non-instructional interventions such as electronic performance support systems (EPSS) have gained increasing attention as alternatives to training interventions (Barker & Van Schaik, 2010; Hung & Chao, 2007; Rossett & Schafer, 2007).

The goal of EPSS is to provide whatever is necessary to generate performance and learning at the point of need. Using computing technology, EPSS provide support for task performance on demand, any time, any place, and regardless of situation, without unnecessary intermediaries such as instructors, peer mentors or supervisors (Gery, 1991; Rossett & Schafer, 2007). A key element in achieving such a goal centers on the system interface (Barker & Van Schaik, 2010;Gery, 1991; Hung & Chao, 2007). As Gery stated in her landmark introduction to EPSS, "the user interface may be the single most important element of a successful electronic performance support system. If it is inadequate, unclear, or too complex, the power of the underlying system is essentially irrelevant" (p. 44). According to Nguyen, Klein & Sullivan

(2005), "it is important to design the system in such a way that users prefer the support system, have easy access to information, and feel that they will find the answers they need" (p.84).

In order to assure on demand, just in time delivery of performance support, Gery (1995) and Raybould (2000) have asserted that an EPSS should be as integrated as much as possible into the user's work space. According to Gery, an EPSS interface can be categorized as intrinsic, extrinsic or external, reflecting the level of seamlessness experienced by the user. Users of an external tool must interrupt their workflow and leave their primary work space to search for answers to questions or obtain advice. Stopping work to access an online help desk is an example of use of an external tool. Users of an extrinsic tool can access support and assistance within their primary workspace, but must stop and click on an embedded link or cue, such as the Paperclip character found in Microsoft Office programs. Intrinsic tools, on the other hand, are so seamlessly designed into the interface that the users do not know that they are even accessing the tool (Huff, 2007). According to Nguyen et al. (2005), this framework underpins a broadly based belief among EPSS designers that the intrinsic tool is optimal for supporting performance. However, while widely adopted by EPSS interface designers, Gery's (1995) categories have not been supported definitively by empirical research.

In addition to determining the appropriate level of integration, EPSS designers face the challenge of integrating diverse components related to a particular task in a way that is easy to use, and which allows access to only those information resources that are needed at the precise time of need. Because EPSS tools are intended to be used without presence of a classroom instructor or other type of mentor, the component choices must be easy to locate, and the interface must be easy for the user to learn on his or her own.

A critical role played by EPSS tools is providing external memory support while users perform tasks and solve problems on the job (Barker & Van Schaik, 2010). As memory support tools, EPSS have their origins in job aids (Rossett & Schafer, 2007). According to Clark & Nguyen (2008), use of job aids emerged as part of the behavioral engineering approach to performance improvement. For example, Thomas Gilbert’s (1978) human competence model highlighted memory support in the form of job aids (and by extension, EPSS) in situations where knowledge and skills are needed for performance. Research on job aids is not broad, but has established that providing memory support and on-the-job procedural guidance facilitates learning and work performance at levels comparable to that of training interventions (Duncan, 1985).

Viewed from the information processing perspective, a learner’s working memory can become overloaded when a highly integrated EPSS interface imposes an additional “learning curve.” In such a situation the learner must divert resources in working memory from solving the problem at hand in order to learn how to use the interface and understand its components (Barker & Van Schaik, 2010; Hung & Chao, 2007; Milheim, 1997; Sherry & Wilson, 1996). Particularly when a user must solve an unfamiliar or seldom used task, this can overload working memory. When the EPSS is highly integrated into the worker’s performance context, he or she must interact with the EPSS, determine how to use it, and learn how to locate and apply relevant information, while in the midst of performing a task on the job. If the task or the environment is complex, the working memory will become overloaded. The purpose of this research is to better understand how to design an EPSS with an appropriate level of integration in order to maximize performance outcomes and minimize time on task, without overloading working memory. This is an important question, because, “no matter how wonderful the innovation, it is worthless unless it is used” (Sherry & Wilson, 1996, p. 28).

Research suggests that if users find an interface too difficult to use, they will not use the tool, and may even abandon it (Nguyen, et al., 2005; Sherry & Wilson, 1996; Van Schaik, Barker & Famakinwa, 2007); further research suggests that this may result in lower levels of achievement on task based measures such as accuracy, completion and time on task (Darabi, Nelson, & Mackal, 2004; Mao & Brown, 2005). Unfortunately, little research evidence exists to guide design decisions to avoid problems such as this (Nguyen, et al., 2005).

Early studies in the literature have connected the complexity of an EPSS interface with willingness of individuals to use an EPSS (Van Schaik, et al., 2007) and by extension, with the frequency with which they use the system (Sherry & Wilson, 1996). Taking this a step further, Nguyen et al. (2005) argued that “if users feel that the system is annoying or unhelpful, they will not use it and, therefore, will not maximize the benefits it may offer to aid task performance” (p. 84).

It would seem logical to connect user acceptance of an EPSS with corresponding levels of performance outcomes; however, empirical evidence to support this notion is incomplete. Barker & Banerji (1995) found a relationship between the type of EPSS interface and performance of an online procedural task, but the study was limited by a small sample size. Van Schaik, Pearson & Barker (2002) found EPSS to be effective in supporting knowledge retention and performance outcomes, but revealed no significant findings to relate these outcomes to the level of integration.

Darabi et al. (2004) found EPSS to be effective in supporting task performance by graduate students in a performance analysis course and found a relationship between students' performance results and their ability to understand and use the EPSS. Unfortunately, the small sample used in this study made the results of this study difficult to generalize.

Mao & Brown (2005) found that users of an EPSS performed significantly better on an achievement test than a training group on software-related performance tasks and suggested that familiarity with the EPSS interface played a role in participants' performance outcomes.

Based upon Gery's (1995) intrinsic, extrinsic and external levels of EPSS integration, Nguyen et al. (2005) compared performance outcomes and frequency of use. Interestingly, they found that the most frequently used and most preferred interface was not the intrinsic interface, but the less integrated extrinsic EPSS tool.

The above findings present an incomplete picture of how the integration level of an EPSS impacts performance outcomes. Research has established the effectiveness of EPSS and memory support aids on performance outcomes and reduction of time on task. A connection has been established between the integration level of an EPSS with the frequency of EPSS use, and two studies (Darabi et al., 2004; Nguyen, et al., 2005) have identified frequency of use as a potential factor in influencing performance outcomes. However, the small sample sizes connected with these studies make generalization difficult. In addition, with the exception of Darabi, et al., these studies are limited by experimental designs in which participants performed contrived tasks in laboratory situations rather than in real world contexts. The literature would be strengthened by follow up studies using larger sample sizes and conducted in authentic work environments with real world tasks.

Significance of the Study

The current study contributes to the field of Instructional Technology by seeking to expand understanding of EPSS tools and how they should be designed to interact with the user's task environment so that users achieve maximum performance. Gery (1995) and Raybould (2000) have recommended that an EPSS tool should be integrated as much as possible into the performer's work environment, and as recently as 2011, Gal & Nachmias argued that "intrinsic EPSS is the best approach for both performance support and online learning" (p. 27). Yet, the research provides little insight as to what level or type of integration provides optimal results. Nguyen et al. (2005)'s research did not definitively support this notion. They found that users do not prefer the intrinsic EPSS, and use it less frequently than less integrated tools. Given the growing interest in application of EPSS tools, the scarcity and incomplete nature of empirical evidence to support the design and application of these tools is problematic. Citing Huglin, Johnsen & Marker (2007), Binder (2010) emphasized the importance of basing practice-based, intervention design decisions on research. Binder argued that when "attempting to assemble programs or interventions composed of multiple elements or variables, [Research evidence] can provide guidelines for what we might try in our 'best bet' interventions and enable us to improve the likelihood that our initial designs will be effective" (p. 8).

As Clark & Mayer (2010) stated,

> One way to ensure a return on more than $100 billion invested annually in workforce learning is to adopt instructional strategies that are rooted in evidence. We recommend that [practitioners] consider research on instructional methods proven to support learning as one factor in your course design, development and selection decisions. We prefer experimental research as the most valid indicators of instructional methods that work (p. 334-35).

Yet, according to Clark & Estes (2002), there is a lack of empirical evidence available upon which to base practice-related decisions.

> The harsh reality is that a significant number of very popular performance products and remedies simply do not work … It doesn't need to be that way … [if] you adopt the results of solid performance research and turn it into practical and cost-beneficial performance results in your organization. (p. xi)

Underscoring this point, Clark (2006) asserted the need for development of evidence-based IT practice that uses research evidence to guide practice decisions. Clark argued that in order for the profession of human performance improvement to continue to grow, practitioners must ensure that evidence be weighed as heavily as any other factors such as an organization's culture, the availability and use of technology and time, budget and politics. "To do less diminishes us all as a fledgling profession and our opportunities to support the organizations and the staffs within them that we serve" (p. 896).

Potential Limitations of the Study

There are a number of potential limitations to this study. The current study focuses on a specific set of library research tasks applied in a particular library context. As a result, the study results may not be applicable to other types of tasks, or to other performance environments. The nature of the study sample may present another potential limitation. The sample is limited to college students, and the project is designed to address their specific needs. Because other types of users may react differently, it may not be possible to generalize findings beyond student group. Finally, the study design calls for a sample size of 256, requiring 64 participants per group. While this is the goal for participation, it is possible that the actual study may attract a smaller than desired sample size. This could impact generalizability of the findings.

CHAPTER 2

Review of Relevant Literature

What is EPSS?

The literature provides a number of definitions and views about EPSS (Hudzina, Rowley, & Wager, 1996; Raybould, 1995). The most frequently cited definition, offered by Gloria Gery (1991), describes EPSS as "the use of technology to provide on-demand access to integrated information, guidance, advice, assistance, training and tools to enable high-level job performance with a minimum of support from other people" (Gery, 1991 as cited in Laffey, 1995, p. 31).

Development of EPSS tools has been driven by the rapid development of computing technology, the increasing complexity of the work place, and the need for increased worker performance to enable organizations to compete in the world market (Gery, 1991 as cited in Hudzina, et al. 1996, p. 36). As computing technology has become more powerful and available, organizations and consumers have raised demands for support that is immediate and that allows self-initiated access, any place, and any time (Rossett & Schafer, 2007).

EPSS tools are part of a broad array of non-instructional performance interventions such as process reengineering, management standards and training, job standards, performance feedback, incentives and job aids (Clark & Nguyen, 2008). Performance support tools such as job aids are considered forerunners of EPSS (Rossett & Schafer, 2007) and have long been of interest to the performance improvement community. For example, Gilbert (1978) argued that simply following the directions in a well-designed guide, [based upon proper procedures of performance analysis] can convert a novice to a level of troubleshooting efficiency surpassing that of the best experienced [performers]. In an early summary of experimental research on the effectiveness of job aids, Rowan (1973) concluded that compared to traditional training, use of job aids can produce equivalent or superior task accuracy and allow a task to be completed in less time. Duncan's (1985) analysis of military research on job aids concluded that job aids saved on development costs, while producing performance outcomes that were comparable to those achieved through training.

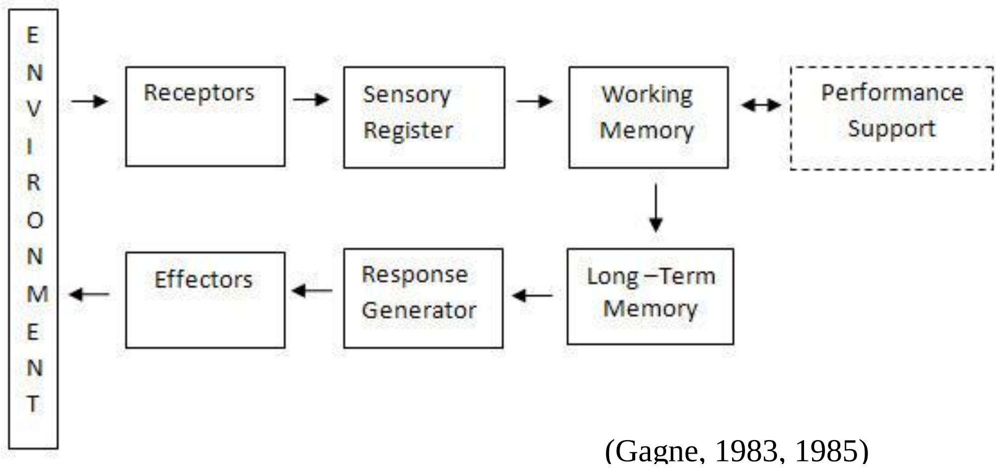
Memory Support and Performance Outcomes

According to Tessmer & Richey (1997), a key problem with traditional training is that it takes place before the worker must perform the task. As a result of the delay between learning and actual application of skills on the job, much of the learning can be forgotten. This delay between learning and actual application of skills on the job can result in loss of potential performance (Chang, 2004).

In contrast, EPSS tools reduce the demand on a worker's memory by providing a way for the performer to access needed information externally (Barker & Van Schaik, 2010; Bastiaens, Nijhof, Streumer, & Abma, 1997; Gilbert, 1978). Gilbert argued that simply following the directions in a well-designed performance support aid can convert a novice to a level of troubleshooting efficiency surpassing that of the best experienced performer.

According to Information Processing Theory, memory support should reduce the burden on working memory. Information processing theory is based upon the view of the human mind operating in much the same way as a computer: taking in data, then analyzing, storing and retrieving it (Atkinson & Shiffrin, 1968). From this perspective, information is thought to be processed in a serial, discontinuous manner as it moves from one stage to the next, from sensory memory, where external stimuli are detected and taken into the nervous system, to short-term memory, to long-term memory (Gagne, 1983, 1985). Figure 1 provides an information processing model of learning and memory offered by Gagne (1983, 1985). The figure also demonstrates the role played by performance support.

Figure 1. Information Processing Model



(Gagne, 1983, 1985)

Sensory Register & Selective Perception. According to Atkinson & Shiffrin (1968), we receive information from our environment through sensory receptors, our senses. Sensations are converted to messages that are sent to the brain, where they are stored very briefly in a structure called the sensory register. Perceptions of many environmental stimuli enter this register at any given moment. However, very few are attended to and passed along to be further processed within the brain (Sperling, 1960). Without such a process, we would be overwhelmed by the multitude of environmental stimuli we encounter every day. Determination of which stimuli to which we attend is influenced by our prior personal experience and knowledge

Working Memory. Information to which attention has been paid is passed into working memory. Working memory can be thought of as a desktop where everything happens, but which can only hold a finite amount on its surface. Researchers generally acknowledge that only seven, plus or minus two, chunks of information can be retained in working memory at one time (Miller, 1956). In addition to its limited capacity concerning the amount of information that it can retain, working memory also is recognized for its short duration in terms of the limited amount of time that information can be retained there (Sweller, VanMerrienboer & Paas, 1988). Ten to twenty seconds is considered the amount of time that information is kept in working memory (Gagne, 1985; Murdock, 1961). Not all information that enters working memory is transferred to long-term memory (Gagne, 1983; Lindsay & Norman, 1972; Atkinson & Shiffrin, 1968). For example, people commonly experience a dropout of information when they have retained a phone number only long enough to be able to dial it. It is possible to keep that information in working memory longer than 10 to 20 seconds by rehearsing or repeating it (Lindsay & Norman). However, for situations involving a large number of elements and decisions, such a process would be an impossible method to retain all the information we need. Therefore, information that we need to remember for more than a short period of time must be transferred, or encoded, into long-term memory (Atkinson & Shiffrin). If such encoding does not occur, the information in working memory is replaced by other information, and discarded. In other words, it is forgotten.

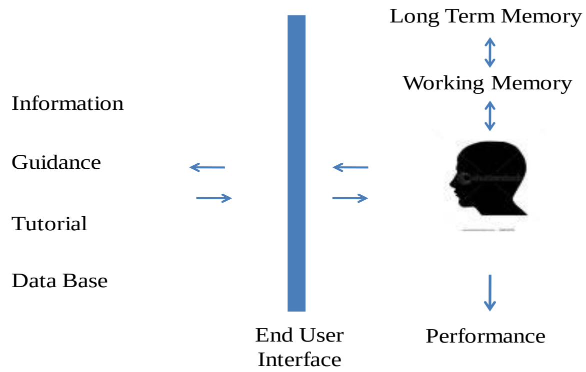
While the above explanation of working memory has focused on learning processes, working memory behaves in a similar way when we must solve a problem or perform a task (Van Schaik, 2010; Sweller, et al., 1998). During the process of performing a task, or solving a problem, a performer typically must use knowledge and information relevant to the task, and may need to recall pertinent principles and rules for applying the information and knowledge. When tasks are simple and familiar, the performer can more easily keep the needed background information in working memory while using remaining working memory resources to keep track of the problem solving steps. However, when tasks become more complex, or when a task is unfamiliar, it becomes more difficult to keep all the information elements needed to perform the task within working memory (Sweller et al., 1998). Because working memory can only process limited amounts of new information, overload can result. This is the central assumption of the cognitive load approach (Seel, 2008; Sweller et al.). Cognitive load may be influenced by the mental effort necessary to process new information or perform a task (intrinsic cognitive load) and through the manner in which the material is presented (extraneous cognitive load) (Seel, 2008, p. 40-42; Van Schaik, 2010; Sweller et al.). To assist with this problem, performance support tools provide a way for the performer to offload the burden of memory to an external tool within the work environment (see Figure 1) (Barker & Van Schaik, 2010, p. 42). Research indicates that for the performer, use of an external memory support tool results in fewer errors (Gilbert, 1978; McGraw, 1993), greater quality of task completion (Darabi, et al., 2004) and reduced time to complete the task (Barker, 2010; Barker & Banerji, 1995).

EPSS Interface

The current research involves the EPSS interface, and at what level it should be integrated into a work environment to maximize task related performance outcomes without overloading cognitive processing. Important to this question is an understanding of the complexity of the EPSS interface, how it relates to cognitive processing, and how this, in turn, affects task performance.

By their nature, EPSS tools are complex. They seek to unite a range of different performance support resources within a single access point that can be easily used and understood by novice users while they are performing new or unfamiliar tasks. This is accomplished through design of the EPSS interface (Barker & Banerji, 1995; Barker & Van Schaik, 2010; Gery, 1995; Raybould, 1995; 2000). According to Hung & Chao (2007), this challenge goes beyond simply pasting together diverse resources. Hung & Chao argued that through the EPSS interface design, users should be able to "interact with, generate, store, and retrieve information contained in various system modules without sensing disparity or disconnection" (p. 182). According to the Human Computer Interaction (HCI) and Usability literature, this involves visual design of the screen displays (Huff, 2007). The visual design of the interface should provide a meaningful representation of content, which in turn can make information easier and quicker to locate. However, the current research argues that a highly integrated EPSS may make the interface more visually complex, overloading the performer's working memory, and adding time and effort to the task performance process. This, in turn, may cause errors and decrease the likelihood that the user will complete the task at hand. The function of the EPSS interface is shown in Figure 2.

Figure 2. EPSS Interface



(Adapted from Barker, & Van Schaik, 2010)

Levels of EPSS Integration

Providing on-demand access at the point of need requires that the EPSS be integrated into a worker's immediate performance environment. However, according to Clark (1992), integration into the workplace can itself become a barrier to learning and performance. When the EPSS is integrated into the work environment, the performer must engage with the EPSS, understand how to use it, and learn how to locate and apply relevant information, while in the midst of performing an unfamiliar task. Yet, "many work environments are filled with interruptions or environmental noise, making the concentration required for learning impossible" (Clark, 1992, p. 24). If the task is new or unfamiliar, the working memory will quickly become overloaded, and if the interface requires too much time to learn to use, it simply will not be used (Clark, 1992, p. 24). The purpose of this research is to better understand how to design an EPSS with an appropriate level of integration in order to maximize performance outcomes and minimize time on task without overloading the performer's working memory.

Gery (1995) identified three levels or types of integration for an EPSS.

Intrinsic Support. Intrinsic support is inherent to the target program interface. Intrinsic support is intended to provide support to the user without his/her having to take any specific action (Huff, 2007). When there are high levels of intrinsic support, people should not be aware of the interface, but should just feel that they are doing their work (Gery, 1995). Typically, intrinsic support is embedded directly into the target work software, and assistance and support are made available as needed.

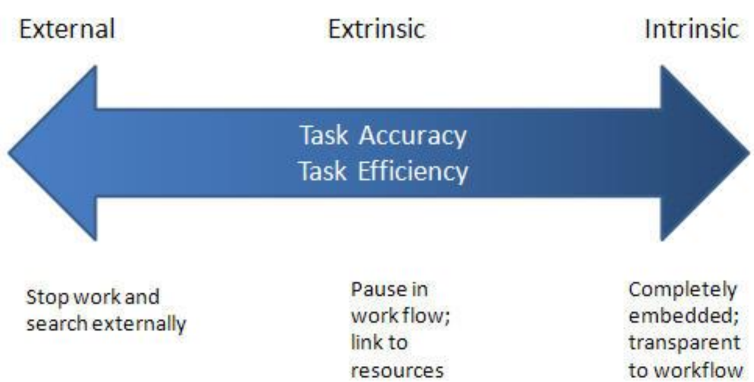
Extrinsic Support. Extrinsic support also is located and integrated within the target software system, but the support content itself resides in a location that is external to the work environment, on a separate server for example. With this type of support, the user stops the actual performance, but remains within the performance software environment. This type of support may take the form of an icon placed strategically within the software. The user can obtain help by clicking on the icon, but has the option of turning off the help icon if desired. The paperclip in Microsoft Office applications is an example of an extrinsic tool (Gery, 1995).

External Support. External support is completely external to the worker's workspace. External support may or may not be computer mediated. To use an external support tool, performers must break their performance flow and leave the target work environment to search for and locate the appropriate support. Examples of external support tools include job aids, help desks, and help web sites (Gery, 1995).

It should be noted that the above definitions reflect adjustments made to accommodate the current technological landscape, rather than the landscape of 1995. The above definitions therefore have been adjusted to reflect current technological capabilities, rather than the print-based and more limited technological landscape of the 1990s.

According to Raybould (2000), the three EPSS integration levels can be viewed along a continuum as shown in Figure 3.

Figure 3. Continuum of Integration



[illegible]) has been expanded and re[illegible] performance support continuum as a progression toward transparency of support "where there is no distinction between a task and the technological support provided to accomplish that task" (p.29). Cavanaugh's spectrum of support added two levels to Gery's three levels of integration.

Intuitive Support. As with intrinsic support, intuitive support is integrated into the performance task. However intuitive support is proactive and adaptive to the performer's context. An intuitive support system anticipates what the user will need, and provides proactive support. An example of intuitive support is the auto correct feature in Microsoft Word (Cavanaugh, 2004).

Intelligent Support. Intelligent support is completely transparent. "It knows when you need it and is there, fully integrated into the task" (Rossett & Schaefer, 2007, p. 39). Noting that this level of performance support has yet to be fully realized, Cavanagh (2004) offers some futuristic scenarios. Examples include mechanical equipment that will not function unless properly held; facial recognition algorithms that identify user expressions and modify the work flow accordingly; artificial intelligence built into aspects of daily life, such as toasters that will not burn bread, cars that cannot crash (Cavanaugh, 2004, p. 31).

The notion that greater integration results in better task performance is not universally embraced in the literature. For example, Rossett & Schaefer (2007) advocated looking at EPSS design in terms of the nature and purpose of the EPSS tool and the type of activity to be supported. Rossett & Schaefer categorized EPSS based upon the point at which it is used within the performance of a task. Using this approach, they identified two types of EPSS. EPSS that are used during the work process are known as sidekicks, while EPSS that are used right before performing a task are known as planners. The purpose of an EPSS sidekick is to be "at your side during the task." (p. 64). While this type of EPSS requires integration into a work process, Rossett & Schaefer also believed that "value can come from the absence of integration, from an opportunity to pause and reflect, inspired by expert advice and pithy guidance surrounding the task" (p. 39). They described this type of an EPSS tools as a planner, "whose purpose is to be in our lives just before or after the challenge." (p. 64).

According to Gery (1995), Raybould (2000) and Cavanaugh (2004), increasing EPSS integration should produce fewer pauses in workflow and faster access to support. Based upon learning, instructional and HPT theory, this should produce increased accuracy and quality of task completion (Brown, Collins, & Duguid, 1989; Gilbert, 1978; Tessmer & Richey, 1997).

According to Barker & Banerji (1995), increased integration also should decrease the amount of time needed to complete a task.

The problem addressed in the current study is that, while widely adopted, Gery's EPSS integration framework has not been definitively supported by research. Nguyen, et al. (2005) compared the use of Gery's intrinsic, extrinsic and external interfaces with seventy-two (n=72) employees from a large corporation on performance of a basic procedural software task. The findings indicated that use of the intrinsic EPSS tool did not result in a significant difference in task performance outcomes over the less integrated external and extrinsic tools. This finding is of interest to the current study; of further interest is the finding that the extrinsic EPSS tool was used more frequently and was more highly preferred by participants than the intrinsic EPSS tool. Nguyen et al. suggested that this may have been the result of the visual complexity of the intrinsic interface.

There were some design and procedural problems with this study that limit the generalizability of the findings. For example, most of the sample participants had relatively high computer system familiarity. Noting that users with less prior knowledge could perform differently, the authors cautioned that the study should be reproduced in other settings. Unfortunately, the data for this study were collected with instruments that had not been validated, severely limiting the ability to generalize the findings for other groups and settings.

These and other findings raise questions about how individuals interact with an EPSS, and how these interactions impact frequency of use and optimal performance. Nguyen (2009) interviewed EPSS users and found that EPSS produced more positive user attitudes compared to an online training module. On the other hand, the participants in a study by Bastiaens, et al.

(1997) indicated a preference for in-person training over the EPSS. Findings by Paino & Rossett (2008) suggest that the interface design could play a role. They surveyed a convenience sample of 30 users of commercial performance support tools and found that users indicated a strong preference for tools that are intuitive and easy to use. Although the design and methodology of this study were not rigorous enough to serve as solid evidence, the findings present an interesting context for viewing the findings of the Nguyen et al. (2005) study in which users significantly preferred a less integrated (extrinsic) EPSS design to a more integrated (intrinsic) design. Taken together, these findings raise more questions than they answer. For example, how does the type of EPSS design influence willingness to use an EPSS, and how does user willingness to use an EPSS influence performance outcomes?

Library Research and Performance Support

The current study will examine the impact of an EPSS on users' ability to utilize an online library catalog to locate appropriate resources. A library catalog provides an index of all the items held in a library, along with a description of where these items are stored. By combining a range of catalog search features, library users can search for and identify a resource by the name of the author who created a particular item held by the library, by the title of an item, or by the date of publication of a particular item. Catalog search features also provide the ability to retrieve items through use of subject descriptors and keywords.

The ability to effectively use the search features of an online library catalog is widely acknowledged as an essential part of performing library research (Grassian & Kaplowitz, 2009). However, library users often have difficulty performing this task (Famakinwa & Barker, 2010 Grassian & Kaplowitz). As a result, to the dismay of their instructors and librarians, students often turn away from the library catalog to consult less authoritative, but simpler, easier to use information sources such as the Internet, their family or their friends (DeRosa et al., 2005). In response, academic libraries have instituted various types of training programs and courses to teach library research skills. However, despite these training efforts, library users have continued to experience problems when performing basic library research tasks.

Based upon criteria identified by Nguyen (2010), library research would benefit from a performance support approach, in that, the research process tends to involve a number of complex tasks, and because library research is typically an infrequently performed task. A few studies of an EPSS with a library catalog have been reported (Van Schaik, et al., 2007; Famakinwa & Barker, 2010; Van Schaik, et al., 2002). While these studies have involved small samples and have not produced significant findings, they do highlight the library catalog as an interesting target environment in which to study the impact of EPSS on task performance.

Case Reports and Case Studies

Much of what is known about EPSS comes from case report descriptions of successful EPSS applications. While not rigorously designed, results of these studies indicate that EPSS can be applied in a range of settings. For example, in a corporate setting, Chabrow (2005) described use of an EPSS by an auto dealer who tested a wireless headset with a flip down screen to allow mechanics to search and consult manuals to support auto repair procedures. Hung & Chao (2007) described a design of an EPSS to support customer service representatives in a call-center setting.

In a library setting, Whitney (2005) described a project by the Library of Congress which involved development of a learning management system to help employees and their managers build individual development plans, administer hundreds of library training and access online courses. The system includes a help component with an embedded "Show Me" animated help screens to support users who are not strong computer users. In another library application, Van Schaik, et al., (2007) described a prototype EPSS designed to serve as a front end interface integrating all components of a library system to facilitate use of the library catalog.

In an educational application, Rossett & Schafer (2007) described the use and evaluation of a rubric in a course designed to assist teachers in improving their performance in planning unit lessons (Wiggins & McTighe, 1998, as cited in Rossett & Schafer, 2007, p. 78-79).

Many of the above case studies can be characterized as "success stories" that are based on anecdotal accounts. While these studies provide insight as to how EPSS systems may be developed and implemented, they also tend to start from positive assumptions about EPSS, their benefits and potentials that have not been tested empirically. In response, some researchers have voiced caution about embracing EPSS and other evolving interventions without empirical testing. For example, Chang (2004) observed that "EPSS facilities are sometimes successfully developed and implemented in some situations and fail in others… Not all jobs or tasks lend themselves to the successful development and use of EPSS" (p.344). Clark (1992) further cautioned that

> Early advocacy of any new intervention requires some overstatement. Yet that same overstatement can create false expectations and lead down the all too common path of early enthusiasm, ineffective or uneven adoption, little or no evaluation of cost benefit, waning interest, and finally disillusionment and abandonment. As with most new interventions, there are some real benefits to be realized given thoughtful consideration and evaluation of how and when to use it (p. 21).

Empirical Research

The base of empirical research on EPSS is small. Underlying much of the empirical study of EPSS is the concern about shortcomings of training interventions in improving individual performance and impacting organizational results. As early as 1978, Gilbert (1978) stated that training is not effective in improving worker competence and accomplishment and is too costly to develop and deliver. It, therefore, is not surprising that the empirical literature on EPSS focuses on establishing the effectiveness of EPSS as an alternative to training interventions with respect to improving performance results, at the individual and organizational level, and with respect to demonstrating a return on investment. For example, return on investment (ROI) is a claim made about EPSS in the practice based literature, but there is little hard evidence to support this claim. In one of the few studies of EPSS impact on organizational outcomes, Chang (2004) surveyed EPSS administrators in a range of business organizations to obtain their perceptions about the relative contributions of six EPSS components - advisory system, data or information database, learning or training support, online help or reference, productivity software and user interface. Study results indicated that job oriented or problem-solving components of an EPSS made a higher contribution to overall performance than other EPSS elements. Chang argued that his results confirmed the overall effectiveness of EPSS in improving individual and organizational performance; however, a number of problems with this study call the findings into question. For example, the data collected were based upon perceptions of EPSS coordinators rather than on direct observation of system use by the workers. Further, the study design produced soft data that were not triangulated by other data sources, and did not produce the hard performance data needed to support ROI claims. Bastiaens, et al. (1997) did attempt to establish a connection between the use of an EPSS with sales results; however, the study results showed no significant impact.

Studies of EPSS Integration

The problem addressed in the current study is that, although widely adopted, Gery's EPSS integration framework (1995) has not been definitively supported by research. Viewing Gery's framework as a continuum as shown in Figure 3, it would be logical to expect that performance would improve progressively with the level of integration. In other words, if the level of integration is considered a treatment, the framework would be expected to predict that users of the intrinsic EPSS would perform better on accuracy measures than users of the extrinsic EPSS, and, in turn, that users of the extrinsic EPSS would perform better than users of the external EPSS (Krauth, 2000; Maracy, 2011). However, empirical research thus far has not supported this prediction.

In the first of two tests of Gery's framework, Nguyen, et al. (2005) compared the use of Gery's intrinsic, extrinsic and external interfaces with seventy-two (n=72) employees from a large corporation on performance of a basic procedural software task. The findings indicated that use of the intrinsic EPSS tool did not result in a significant difference in task performance outcomes over the less integrated external and extrinsic tools. The authors suggested that this may have been because the intrinsic tool was not used as frequently as the less integrated extrinsic tool. Nguyen et al. suggested that this may have been the result of the visual complexity of the intrinsic interface. There were some design and procedural problems with this study that limit the applicability of the findings. For example, the study design did not include controlling for prior knowledge of the participants. Additionally, the study design did not include an explanation as to how or whether the data collection instruments were validated.

Seeking to extend Nguyen et al.'s (2005) findings, Gal & Nachmias (2011) studied the performance of 294 call center representatives when using external and intrinsic versions of an EPSS as part of learning and work environments. Measuring participant performance against an absolute competency score, study results indicated significant differences between the performances of the intrinsic group compared to the external group on time on task and quality of service criterion measures. However, this result included testing in both learning and work environments. When the results were limited to the use of the EPSS as a performance tool within the work environment, little difference was found between the impact of the external and intrinsic tools on task performance. While interesting, the results of this study are of limited applicability. Because the study did not include an extrinsic EPSS type in the comparison, it cannot be considered a true test of the entire Gery (1995) framework. Further, as with the Nguyen et al. (1995) study, validation of the data collection instruments was not included in the study description, making the findings difficult to generalize.

EPSS Impact on Performance Outcomes

Empirical evidence demonstrating the impact of EPSS tools on individual performance outcomes is limited (Hudzina et al., 1996; Nguyen et al., 2005; Rossett & Schafer, 2006), and has produced mixed results. The largest body of empirical research has involved comparisons of EPSS with training interventions. Underlying these studies is the recognition that training interventions tend to be disconnected from the job context and are expensive to develop and deliver (Clark & Nguyen, 2008; Gery, 1991; Gilbert, 1978; McKay & Wager, 2007; Nguyen & Klein, 2008).

An early study comparing EPSS to training produced mixed evidence. Bastiaens, et al. (1997) tested the effectiveness of EPSS to support learning, work and productivity measures for field agents in a large Dutch insurance company. They found no significant difference between EPSS compared to traditional classroom training on learning measures. They also found no significant impact on sales performance for EPSS. In fact, Bastaiens et al. found that the participants preferred face to face training to the use of EPSS. Unfortunately, the findings are difficult to interpret broadly due to a small sample size (Nguyen & Klein, 2008).

Mao & Brown (2005) tested the effectiveness of online task support relative to instructor led training on software related tasks. Results indicated that users of online tasks support performed better than instructor-led trainees on a range of software related tasks. However, the study employed a small sample (n=13) for group comparisons. In addition, the composition of the sample included university students who are considerably younger and more educated than the general population. These problems make the results difficult to generalize beyond the study sample.

Nguyen & Klein (2008) found that combining training with EPSS produced the highest performance scores and was most preferred by the participants. Unfortunately, design and procedural problems make the results of this study difficult to generalize. The study did not include a control group due to a relatively small sample size (n=78). Of greater concern, this study included no explanation of the data collection procedures, and whether or how the measurement instruments were validated.

Darabi et al. (2004) investigated the question of whether an EPSS can assist in student learning of complex cognitive skills with a group of graduate students. The students used an EPSS during a performance analysis course to plan and organize their tasks and to report their results. The authors found that the EPSS tool facilitated the students' performance as assessed through a course rubric, and as measured by course grades. Like many of the preceding studies, the findings of this study are difficult to generalize due to very small sample size (n=12).

Barker, et al. (2007) evaluated the impact of an EPSS with undergraduate students to measure their learning and performance of a university library classification system. The study compared two EPSS components - a tutorial and an instructional game. One group of participants was provided with the tutorial component of the EPSS and asked to complete a performance test of their ability to interpret book call numbers and place them in correct order. A second group of participants was asked to complete the performance test after completing an instructional game component of the EPSS. A third control group was asked to complete the performance test with no EPSS. The study results found that the type of EPSS had no significant effect on knowledge retention. While not significant, a three month re-testing session revealed that the students' knowledge scores remained stable over time after use of the EPSS. Student confidence levels also remained stable over time after use of the EPSS.

Van Schaik, et al. (2007) also evaluated the use of an EPSS in a university library setting. Findings indicated that task performance as well as efficiency and speed were improved with EPSS compared to no EPSS. Like many of the preceding studies, validity of study results is problematic due to a very small sample (n=20).

EPSS and Frequency of Use

Frequency of use is a performance measure used in usability testing of websites (Rubin & Chisnell, 2008). According to Rubin & Chisnell, frequency of use is considered a critical measure of a website's usefulness. They define usefulness as "an assessment of the user's willingness to use the product at all. Without that motivation, other measures make no sense, because the product will just sit on the shelf" (p. 4). According to Emmanouilides & Hammond (2000), if an interface is found to be too difficult to use, this will decrease the frequency with which the resource is accessed and used. A small amount of evidence has been produced to support this notion. Darabi et al. (2004) found that users who found their EPSS difficult to use, used the relevant components less frequently and to less advantage. Darabi et al. further found that participants who used the EPSS less frequently achieved lower performance outcomes than those who used the tool more frequently. Unfortunately, the small sample used in this study made the results of the study difficult to generalize.

Nguyen et al. (2005) found that a highly integrated EPSS was less frequently used and significantly less preferred than a less integrated tool. Nguyen & Hanzel (2007) found that users decreased their use and eventually abandoned use of an external EPSS in which they were required to spend time searching through a database for needed information.

Barker & Banerji (1995) argued that more frequent use of a properly designed EPSS tool increases task efficiency by minimizing the time needed to perform the task. On the other hand,

> if a support resource has to be searched for, either in long-term memory or within some external source then the time for completion is likely to increase substantially. If a fact cannot be recalled or found by search then an appropriate one will have to be learned. If a suitable method for handling a task does not exist then an appropriate one will need to be devised. This situation can lead to maximum values for time on task. (p.6)

Barker & Banerji (1995) found a relationship between the type of EPSS interface and performance of an online procedural task, but the study was limited by a small sample size (n=36). Van Schaik et al. (2002) found EPSS to be effective in supporting knowledge retention and performance outcomes, but revealed no significant findings to relate these outcomes to the level of integration.

To these results can be added the findings of Mao & Brown (2005) who suggested in interpreting their results that user incoming familiarity with how to use the EPSS interface played a role in the participants' performance outcomes.

Problem

The EPSS literature contains an insufficient base of rigorously tested evidence to guide EPSS interface design decisions related to integration of the tool within the performance environment. Gery (1995) and Raybould (2000) have theorized that a more highly integrated (intrinsic) EPSS will provide the best performance outcomes and minimize performance time; yet, these recommendations have not been validated by definitive empirical evidence. In fact, based on the small amount of available evidence, intrinsic support has thus far not been found to produce better outcomes, has been found to be less preferred by users and was found to be used significantly less frequently than less integrated EPSS tools. A small amount of research indicates that 1) EPSS tools can produce positive task-related performance outcomes such as accuracy and completion rate; and 2) there is a relationship between the level of integration of an EPSS interface, user satisfaction and the frequency with which the EPSS is used. Research that ties these factors together while validating Gery's EPSS integration framework would strengthen the EPSS literature and HPT theory base while extending the base of evidence available to guide EPSS interface design practice.

Research Question

The current study tests the assumption that a more highly integrated EPSS produces superior performance and efficiency. The study will compare Gery's (1995) three levels of EPSS integration in terms of their impact on performance outcomes and frequency of use, and will address the following question:

What is the relationship between the level of integration of an EPSS, and frequency of use, task accuracy, task completion, and time on task?

Definition of Terms

Electronic Performance Support System (EPSS). An EPSS is an integrated electronic environment that is available to and easily accessible by each user and is structured to provide immediate, individualized online access to the full range of information, software, guidance, advice and assistance, data, images, tools, and assessment and monitoring systems to permit job performance with minimal support and intervention by others (Gery, 1991).

External EPSS Intervention. An external EPSS intervention strategy is a type of EPSS that requires a user to leave his or her primary work space to search externally for answers to questions or obtain advice (Gery, 1991).

Extrinsic EPSS Intervention. An EPSS intervention strategy is an interface that provides a user access to a support system that is contextual to the activities that are being performed, but that requires the user to leave the actual performance environment (Gery, 1991).

Intrinsic EPSS Intervention. An intrinsic EPSS intervention strategy is characterized by performance support that allows a user to receive support without taking any specific action (Gery, 1991).

CHAPTER 3

Methodology

The current research compared the impact of Gery's (1995) three levels of EPSS integration on task accuracy, time on task, task completion and frequency of use. The following section details the methods that were used and identifies the procedures that were followed in order to develop, deliver and analyze this research.

Target Population

Participants for this research were recruited from students enrolled at Wayne State University, Detroit, Michigan. The study utilized a convenience sample. Participants were invited to voluntarily participate in the study. They were recruited from schools, colleges, and programs that incorporate into their courses assignments requiring use of the library catalog. As an incentive for completing all components of the study, participants were given the option of participating in a drawing for a $50 gift card.

Procedures

The research protocol, including protocols for informed consent and confidentiality, was reviewed and approved by the Human Investigation Committee of Wayne State University (see Appendix A). All communication, including study materials, was managed electronically. A letter inviting participation explained the purpose of the study and provided a link to an information sheet which described the study, the time commitment required and the basic details of the exercises (see Appendix B and C). Permission was granted from the Dean of Students Office for use of the WSU student email list (see Appendix D). An advertisement inviting participation and providing a link to the information sheet also was posted on the Library System computer desktops, WSU Pipeline and the library website news section (see Appendix E). Permission to utilize Library System communication mechanisms was granted from the Dean of the University Library System (see Appendix F).

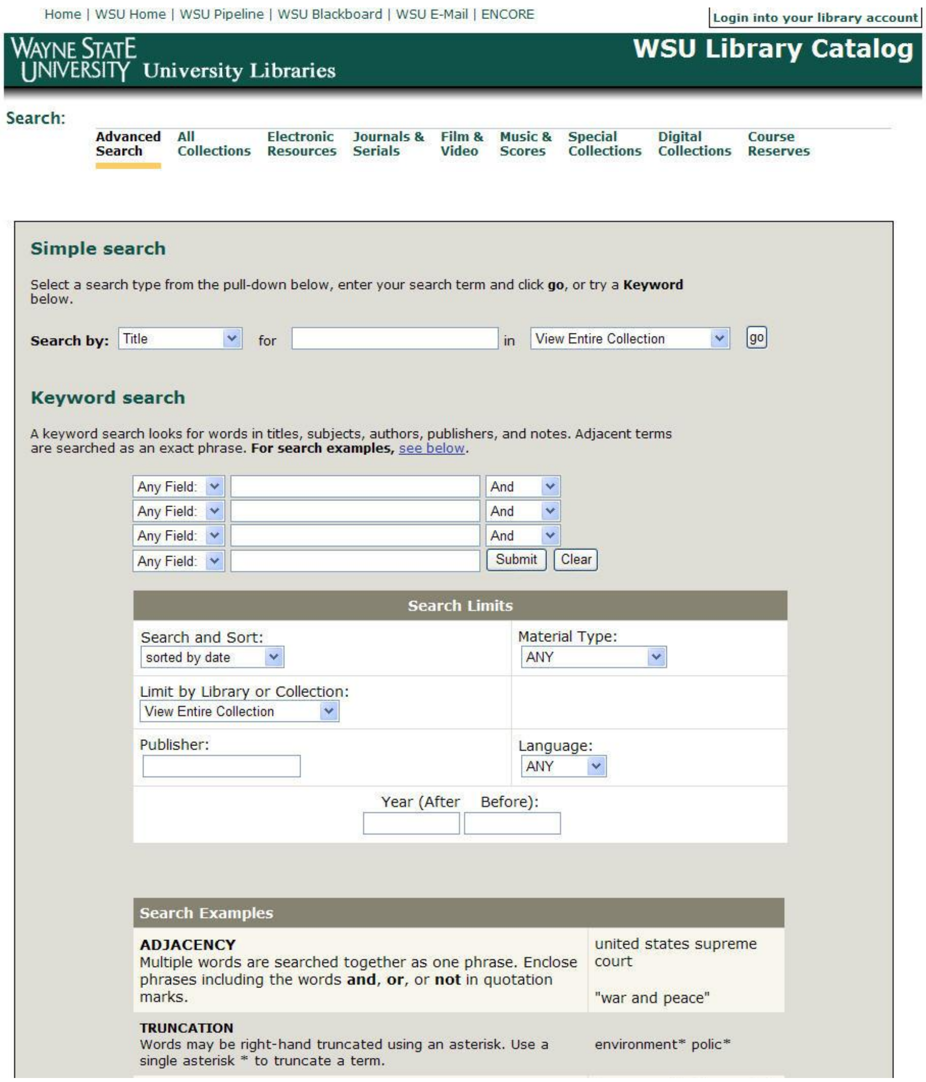
It was emphasized in all communications that participation in the study was completely voluntary. Participants were informed that responses were not associated with names or other identifying information. Participants also were informed that they were free to leave the study at any time, and could choose to not answer any questions without penalty.

Materials

The online catalog of the Wayne State University Library System, Detroit, Michigan, was adapted for use in the study. The catalog was modified to include three different types of EPSS interfaces. A library catalog provides an index of all the items held in a library, along with a description of where these items are stored. By combining a range of search features, library users can identify an item by the name of the author who created a particular item held by the library, by the title of an item, or by the date of publication of a particular item. Catalog system features also provide the ability to identify the shelf location of the item. Users can expand their pool of resources by using subject descriptors to retrieve similar items.

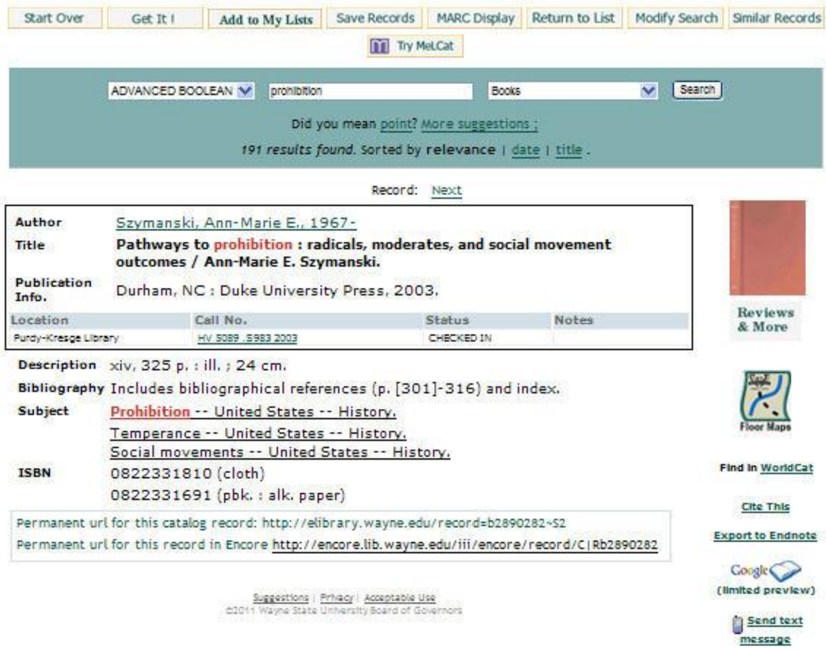
As illustrated in Figure 4, the library catalog screen provides a series of open text fields that allow the user to input relevant data. The screens also include menus that require the user to select from a number of predefined choices.

Figure 4. Library Catalog



In a typical library research scenario, the library user would identify appropriate resources using author, title and subject searching, and then locate the resources on a shelf within a particular building location. In the WSU library catalog, this would involve correctly reading the library catalog record. An example is shown in Figure 5.

Figure 5. Library Catalog Record



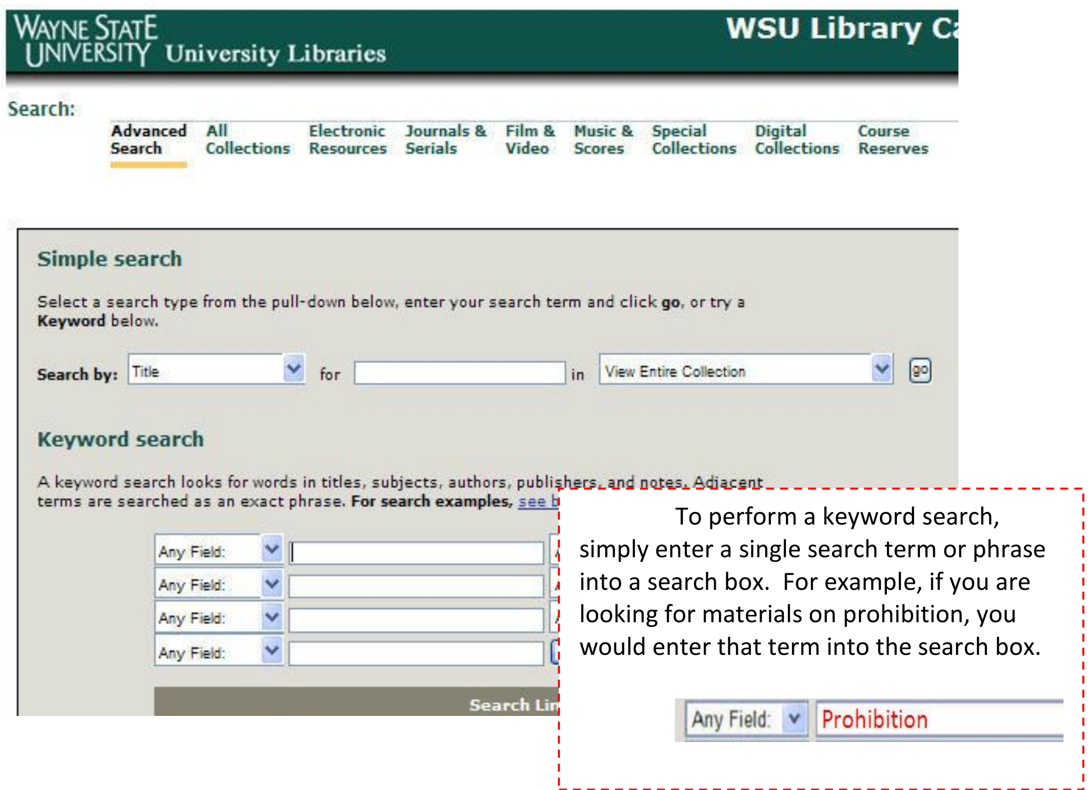
The EPSS content and interfaces were developed by a project design team consisting of an instructional designer, library research subject matter experts, librarian research trainers, system/ software developers and a library user. Based upon a study of student library users as they interacted with the library catalog, and through discussion with experienced library research trainers, the design team identified goals for the EPSS and developed corresponding appropriate informational, advisory and training resources for incorporation into the EPSS.

Treatments

The treatments involved three different types of EPSS tools based on Gery's (1995) three levels of integration, including external, extrinsic and intrinsic support. The content was identical in all three treatments, and differed only in the manner in which the tool was accessed and presented. When a participant signed on to the system, he or she was assigned to one of the three performance support treatments, or to a control group. The control group received no performance support treatment. Participants were not aware that they were being assigned to a treatment group. Neither names nor personal information were recorded.

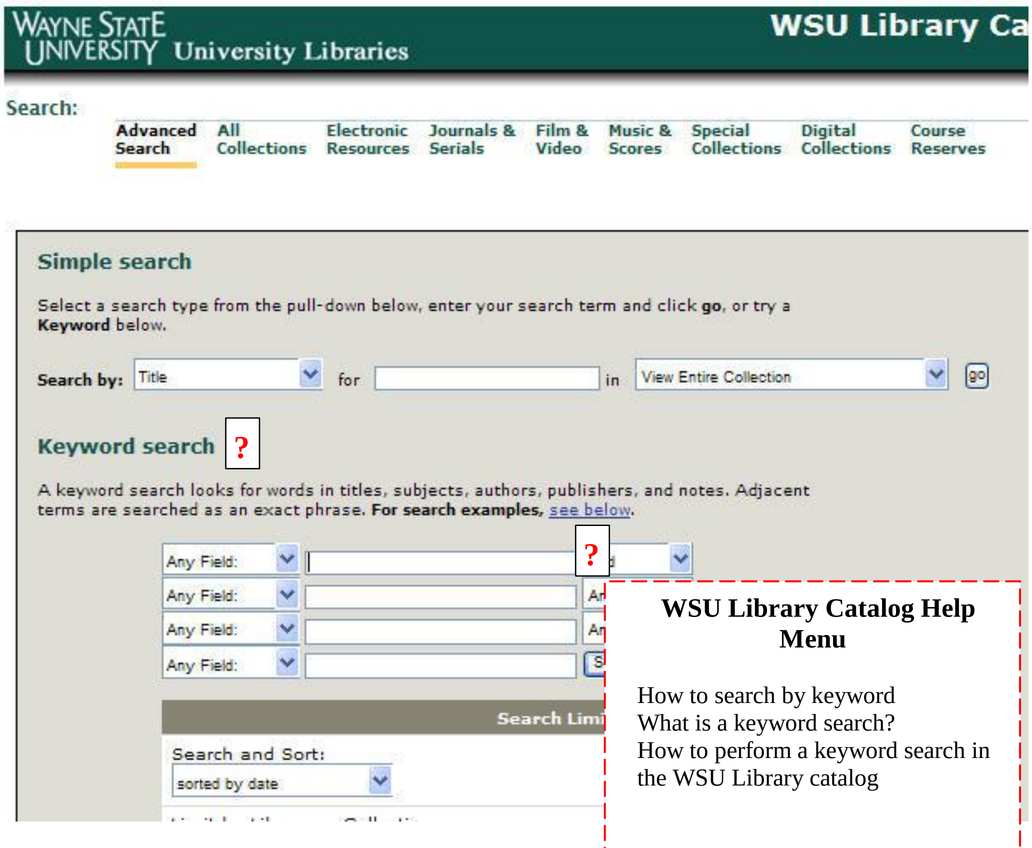
Intrinsic Performance Support System. The intrinsic EPSS is intended to be the most integrated into the user's work flow as he or she works through the performance task. As shown in Figure 6, the intrinsic EPSS involved use of a rollover. When the user paused over, or began to type into a field, an appropriate help message automatically appeared.

Figure 6. Intrinsic EPSS



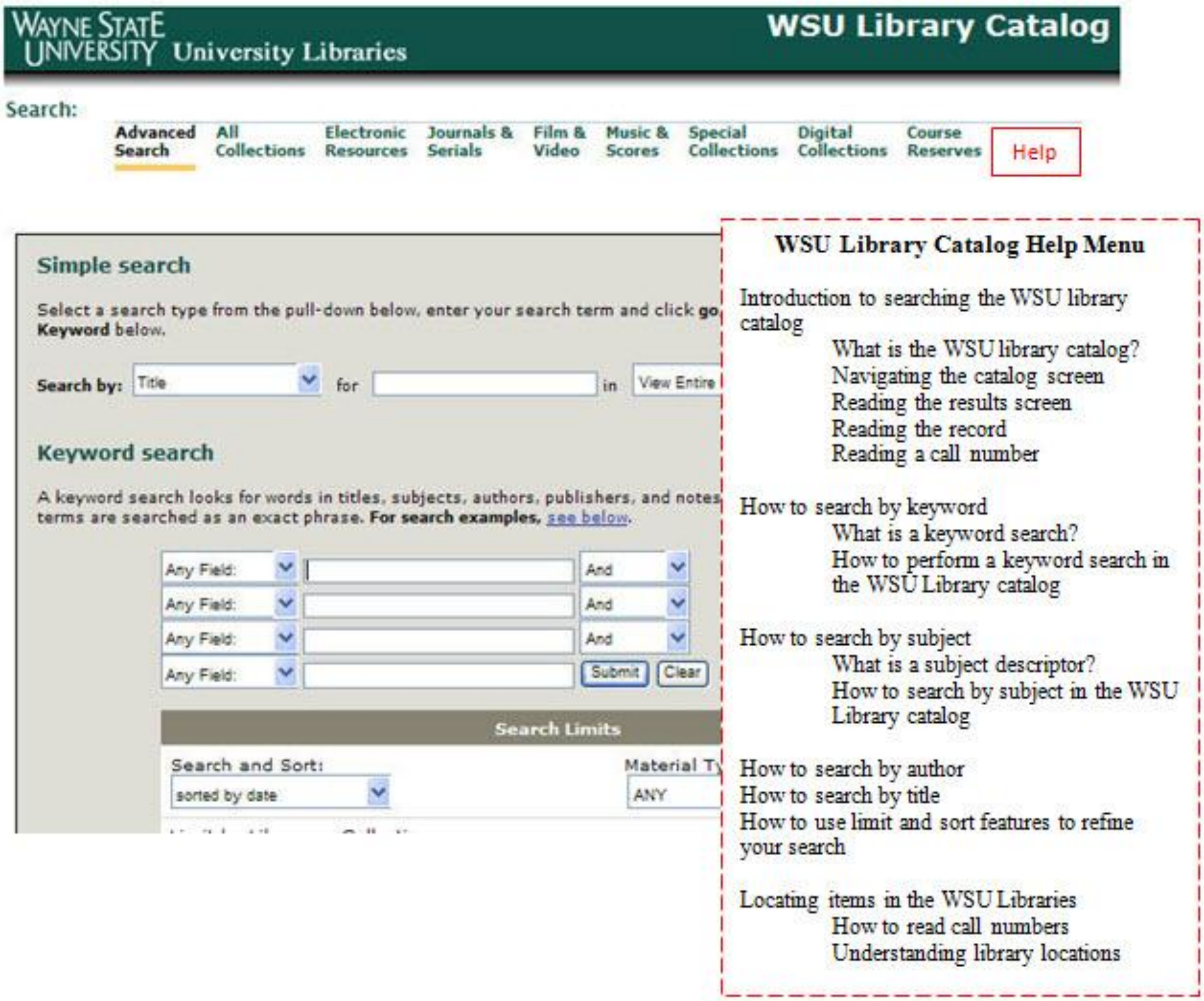
Extrinsic Performance Support System. The extrinsic performance support tool provided help buttons inserted at key points within the catalog screen. When users clicked on a help button they were taken to the relevant portion of an external help menu. An example of the Extrinsic EPSS is shown in Figure 7.

Figure 7. Extrinsic EPSS



External Performance Support System. The external support system was a webpage that provided a menu of help topics. This type of EPSS provided catalog users with a help button located on the navigation bar of the catalog screen. When users clicked the help button, they were taken to the external webpage containing the full library help menu as shown in Figure 8.

Figure 8. External EPSS



Instruments

Pre-task demographic questionnaire. A seven item pre-task demographic questionnaire was administered at the beginning of the study. The demographic variables were selected based on a review of the library and EPSS literature and in consultation with the project expert panel. The questionnaire is shown in Appendix G. The first question prompted participants to indicate their student status from a list. The second question prompted participants to indicate their general academic discipline. The third question asked participants to specify their age based upon a choice of age ranges. The fourth question prompted participants to indicate their gender. The fifth question asked participants about the extent to which they had received formal training in library research through the University Libraries. The sixth question prompted participants to estimate their skill level in using the library catalog to perform library research. Participants who indicated their skill level as expert were excluded from the study. These data were gathered for descriptive purposes and used to identify any possible moderating effects that demographic characteristics may have had on the impact of the treatment (level of integration) on the dependent variables. The seventh question, which was optional, prompted participants for their e-mail address. This optional information entered the participants into a drawing for gift cards once they had completed all of the components of the research study. These items served as incentives for participation in the study.

Task scenario. The task scenario presented participants with a typical situation that the user might encounter when using the online library catalog to perform library research (see Appendix G). The scenario was developed by the project design team based upon performance goals identified by the team and based on a needs assessment of library users. To test performance accuracy, each scenario task required participants to select a correct response from a range of choices (see Appendix H). Survey Monkey software (www.surveymonkey.com) was used to construct the task scenario. Survey Monkey features were used to automatically generate an Excel spreadsheet from the captured responses. The scores then were exported to the Statistical Analysis Software (SAS) program (Cody & Smith, 1997) for analysis. SAS functionality was used to calculate accuracy and completion scores. The completed spreadsheets and related statistical files were stored electronically on a secure server which was accessible only by the researcher through password protection.

Rubric. Performance task accuracy and completion scores were calculated based on a rubric developed by the project design team and reviewed for validity by a separate SME expert panel (see Appendix H).

SME expert panel. A key part of the research project involved use of an expert panel of three subject matter expert (SME) librarians. The purpose of the expert panel was to determine that the research tasks in the scenario were representative of a typical library research situation, and that the performance tasks were related to critical library research skills. Membership of the expert panel was separate from the membership of the project design team. Each expert panel member held an American Library Association (ALA) accredited Master's Degree in Library & Information Science, and had attained senior librarian status within the University's tenure and promotion structure. Expert panel members possessed at least twenty years of concentrated experience with teaching university students to perform library research using a library catalog, and therefore had an in-depth knowledge of the types of typical problems students typically encounter while conducting library research.

Task accuracy and completion. Each submitted task scenario sheet received scores for accuracy and completion. The accuracy score (correct/not correct) was calculated automatically through the Survey Monkey spreadsheet function, and was evaluated individually by at least two members of the Expert Panel. The score was calculated as a percent reflecting the number of correct responses divided by the total number of possible correct responses.

The completion score was also calculated as a percent based on the number of completed responses divided by the total number of responses, and exported to the SAS program, where the responses were calculated automatically through the SAS system features (Cody & Smith, 1997).

Completion time. The amount of time participants spent completing the task was measured by calculating the difference between the time at which participants log into and out of the software application. Completion time recorded for each participant was uploaded to an Excel spreadsheet and exported to the SAS program (Cody & Smith, 1997) for analysis.

Frequency of use. At the end of the task scenario, participants were asked to identify from a range of choices, how often they used the EPSS help features to perform the tasks. They also were asked to explain why they did or did not use the EPSS help.

Research Design

The study employed an experimental design. Three treatment groups, along with a control group, were used. A minimum of 64 members per group were needed, based upon recommendations stated by Hair, Black, Babin & Anderson (2010), and based upon an effect size analysis. Given the small base of available research findings upon which to perform an effect calculation, effect size was based upon on examination of the existing studies, their sample sizes, and overall findings. This analysis resulted in an expected medium effect size for the current study (Cohen, 1977; Ellis, 2010). From this it was determined that a sample size of 256 participants would be needed for the current study. Significance level was fixed at .05, with a .95 confidence level. A research design overview is presented in Table 1.

Table 1. *Research Design Overview*

	Questions	Design	Instrumentation	Statistical Analysis	Sample Size
1.	What is the relationship between level of EPSS integration and frequency of use?	Experimental: 4 groups	Task scenario	Chi-Square Test	256 (64 per group)
2.	What is the relationship between level of EPSS integration and task accuracy?	Experimental: 4 groups	Task scenario	MANOVA GLM Contrast statements	
3.	What is the relationship between level of EPSS integration and task completion?	Experimental: 4 groups	Task scenario	MANOVA GLM Contrast statements	
4.	What is the relationship between level of EPSS integration and time on task?	Experimental: 4 groups	System log*	MANOVA GLM Contrast statements	

*System data logs measured the amount of time each participant took to complete the scenario tasks. The study website was configured to record the time when a participant opened the study link, and when he or she submitted the completed response sheet. The system recorded the time. Elapsed time was calculated by the spreadsheet function within Survey Monkey.

Variables

The variables were developed based upon examination of previous research and are shown in Table 2.

Table 2. *Description of Variables*

Variable Description	**Variable Type**	**Measurement Scale**	**Function**
Type of EPSS Interface	Non metric	Nominal	Independent Variable
Frequency of EPSS Use	Non metric	Ordinal	Dependent Variable
Task Accuracy	Continuous	Ordinal	Dependent Variable
Completion Time	Continuous	Ordinal	Dependent Variable
Completion Score	Continuous	Ratio	Dependent Variable

The independent variable in this study was the type of EPSS category, with three levels (intrinsic, extrinsic or external). There were three dependent variables. The first was the accuracy of task performance that the participants displayed after using an Electronic Performance Support System. Participants were evaluated on their ability to perform based on a task scenario that portrayed a realistic situation that the user might encounter when using the library catalog to perform library research. Testing involved performance of tasks such as the following:

1. Locate a resource by author
2. Locate a resource by title
3. Use subject descriptors to locate resources

Completion score was rated based on the number of tasks completed compared with the total number of test items. Task completion time was measured while the participants used the

EPSS application. Frequency of use was rated by the participants at the conclusion of the exercise.

Validity

Validity of the task scenarios and rubric was determined through the project design process. The design process involved iterative testing and revision of the task scenarios based on continuous review and input provided by the expert panel and student volunteers. The scenario was designed to portray a realistic situation involving tasks that a student user would typically encounter when using the library catalog to perform library research. Data gathered from pilot testing, observations, and debriefing with users was continuously reviewed to confirm that the performance tasks were representative of the types of situations users would typically encounter when using the library catalog, and to confirm that the skills being tested were closely tied to the performance task. Reliability was determined through the pilot study.

Pilot Study

To establish reliability, a pilot study was administered prior to conducting the research on the full sample. A key purpose of the pilot study was to identify problems with the mechanics of the EPSS tool and related data collection instruments. This made it possible to make adjustments to the tools and instruments prior to exposing the sample groups to the EPSS tool.

The pilot study employed the full research design as shown in Table 1 and Table 2, and also included observations of the task screens used by pilot participants. As described in the full study, three treatment groups were used, along with a control group. Testing followed the same procedures that were used for the full study. The treatments for the pilot test involved three different types of EPSS tools based on the EPSS categories as described in the full research design. These included external, extrinsic and intrinsic support. The pilot also included interviews with four individuals to assess the overall difficulty of the tasks and obtain any other input that might be useful in improving the research design.

Approximately twenty four participants were randomly assigned to one of the three treatment groups, or to the control group. The participants completed the task scenario as described in Appendix H. The completed pilot data collection instruments were collected and rated using the rubric established for the full study. Rating of each pilot participant's performance was evaluated by the expert panel of three subject matter experts. Each expert panel member individually reviewed the calculated performance scores of all pilot study participants, using the Rubric (see Appendix I). Scores of each treatment group were analyzed as described in Table 1 and Table 2. Pilot participants then were asked to complete a brief post-task questionnaire to determine their satisfaction and comfort level with completing the task scenario using the EPSS features (see Appendix J). This helped to identify areas of the task scenario, instructions or EPSS tools that were unclear or troubling for the participants. The pilot questionnaire also sought to confirm that the performance tasks were of appropriate difficulty and complexity.

Based on observations and data collected in the pilot, a number of adjustments were made to clarify the wording of some of the tasks presented in the task scenario. Two questions were added at the end of the task scenario asking the participants to indicate how frequently they used the help tools in completing the exercise, and to indicate why they did or did not use the help. The pilot also revealed the opportunity to make a number of technical adjustments to increase control. Complexity and functionality of the library catalog in some situations allowed participants to utilize some unintended search options that were not part of the study design. For example, the pilot revealed that participants were using some navigational features that were either distracting from the performance task or allowing participants to leave the search screens where the tasks were being tested. As a result of the pilot, some navigation buttons were removed from the test interface and others were adjusted to keep participants within the test environment.

Data Analysis

Data analysis was performed in two phases. The first phase used descriptive statistics to describe the characteristics of the participants. The SAS Freq procedure (Cody & Smith,1997) was used to derive the frequency distributions of the demographic variables across the four treatment groups.

Chi-Square test of association was conducted using the SAS FREQ Procedure (Cody & Smith, 1997) to determine whether relationships existed between treatment group assignment and each of the categorical demographic variables. Chi-Square testing is a non-parametric statistical technique used for analysis of nominal and ordinal data. It is commonly used to compare observed frequencies of a variable with expected frequencies. The calculation allows determination as to whether the differences between the expected and observed frequencies of a variable reflect random fluctuation, or whether they are associated with a particular sample being tested (Hinkle, Wiersma, & Jurs, 2003). The significance for the Chi-Square analysis was set at .05.

The second phase of data analysis related to the research question posed for the study. Dependent variables for the study are shown in Table 2. Data gathering related to the first dependent variable, Frequency of Use, yielded categorical data. Initial analysis of this variable was accomplished by calculating the frequency distribution. To test for significant differences among the groups related to the Frequency of Use variable, Chi-Square testing was used with significance level set at .05. These analyses were conducted using the SAS FREQ Procedure with the Chi-Square option (Cody & Smith, 1997).

As shown in Table 2, the remaining dependent variables – task accuracy, completion time and completion score, are continuous variables. Inferential statistical methods were employed to analyze the data; this involved a two-part process. The first part of the analysis employed measures of central tendency and dispersion to provide information regarding participant performance scores.

The second part of the inferential analysis involved investigation of between-group differences among the treatment groups. To accomplish this, general linear models (GLM) were developed and tested using PROC GLM in SAS. When the research design is unbalanced (i.e. an unequal number of subjects per treatment group) and/or when it is desirable to determine which group means if any, differ, GLM is preferable to one-way analysis of variance (ANOVA) (Cody & Smith, 1997).

GLM. Significance testing with GLM involves a two-step process. In the first step, the significance of the F-value must be examined. The F-value is a ratio of the average variability in the score that is due to treatment group assignment to the average variability in the score that is due to individual respondent's characteristics. As the F-value approaches 1.0, this indicates that the target treatment group is not contributing more to the outcome than individual differences; in other words, the group is not impacting the performance score. If the probability

(P-value) associated with the F-value is statistically significant, then it can be assumed that some variability in the outcome is, indeed, due to treatment group. In the current study, it was expected that there would be a difference between the control group and one or more of the EPSS conditions. A significance level of .10 was selected for this part of the analysis. When the p-value associated with the F-value is significant (with a more generous threshold of p = .10), then, and only then, should analysis proceed to step two, which involves determining which group means differ.

Contrast statements. The second step of significance testing with GLM is accomplished using contrast statements in GLM. The contrast statements are *a priori* comparisons of groups that are thought to differ in outcome. Contrast statements provide the unadjusted mean scores and related standard deviations by treatment group, along with associated probabilities of the between-group differences in mean scores.

CHAPTER 4

Results

The current research compared the impact of Gery's (1995) three levels of EPSS integration on task accuracy, time on task, task completion and frequency of use. An experimental design was used to compare the three integration levels to the above four variables. The following section reports the results of the data analysis.

Characteristics of the Sample

Participants for the current research were recruited from students enrolled at Wayne State University, Detroit, Michigan. The research protocol, including protocols for informed consent and confidentiality, was reviewed and approved by the Human Investigation Committee of Wayne State University (see Appendix A). A letter of invitation was distributed electronically through the University e-mail system and through electronic communication channels of the Wayne State University Library System (see Appendix B). The letter of invitation included an information sheet that described the time commitment required and the basic procedures; the information sheet also provided a link to the study website. Participants were informed that clicking on the web link to begin the research study represented agreement to participate in the study (see Appendix C). It was emphasized in all communications that participation was completely voluntary, and that the participant could withdraw from the study at any time.

A total of 634 responses were received electronically during a two week period in January 2013. An initial step in the analysis involved examining the data to identify cases containing incomplete or missing data, as well as numerical outliers that might impact the statistical analysis. Upon review of the responses with the research project expert panel, the decision was made to also eliminate those cases in which no attempt was made on any of the 15 accuracy items, along with cases with completion times lower than five minutes or longer than 120 minutes. Removal of these cases resulted in a final sample of 305 usable cases.

Although limiting the completion time to between five and 120 minutes provided an improved level of integrity and validity of the data and related statistical analysis, the elimination of these cases necessarily prevented the sample from meeting standard assumptions of normality. However, the adequate sample size and availability of robust statistical methods allowed bending of the assumptions of normality (Hair et al., 2010). On this basis, the decision was made to proceed with the analysis.

Demographic Data Analysis

Prior to taking part in the study, participants were asked to provide demographic data including age, gender, academic status (graduate/undergraduate student), and academic discipline. Participants also were asked to indicate the extent to which they had received prior training on library research, and to identify their level of prior experience using the library catalog. These variables were derived from examination of previous research; the data were used in interpreting the study results and to identify any possible moderating effects that demographic characteristics may have had on the impact of the treatment (level of integration) on the dependent variables, e.g., performance accuracy, completion time, completion rate, and frequency of use.

The SAS FREQ Procedure (Cody & Smith, 1997) was used to derive the frequency distributions of the demographic variables across the four study groups.

Age. Participants were asked to indicate their age from a choice of ranges. The largest group of respondents (n=196, 64.3%) reported their age between 18 and 25 years. Respondents between 26 and 35 years comprised the second largest group (n=71, 23.3%). Twenty-two participants (7.2%) listed their age between 36 and 45 years, while 16 individuals (5.3%) reported their age as more than 45 years. Frequency distributions for gender are shown in Table 3.

Table 3. *Frequency Distributions - Age Ranges by Treatment Group*

	Frequency				
Treatment	18-25 yrs N (%)	26-35 yrs N (%)	36-45 yrs N (%)	46 + yrs N (%)	Total N (%)
No EPSS	55 (18)	20 (6.6)	4 (1.3)	3 (0.9)	82 (26.9)
External EPSS	40 (13.1)	11 (3.6)	5 (1.6)	0 (0)	56 (18.4)
Extrinsic EPSS	53 (17.4)	23 (7.5)	9 (3.0)	6 (2.0)	91 (29.8)
Intrinsic EPSS	48 (15.7)	17 (5.6)	4 (1.3)	7 (2.3)	76 (24.9)
Total	196 (64.3)	71 (23.3)	22 (7.2)	16 (5.3)	305 (100)

Gender. The majority of participants (n=222, 72.8%) reported their gender as female, with the remainder male (n=83, 27.2%). Frequency distributions for gender are shown in Table 4.

Table 4. *Frequency Distributions - Gender by Treatment Group*

Treatment	Frequency Male N (%)	 Female N (%)	 Total N (%)
No EPSS	24 (7.9)	58 (19.0)	82 (26.9)
External EPSS	12 (3.9)	44 (14.4)	56 (18.4)
Extrinsic EPSS	23 (7.5)	68 (22.3)	91 (29.8)
Intrinsic EPSS	24 (7.9)	52 (17.1)	76 (24.9)
Total	83 (27.2)	222 (72.8)	305 (100)

Academic status. Participants were asked to indicate whether they were graduate or undergraduate students. Frequency distributions for academic status are shown in Table 5. Participants identifying themselves as undergraduate students (n=162, 53.1%) formed the largest group, while 143 (46.9%) individuals identified themselves as graduate students.

Table 5. *Academic Status by Treatment Group*

Treatment	Frequency Grad Student N(%)	 Undergrad Student N(%)	 Total N(%)
No EPSS	35 (11.5)	47 (15.4)	82 (26.9)
External EPSS	23 (7.5)	33 (10.8)	56 (18.4)
Extrinsic EPSS	43 (14.1)	48 (15.7)	91 (29.8)
Intrinsic EPSS	42 (13.8)	34 (11.2)	76 (24.9)
Total	143 (46.9)	162 (53.1)	305 (100)

General academic discipline. Participants were asked to identify their general academic discipline by selecting from among the Humanities, Social Sciences and Sciences. Frequency distributions for academic discipline are shown in Table 6. The largest group of participants (n=148, 48.5%) indicated their general academic discipline as the Sciences. The second largest group of respondents (n=94, 30.8%) identified their academic discipline and Social Sciences. Sixty-three participants (20.7%) selected Humanities as their general academic discipline.

Table 6. *Frequency Distributions - Academic Discipline by Treatment Group*

	Frequency			
Treatment	Humanities N (%)	Social Sciences N (%)	Sciences N (%)	Total N (%)
No EPSS	21 (6.9)	25 (8.2)	36 (11.8)	82 (26.9)
External EPSS	13 (4.3)	18 (5.9)	25 (8.2)	56 (18.4)
Extrinsic EPSS	16 (5.3)	29 (9.5)	46 (15.1)	91 (29.8)
Intrinsic EPSS	13 (4.3)	22 (7.2)	41 (13.4)	76 (24.9)
Total	63 (20.7)	94 (30.8)	148 (48.5)	305 (100)

Prior catalog experience. Participants were asked to identify, by selecting from a list of choices, their level of prior experience with using the library catalog. Frequency distributions for prior catalog experience are shown in Table 7. The largest group of participants (n=136, 44.6%) indicated that they had used the catalog a few times. The second largest group of respondents (n=97, 31.8 percent) listed themselves as frequent users. Forty-five individuals (14.8%) indicated that they had never used the library catalog. Twenty-seven participants (8.9%) identified themselves as experts in using the library catalog.

Table 7. *Frequency Distributions - Prior Experience by Treatment Group*

Treatment	No Experience N (%)	Used Few Times N (%)	Frequent User N (%)	Expert N (%)	Total N (%)
No EPSS	19 (6.2)	33 (10.8)	25 (8.2)	5 (1.6)	82 (26.9)
External EPSS	7 (2.3)	25 (8.2)	18 (5.9)	6 (2.0)	56 (18.4)
Extrinsic ESS	12 (3.9)	46 (15.1)	27 (8.9)	6 (2.0)	91 (29.8)
Intrinsic EPSS	7 (2.3)	32 (10.5)	27 (8.9)	10 (3.3)	76 (24.9)
Total	45 (14.8)	136 (44.6)	97 (31.8)	27 (8.9)	305 (100)

Prior training on library research. Participants were asked to select from a list of choices in order to indicate the amount of prior training they had received on library research skills. Frequency distributions for prior library research training are shown in Table 8. The largest group (n=120, 39.4%) indicated that they had no prior training on library research techniques. The second largest group (n=114, 37.4%) indicated that they had consulted at least once with a WSU librarian about library research. Seventy-one individuals (23.3%) indicated that they had viewed a WSU library tutorial.

Table 8. *Frequency Distributions - Prior Training by Treatment Group*

	Frequency			
Treatment	No Training N (%)	Met with Librarian N (%)	Used WSU Tutorial N (%)	Total N (%)
No EPSS	39 12.8)	29 (9.5)	14 (4.6)	82 (26.9)
External EPSS	23 (7.5)	20(6.6)	13 (4.3)	56 (18.4)
Extrinsic EPSS	36 (11.8)	33 (10.8)	22 (7.2)	91 (29.8)
Intrinsic EPSS	22 (7.2)	32 (10.5)	22 (7.2)	76 (24.9)
Total	120 (39.4)	114 (37.4)	71 (23.3)	305 (100)

Table 9 shows a summary of the Chi-Square analysis, listing each demographic variable along with the calculated degree of freedom, critical value, and probability statistic (P-value).

Table 9. *Summary of Chi-Square Results for Demographic Characteristics*

	DF	X^2 Value	Probability (p-value)
Age	9	9.70	0.38
Gender	3	2.02	0.57
Academic Status	3	3.49	0.32
Discipline	6	3.26	0.78
Prior Catalog Experience	9	10.59	0.31
Prior Training	6	6.59	0.38

The significance for the Chi-Square analysis was set at .05. As shown in Table 9, the p-value exceeded the .05 threshold for each demographic variable. Therefore, none of the demographic characteristics was found to occur more frequently in any treatment group than would have been expected to occur through random fluctuation within the study sample. The conclusion from this analysis is that the participants' demographic characteristics such as age, gender, etc., reflected random occurrence across the four treatment groups (level of integration). This result increases the likelihood that variations in the group scores for frequency of use, task accuracy, completion time, and completion rate were influenced by the EPSS tool, rather than by any demographic characteristics such as age, gender, etc.

Research Question

The current study tested the assumption that a more highly integrated EPSS produces superior performance and efficiency. The study addressed the following research question: What is the relationship between the level of integration of an EPSS, and frequency of use, task accuracy, task completion, and time on task?

Frequency of use. Upon completion of the task scenario, study participants were asked to indicate, by selecting from a range of choices, how frequently they used the EPSS help features to perform the study tasks. Because this approach yielded categorical data for the dependent variable, analysis was performed through calculation of the frequency distribution, followed by Chi-Square testing to determine whether relationships existed between frequency of use and treatment group assignment (Hinkle, et al., 2003). The analyses were conducted using the SAS FREQ Procedure with the Chi-Square option (Cody & Smith, 1997).

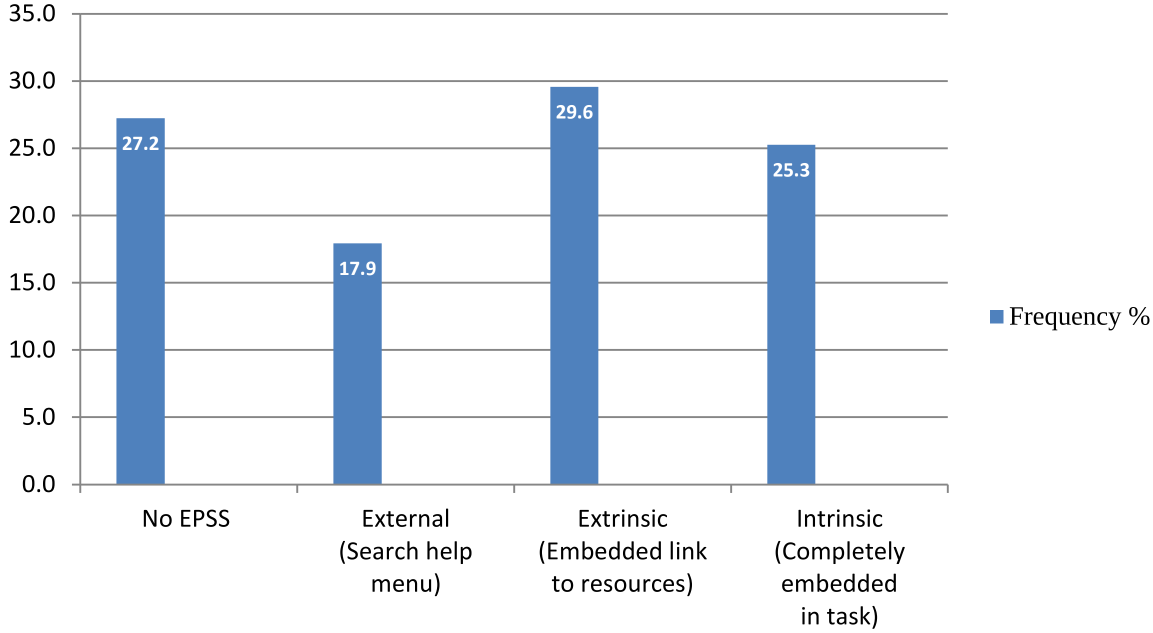
Summary statistics for frequency of use by treatment group. Table 10 shows the frequency distributions for the variable Frequency of Use across the four EPSS treatment groups. The largest group (n=205, 67.5%) reported that they did not use the EPSS tool at all during performance of the task scenario. The second largest group (n=53, 17.7%) reported using the EPSS between one and four times while performing the tasks. Twenty-four (8.6%) indicated that they had used the EPSS ten or more times, while the smallest group (n=19, 6.6%) reported using the EPSS tool between four and nine times during the study.

Table 10. *Frequency Table for Frequency of Use by Treatment Group*

	Frequency				
Treatment	No Use N (%)	1-4 Times N (%)	4-9 Times N (%)	10 + Times N (%)	Total N (%)
No EPSS (Control)	57 (18.9)	15 (5.0)	5 (1.7)	5 (1.7)	82 (27.2)
External EPSS	38 (12.6)	8 (2.7)	3 (1.0)	5 (1.7)	54 (17.9)
Extrinsic EPSS	62 (20.6)	16 (5.3)	4 (1.3)	7 (2.3)	89 (29.6)
Intrinsic EPSS	48 (16.0)	14 (4.7)	7 (2.3)	7 (2.3)	76 (25.3)
Total	205 (68.1)	53 (17.6)	19 (6.3)	24 (8.0)	301(100.0)

Figure 9 provides a visual representation of the comparative percent frequency of use across the treatment groups. The Extrinsic EPSS had the highest percentage of participants reporting that they had used the tool at least once (29.6 %). Usage of the Intrinsic EPSS was reported by 25.3% of the participants to perform their tasks, while the External EPSS (17.9%) had the smallest percentage of participants who said they had used the tool.

Figure 9. Frequency of Use Percentages by EPSS Integration Level



Significance testing for frequency of use by treatment group. Testing for significant differences among the treatment groups related to the variable frequency of use was conducted using Chi-Square testing with significance level set at .05. As shown in Table 11, the p-values of .97 for the Pearson Chi-Square and .97 for the Likelihood Ratio Chi-Square exceeded the significance threshold, indicating no significant difference among the EPSS treatment groups as to how frequently the tool was used.

Table 11. *Chi-Square Analysis Summary - Frequency of Use by Treatment Group*

Statistic	DF	Value	P-value
Chi-Square	9	2.82	0.97
Likelihood Ratio Chi-Square	9	2.79	0.97
Mantel-Haenszel Chi-Square	1	0.85	0.36
Phi Coefficient		0.10	

Contingency Coefficient	0.10
Cramer' s V	0.56

Performance accuracy. Study participants were evaluated on their ability to accurately perform library research tasks based on a task scenario that was developed to portray a realistic situation that the user would typically encounter when using the library catalog to perform library research. The scenario and component tasks were designed through an iterative, rapid prototyping process involving dialog with the expert panel and student users; data from pilot testing, observations, and debriefing with users were gathered to assure that the scenario tasks focused on typically troublesome search problems that would also lend themselves to an experimental design.

The accuracy for each task (correct/not correct) was calculated automatically through the Survey Monkey spreadsheet function (http://www.surveymonkey.com). Resulting scores were evaluated by at least two members of the expert panel. The dependent variable used in the data analysis was calculated as the sum of the number of correct responses (possible range of 0 to 15). Since the study only included those respondents who attempted all 15 of the items, the total score was not skewed by variability in the total items attempted. This resulted in a valid outcome for study.

Summary statistics for performance accuracy by treatment group. Accuracy scores by treatment group ranged from a low of 0 to a high of 14. The lowest mean accuracy percentage was 5.8 among the control group; the highest mean was 7.3 among the Intrinsic EPSS group. Table 12 provides a summary of the performance accuracy data.

Table 12. *Summary of Performance Accuracy by Treatment Group*

Treatment	N	Accuracy Score (Mean $\bar{x}$)	Standard Deviation	Minimum Score	Maximum Score
No EPSS	82	5.8	3.8	0	13
External EPSS	56	6.2	3.8	0	13
Extrinsic EPSS	91	6.1	3.8	0	14
Intrinsic EPSS	76	7.3	3.5	0	13

Significance testing for performance accuracy by treatment group. To test for between-group differences in the continuous dependent variables, in this case mean performance accuracy, general linear models (GLM) were developed and tested using PROC GLM in SAS. When the study design is unbalanced (i.e. an unequal number of subjects per treatment group) and/or when it is desirable to determine which group means differ, if any, GLM is preferable to one-way analysis of variance (ANOVA) (Cody & Smith,1997).

Significance testing with GLM involves a two-step process. First, the significance of the F-value must be examined. The F-value is a ratio of the average variability in the score that is due to treatment group assignment to the average variability in the score that is due to individual respondent's characteristics. As the F-value approaches 1.0, this indicates that treatment group is not contributing more to the outcome than individual differences; in other words, treatment group is not impacting the accuracy score. On the other hand, if the probability (P-value) associated with the F-value is statistically significant, it can be assumed that there is some variability in the outcome that *is* due to treatment group. In the current study, such a finding would support the expectation of a difference between performance of the control group and one or more of the EPSS conditions. A significance level of .10 was selected for this step, rather than the more conservative level of .05. The selection of the .10 p-value is appropriate at this stage of analysis because the purpose of the analysis is simply to detect a sufficient level of variability to justify more stringent examination (McNeil, Newman & Kelly, 1996). When the p-value associated with the F-value is significant (with a more generous threshold of p = .10), then, and only then should analysis proceed to step two and determine which group means differ.

Step two of significance testing with GLM is accomplished using contrast statements in GLM. These statements are *a priori* comparisons of those groups that are thought to differ in outcome. Contrast statements provide the unadjusted mean scores and related standard deviations by treatment group, along with associated probabilities of the between-group differences in mean scores.

Comparing the mean accuracy scores by treatment group yielded an F-value of 2.39, with an associated p-value of .069. Since this is below the probability threshold of .10 set for this testing, at least one group mean accuracy score is significantly different from other groups. Based upon this finding, examining contrasts (step two) is appropriate.

Table 13 shows a summary of the compared means, along with associated degrees of freedom, critical values (F-values) and associated probability values (P-values).

Table 13. *Summary of Comparison of Between-Group Mean Accuracy Scores*

Contrast	Comparison of Means	F-value	P-value
Intrinsic vs. Control	7.3 vs. 5.8	6.47	0.012
Intrinsic vs. External	7.3 vs. 6.2	2.87	0.092

Intrinsic vs. Extrinsic	7.3 vs. 6.1	4.00	0.047
Intrinsic vs. All Groups	7.3 vs. 6.0	6.44	0.012

The *a priori* assumption being tested was that the Intrinsic EPSS group would have greater accuracy than each of the other groups individually and/or combined. Indeed, as shown in Table 13, results indicate that the mean accuracy of the Intrinsic EPSS group was significantly different from the control group (7.3 vs. 5.8, p=.012), and from the Extrinsic EPSS group (7.3 vs. 6.1, p=.047). The intrinsic group also was significantly different from all the groups combined (contrast Intrinsic with Extrinsic plus External plus Control, 7.3 vs. 6.0, p=.012). While the Intrinsic EPSS group did have higher accuracy mean scores than the External EPSS group (7.3 vs. 6.2), the difference was not statistically significant at the .05 level.

Completion score. Completion score reflected the extent to which each participant completed the tasks set out in the scenario. To arrive at this calculation, each study participant's response on the task scenario was evaluated and coded as completed/not completed. Completion scores were calculated automatically through the Survey Monkey spreadsheet function (http://www.surveymonkey.com), and reviewed by at least two members of the Expert Panel. The completion score used as the dependent variable in these analyses was calculated for each participant as a sum of the total number of items completed, with a possible range of 0 to 15. As with the accuracy measure, since the study only included those respondents who attempted all 15 of the items, completion score was not skewed by variability in the total items attempted, rendering another valid outcome for study.

Summary statistics for completion score by treatment group. Completion score by treatment group ranged from a low of 7 to a high of 15. The Extrinsic group (n=91) achieved the highest mean completion score of 13.6. The Intrinsic group (n=76) and External group (n=56) each had mean completion scores of 13.1. Finally, the lowest mean completion score of 12.8 was achieved by the control group (n=82). Table 14 provides a summary of the completion score data.

Table 14

A Summary of Completion Rate by Treatment Group

Treatment	N	Completion Score (Mean $\bar{x}$)	Standard Deviation	Minimum Score	Maximum Score
No EPSS	82	12.8	3.6	7	15
External EPSS	56	13.1	3.3	7	15
Extrinsic EPSS	91	13.6	2.9	7	15
Intrinsic EPSS	76	13.1	3.2	7	15

Significance testing for completion score by treatment group. Using the same logic as for the accuracy score, GLM and *a priori* contrasts were used to examine between-group differences in completion score. Examining the F-value shows a value of 0.99 with an associated p-value of 0.40, showing mean completion scores do not differ by group. Since the p-value is above the .10 threshold, it was not appropriate to examine the contrasts. In summary, mean completion scores for Control, External, Internal, and Intrinsic EPSS groups of 12.8. 13.1, 13.6, and 13.1, respectively, are not statistically significantly different.

Completion time. The completion time measure represented the amount of time each participant took to perform the tasks set out in the task scenario. The completion time was determined as the elapsed time between the recorded time when a participant opened the study link, and the time recorded when he or she submitted the response sheet. The completion time was recorded automatically in the Survey Monkey spreadsheet function (http://www.surveymonkey.com), and represents the dependent variable in these analyses.

Summary statistics for completion time by treatment group. The External EPSS group had the lowest average time of 19.5 minutes, followed next by the control group with a score of 20.1 minutes, followed next by the intrinsic group with a score of 21.5. The intrinsic group recorded the highest average completion times with an average score of 22.1 minutes. Table 15 displays a summary of the descriptive results for completion time.

Table 15

A Summary of Completion Time By Treatment Group

Treatment	N	Completion Time (minutes) (Mean $\bar{x}$)	Standard Deviation	Minimum Score	Maximum Score
No EPSS	82	20.1	17.9	5.1	101.5
External EPSS	56	19.5	14.5	5.0	70.5
Extrinsic EPSS	91	21.5	17.2	5.0	92.2
Intrinsic EPSS	76	22.1	20.2	5.0	94.1

Significance testing for completion time by treatment group. For the final continuous dependent variable of completion time, GLM and *a priori* contrasts were again used to examine between-group differences. Examining the F-value shows a value of 0.33 with an associated p-value of .80, showing mean completion time did not differ by group. Since the p-value is above the .10 threshold, it is not appropriate to examine the contrasts. In summary, mean completion times for Control, External, Internal, and Intrinsic EPSS groups of 20.1, 19.5, 21.5, and 22.1 minutes, respectively, are not statistically significantly different.

Summary of Findings

In summary, the analysis of the research data for the current study supports the following statements:

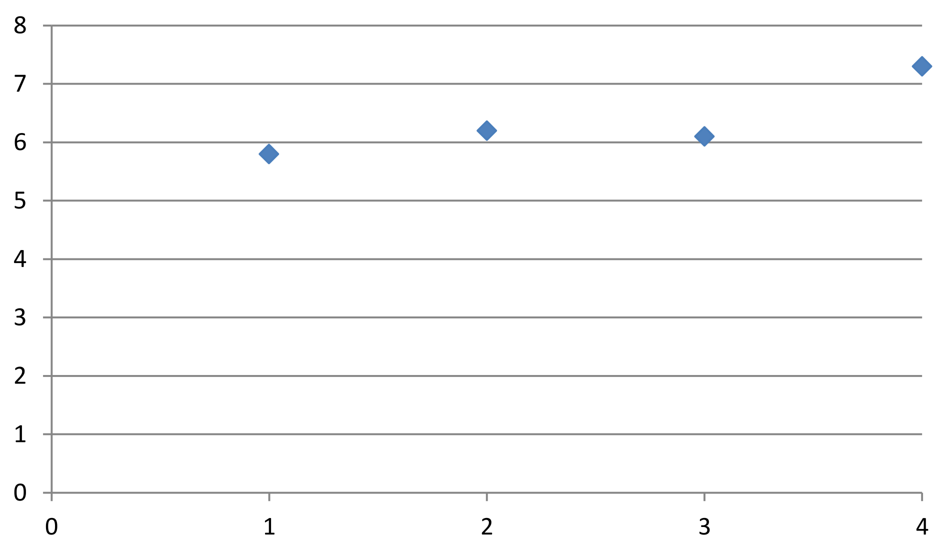
- The level of EPSS integration did not demonstrate a significant impact on frequency of use, completion time or completion score.
- The Intrinsic group performed significantly better than the Control group (no EPSS) on task accuracy.
- The Intrinsic group performed significantly better than the Extrinsic Group on task accuracy.
- The EPSS integration continuum was supported on performance accuracy, but not on efficiency.

CHAPTER 5

Discussion

The present research study sought to determine whether or not, and to what extent, the level of integration of an EPSS affects task performance, time on task, task completion, and frequency of use. Gery's EPSS integration framework (1995), along with Raybould's EPSS Integration Continuum (1995, 2000), both as discussed in Chapter 2, have suggested that as the level of integration increases, task performance and efficiency would improve progressively with the level of integration. The study findings offered confirmation for this notion, although only on the measure of performance accuracy. As shown in Figure 10, the differences in mean scores suggest a linear relationship between the level of integration and performance accuracy.

Figure 10. Mean Accuracy Scores by Treatment Group



A particularly noteworthy finding of the study was the superior performance by the Intrinsic group on this measure. In direct comparisons of accuracy means with the other treatment groups, the Intrinsic group performed significantly better than all groups combined, and individually outperformed the Control Group (p=.012) and the Extrinsic Group (p=.047). The difference between the performance of the Intrinsic and External Groups was not significant at the .05 level. These results are of practical significance in that they support Gery's (1995) assertion that optimal EPSS designs should include 80% Intrinsic integration, and 20% External and Extrinsic integration tools. The results also support Raybould's (1995; 2000) assertions that designers should begin with the right hand side of his EPSS Integration Continuum, and move toward the less integrated tools only when necessary.

These results also confirm findings of Nguyen, et al. (2005), which found a significant difference between performance accuracy among the treatment groups, and fit partially with results found by Gal & Nachmias (2011). Taken together, these findings point to the superiority of Intrinsic EPSS when task accuracy is the primary goal.

In considering these findings, however, it must be kept in mind that performance accuracy is the only variable for which the EPSS integration level made a difference. EPSS integration produced no significant differences in completion rates, time on task, or frequency of use. While not significant, noteworthy observations concerning time on task and frequency of use bear further discussion.

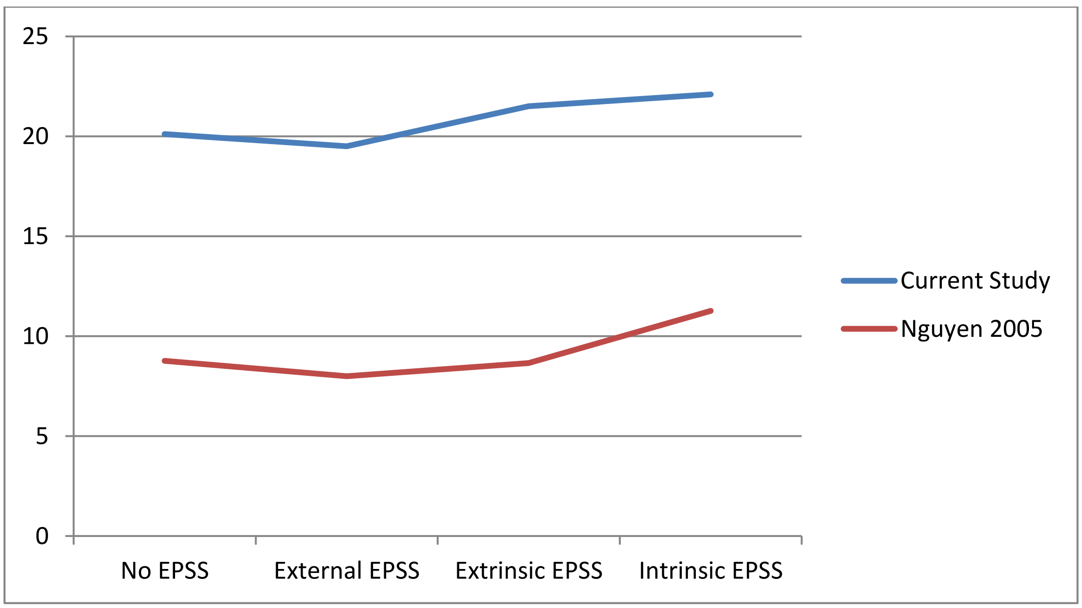
Time on Task

Study results indicate that the level of EPSS integration had no influence on task completion time (time on task). While not significant, a comparison of group means on completion time shows that the Intrinsic Group actually had the highest completion time, while the External Group had the lowest completion time (see Figure 9). Interestingly, the control group, which did not receive an EPSS support tool, did not exhibit the lowest score for time on task. This finding is consistent with findings of Van Schaik, et al. (2007) and with Shute & Gluck (1996). Van Schaik et al. compared student use of an EPSS with a control group on task accuracy, efficiency (number of steps taken) and speed (time on task). The findings showed a significant improvement on task accuracy and efficiency (fewer "clicks" were required), but no difference was found concerning time on task. That study was limited by a small convenience sample which makes comparison difficult. Shute & Gluck tested two types of online support tools with four groups of learners on a learning task. The findings showed a main effect between the two groups on learning outcome, but not on learning time.

The current findings also parallel findings by Nguyen et al. (2005), which used a similar research design to compare EPSS integration levels. Not only did Nguyen et al. also find the Intrinsic group to have the highest time on task, but the trend of the data suggests a linear relationship among the data. According to Barker & Banerji (1995), and based upon the frameworks proposed by Gery (1995) and Raybould (1995; 2000), time on task would be expected to decrease with the level of integration. Nguyen et al. argued that users of external EPSS tools would be expected to take longer than users of more integrated tools to complete their tasks because of the time required to stop the workflow and search externally for information. Yet, both Nguyen, et al. and the current study showed that external EPSS users spent less time performing their work than users of the more embedded EPSS tools. This does raise questions about the reasons for this result.

It is possible that the extra time spent by the Intrinsic Group reflected a higher level of engagement with the task. This could be explained through John Keller's notions about motivational design of instruction (Keller, 1979, 1987). Viewed from the perspective of the ARCS model and ARCS –V models (Keller, 1999; 2010), the unexpected appearance of the Intrinsic tool during the task performance could have functioned to enhance attention to the task at hand, and may have added to the user's curiosity. This would be consistent with Keller's notion of inquiry arousal which involves creating a problem solving situation which then activates knowledge seeking behavior.

Figure 11. Completion Time in Minutes - Comparison of EPSS Groups



It is further possible that the design of the study, in which participants performed the tasks remotely, could have been a factor in the result. Participants were provided with a link which allowed them to access the study materials remotely. While this approach added to the authenticity of the study, it would have been possible for participants to leave the task for minutes at a time to attend to other tasks, and then return to the study. On the other hand, the large sample size and the confirmed randomized assignment of groups indicates that this situation would have occurred consistently across the groups, strengthening the likelihood that the time spent on the tasks was in fact related to the type of EPSS tool.

Again, while not statistically significant, the results do highlight a need for better understanding of how performance support tools interact with individual characteristics and environmental factors to impact task performance. The fact that increased integration produced higher accuracy, but at the expense of time on task, is of practical significance to the performance technology community. Further research to better understand the relationship between performance accuracy and time on task would be of great value.

Frequency of Use

Study results indicated no significant differences among the EPSS tools concerning the frequency of their use. While not significant, it is nonetheless noteworthy that the findings indicate a trend that is opposite to what would be expected based upon the Gery (1995) and Raybould (1995, 2000) frameworks (see Figure 9). While not statistically significant, the findings are of practical importance to performance technologists for whom it would be important to know definitively that the tools they recommend and implement are actually being used, and that they are being used effectively.

A reason for the study results may be related to the study design. System limitations related to the library catalog software did not permit capturing usage numbers on transaction logs. Transaction logs capture within the system software the number of times a particular tool is opened by a user. In the current study, the proprietary nature of the software did not allow this level of access. Instead, participants were asked to rate their frequency of use at the completion of the task scenario. Because the frequency of use measure involved self-reported data, it is possible that a range of individual factors may have influenced the responses. On the other hand, Chi-Square analysis performed on the demographic data confirmed statistically that all demographic characteristics were distributed randomly across the groups. This greatly increases the likelihood that the frequency of use was related to the level of EPSS, and not to demographic characteristics within the groups. Interestingly, the fact that the current study findings follow a trend similar to the findings of Nguyen, et al. (2005) study, which did capture usage data through system-generated transaction logs, strengthens the reliability of this finding. Additional research, including replication of the current study is recommended to further clarify this result.

Low EPSS Usage. An interesting observation from the current study is that the use of the EPSS tools was relatively low. Only 32% of the participants reported using the EPSS tools, while 67.5% of users reported that they made no use of the help tools at all (see Table 10). This result is consistent with findings reported by a number of previous studies (Aleven, Stahl, Schworn, Fischer, & Wallace, 2003; Bartholome, Stahl, Pieschl, & Bromme, 2006; Butler, 1998; Grayling, 1998, 2002; Huet, 2011; Slack, 1991). Based on discussion in the literature, the reasons for non-use of support tools are complex and varied. A series of usability studies of online help users revealed that 55% of users preferred trial and error, rather than using online support, as their first strategy in performing a web-based task (Grayling, 1998, 2002). A similar finding was reported by Dworman & Rosenbaum (2004), who conducted a series of workshops conducted in connection with Computers and Human Interactions (http://www.chi2004.org). They found that study participants persisted using in trial and error, even when actively directed to use help by the researchers. Through observations and interviews with participants, they identified several reasons for users' inability or unwillingness to use help. These include:

1. Cognitive blind spots – users appeared to simply not see support tools even when the delivery mechanism is right in front of them.
2. Distraction aversion – Users often are unwilling to leave their task to seek support.
3. Refusal to admit defeat – Users insist that they can perform a task or solve a problem on their own (Dworman & Rosenbaum, 2004).

The notion of cognitive blind spots raises the issue of cognitive load (Sweller, et al., 1998). According to Clark, Nguyen & Sweller (2006), cognitive load theory involves "a universal set of learning principles and evidence-based guidelines that are proven through experimental research to offer the most efficient methods to design and deliver instructional environments in ways that best utilize the limited capacity of working memory" (p. 342). When learners are confronted with an environment that is too visually complex, learners may refrain from seeking support in order to avoid overloading working memory (Clark, et al., 2006; Aleven, et al., 2003).

Another reason offered by Grayling's usability research (2002) indicates that some users displayed a preference for trial and error as an approach to solving problems and performing tasks, even in the presence of support. This preference is rooted in Carroll's (1987) notion of the active user, who "even as a novice will jump right in and attempt to tackle the task at hand, armed only with previous experience of other software systems, which may or may not apply to the software they are using" (p. 170).

Other researchers have reported that even when users do locate and use online support, they do not necessarily use it effectively to achieve performance goals (Aleven et al., 2003; Huet, 2011; Jansen, 2005). Motivational factors such as confidence, self-efficacy, and interest, and individual characteristics related to prior knowledge have been found to play a role (Aleven, et al., 2003; Bartholome, et al., 2006). Cognitive characteristics, such as metacognitive and self-regulatory capabilities have also been found to influence how well users can use online help (Stahl & Bromme, 2009). In a recent finding, goal orientation also has been found to play a role in users' perceptions of the help seeking process and support tools (Huet, 2011). All of these factors provide rich opportunities for investigation in connection with EPSS.

Some researchers have argued that embedded and contextualized help, as would be found in Extrinsic and Intrinsic EPSS, would be used more than search-based tools as would be exemplified by external EPSS. However, adding visual features to an already complex task environment increases the visual complexity of the interface, and can cause cognitive overload (Huff, 2007). In fact, according to Sweller, et al. (1998), this could cause the user to abandon use of the help tool altogether. In support, Nguyen and Hanzel (2007) reported this exact finding. Huff's comment is further consistent with the results of Nguyen, et al. (2005), whose users significantly preferred the Intrinsic EPSS tool in comparison with the less integrated Extrinsic tool. In considering this result, Nguyen et al. speculated that design issues involved in embedding additional content into the performance interface may have over complicated the visual design in a way that may dissatisfied the users. In a similar finding, Hofer (1996, as cited in Aleven, al., 2003) found that embedded links and hints integrated within a target software interface were not used. Taken together, these findings highlight the need for better understanding of the role of cognitive load related to EPSS and how various design approaches serve to maximize cognitive processing and limit cognitive load.

Implications for Instructional Technology

The findings of this study add rigorous empirical evidence to support the notion in the use of a performance support tool such as an EPSS produces better outcomes on task accuracy than providing no task support at all. A second contribution of the research is the finding that the Intrinsic EPSS tool produced the best accuracy results. The findings further suggest a linear relationship across EPSS integration levels when performance accuracy is a goal. This suggests that progressively increasing the integration level of the EPSS tool would produce a progressively positive outcome on the accuracy of task performance. These results offer a number of practical design insights. For example, the results add support to the notion that Intrinsic EPSS tools should be considered before less integrated tools are used. When performance accuracy is of prime concern, the Intrinsic EPSS tool would be advisable, based upon this study. However, if completion time is a concern, the Intrinsic tool may not be the best choice. In fact, based on the study results, an External tool might provide the best solution.

Implications for Performance Improvement

The overall purpose of the current study has been to produce rigorous data that can be used to guide selection, design and evaluation of electronic performance support systems as part of an overall performance improvement strategy. According to Van Tiem, Moseley, & Dessinger (2012), intervention selection is an integral part of the performance improvement process that includes instructional design, intervention development and producing a business case. It is an interconnected process involving analysis of an organization's environment, definition of the performance problem, identification of a performance gap and analysis of causal factors (Wilmouth Prigmore & Bray, 2010). When a performance gap relates to a lack of knowledge or information on the job, a performance support tool such as an EPSS may be appropriate (Van Tiem et al). Indeed, findings of the current study demonstrated significant improvements in task accuracy among participants who used the Intrinsic EPSS tool.

On the other hand, use of the EPSS did not improve the speed with which users performed their tasks, and the usage of the EPSS tool was low; 67% of study participants did not use the EPSS tool at all. Possible cognitive and perceptual explanations for this finding have been previously discussed. However, from the performance improvement perspective, low usage of a performance support intervention suggests questions concerning not only the validity of the performance and cause analysis phases, but also about attention to implementation planning and change management. According to Stolovich (2007), even though a performance support tool such as an EPSS, may indeed be demonstrated to improve performance, people may resist using it, due to a range of issues including organizational culture, lack of top level buy-in, poor communication, and a range of other issues. Identifying these types of issues involves through a thorough analysis of an organization's environment, a clear definition of the performance problem, identification of a performance gap and analysis of causal factors. According to Van Tiem, et al. (2012), the feasibility and long-term sustainability of an intervention can be enhanced by adopting a collaborative approach to intervention selection that engages key stakeholders in planning for implementation and change management.

Van Tiem, et al. (2012) state further that it is not enough to create successful performance improvement and beneficial change, unless the intervention has been planned carefully so that the new situations they create are realistic, sustainable and add value. Performance improvement processes need to be reliable and repeatable so that performance improvement practitioners can consistently accomplish successful results (p. xxxv). Integral to this approach must be the collection and use of reliable evidence which can be shared with stakeholders to achieve buy-in, solidify top-level administrative support, and extend understanding of the performance improvement process throughout the organization. While more data is needed to underlie selection of interventions such as EPSS, results from the current study have highlighted avenues along which further evidence can be developed.

Implications for Library and Information Science

The current study adds rigorously tested data to support the notion that use of performance tools with library catalogs can be effective in assisting users to more accurately locate and retrieve library resources. Because of the complexity of locating library research information, accuracy is a highly important factor in users' success; yet is a difficult skill for users to develop. Another result of interest to libraries is that users of the Intrinsic tool not only achieved higher accuracy, but spent more time performing the task. This may be because the way in which the Intrinsic tool appeared visually on the catalog screen; it may have helped users to remain focused on the task to be performed, and may have called visual attention to the specific area of screen that required action. Given that much discussion in the library literature has focused on how to design library search features in ways that engage library users in critical cognitive processing during information searching, this result provides an opportunity for further exploration. Studies using qualitative methods would be particularly valuable in providing deeper insight into how users are interacting with the EPSS tool during their catalog session.

Limitations of the Study

One anticipated limitation identified in design of this research, sample size, was not problematic due to the use of electronic communication channels for publicizing the study and accessing the study materials. Use of electronic library communication channels allowed wide distribution and visibility of the study invitation with the target population; further, the study was designed so that participants could access the study materials remotely, without having to visit the library. Finally, participants were offered the incentive of participating in a drawing for a $50 gift card. This strategy produced a large response (N=634), returning sufficient group sizes and allowing use of robust statistical methods for data analysis.

As anticipated in designing the study, the study involved a specific set of library research tasks, which were applied in a particular library context. As a result, the study results may not be applicable to other types of tasks, or to other performance environments. The nature of the study participants presents another factor that must be kept in mind when interpreting the results. The sample was limited to college students, and the project was designed to address their specific needs. Because other types of users in other types of environments may react differently, it may not be possible to generalize findings beyond the library setting and the student group.

Recommendations for Further Research

The current study highlights a number of directions for continued investigation. The following are just a few of many possible avenues for future exploration.

- Although frequency of use was not shown to be significantly related to the type of EPSS integration level, the low usage of the EPSS tools (32%) in the current study raises questions about how the EPSS tools were perceived and used. Qualitative research such as interviews, focus groups and think aloud protocols would be useful in exploring users' perceptions and perspectives. Such data would provide a valuable addition to the quantitative results of the current study in developing further insight to the reasons for, and dynamics of, EPSS use and non-use.

- Because of the critical role played by EPSS in supporting working memory, future research studies investigating the impact of cognitive load with EPSS would be highly valuable. According to Van Schaik (2010) and Aleven, et al. (2003), the concept of cognitive load suggests that even if the EPSS is useful to a worker, the worker may not benefit from the support if the EPSS design overloads working memory related to the simultaneous demands of dealing with problem solving and task performance, in combination with using the support tool. Research comparing cognitive load designs across the EPSS integration levels would add valuable insight.
- Another valuable line of research involves investigation of individual characteristics and how these may influence performers' help seeking behaviors while working in an online environment. For example, Bartholome, et al. (2006) explored a number of performer-related factors that influence how performers use support tools. Factors such as prior knowledge, motivational orientation, interest, self-efficacy, self-estimated competence and epistemological beliefs, have been identified as possible modifying variables in performance outcomes relative to online support tools. Exploration of factors such as these in relation to EPSS would enrich the knowledge base of not only EPSS, but human performance technology generally.

- The current research studied use of EPSS to support complex library research tasks in an academic environment. Additional studies in other types of academic environments, and with different types of complex tasks are recommended to determine whether particular approaches might be more effective with certain types of tasks and types of users, and types of performance environments.
- Finally, while the current study results confirm the Gery (1995) and Raybould (1995; 2000) frameworks, replication of the current study is recommended to provide further validation and confirmation of the study results.

Conclusion

The present research study investigated whether and to what extent the level of integration of an EPSS affects task performance, time on task, task completion, and frequency of use. Design frameworks proposed by Gery (1995) and Raybould (1995; 2000) have suggested that as the level of integration increases, task performance and efficiency should improve progressively with the level of integration. Based on this assumption, it would be expected that users of an intrinsic EPSS would take less time and perform better on accuracy and completion measures than users of an extrinsic EPSS, and, in turn, that users of an extrinsic EPSS would perform better than users of the external EPSS (Krauth, 2000; Maracy, 2011). The current study sought to determine whether these assumptions can be used as reliable design principles for those seeking to employ an EPSS as part of a performance improvement solution. To this end, an experiment was conducted that compared the performance outcomes of users of three levels of EPSS integration using a library catalog to perform library research tasks. Each EPSS type was provided a different level of integration. Upon completing a series of library tasks, participants indicated the frequency with which they used the EPSS took to perform their tasks. They also received scores for task accuracy and task completion. Finally, the EPSS system measured participants' time on task with each EPSS type.

Study results indicated that increasing the level of EPSS integration can produce improvement in performance accuracy, but had no effect on task completion, frequency of use or time on task. In fact, the data suggest that time on task may actually increase with the level of integration. Based on the results, for situations in which performance accuracy is the primary goal, designers can feel confident in recommending an Intrinsic EPSS. However, in situations where speed of performance is a key issue, a less integrated EPSS should be considered. The conflicting nature of the findings indicates the need for further investigation. However, conducting research in the area of EPSS presents a number of challenges. First, supporting performance through use of EPSS is highly complex. It involves a user's perceptive, cognitive and motivational processes, in combination with design elements related to the EPSS interface, and in combination with elements within the user's external environment. Exploration of EPSS in relation to cognitive load theory would provide valuable insight into this complexity, and would also provide a strong base of empirical evidence upon which EPSS research could be built.

A key challenge faced by EPSS researchers is the scarcity and narrow scope of evidence upon which to base decisions regarding EPSS. This presents an obstacle for HPT practitioners. As noted by Clark, et al. (2006), an organization that invests billions of dollars in developing training and performance solutions also expects the HPT practitioner to implement solutions that have been proven to work (p. 16). The base of EPSS research literature could be extended and enriched by incorporating viewpoints from related disciplines. Fields such as Integrated Learning Environments (ILEs), Human Computer Interaction (HCI), Human Factors, Usability, and Library & Information Science have developed bodies of research that offer useful evidence that could be incorporated to create a stronger research base leading to a more complete picture of EPSS and other performance support tools.

Two lines of research that provide insight into how users interact with EPSS tools are found in the literatures of help-seeking and information-seeking behavior. The relationship between problem-solving, performance, information-seeking, and help-seeking has been suggested by Van Schaik (2010), Puustinen & Rouet (2009), Aleven, et al. (2003), and others. Information seeking is a key problem solving skill that has been studied deeply in the Library and Information Science literature. Information seeking models, such as the landmark model proposed by Kuhlthau (1991), offer interesting avenues for exploring the internal processes that occur during task performance. The help-seeking model proposed by Nelson-LeGall (1985) provides a further vantage point from which to investigate how users approach the need for support when performing a task.

While more needs to be done, the findings from the current study add to the base of what is known about how EPSS tools function to support performance. The complex nature and purposes of EPSS, and the limited scope of available research pose challenges, but also provide rich opportunities to better understand the complexities of how learning and performance interact in real world environments. By better understanding the learning-performance relationship, and by broadening the research perspective of performance support tools, performance improvement practitioners will be better equipped to assess performance needs, diagnose problems and recommend evidence-based, sustainable solutions.

APPENDIX A: WSU IRB PROTOCOL APPROVAL

WAYNE STATE UNIVERSITY

IRB Administration Office
87 East Canfield, Second Floor
Detroit, Michigan 48201
Phone: (313) 577-1628
FAX: (313) 993-7122
http://irb.wayne.edu

NOTICE OF EXPEDITED AMENDMENT APPROVAL

To: Sharon Phillips
Deans Office University Library
Office of the Dean

From: Dr. Scott Millis S. Millis, PhD
Chairperson, Behavioral Institutional Review Board (B3)

Date: November 30, 2012

RE: IRB #: 074812B3X

Protocol Title: Electronic Performance Support Systems: Comparative Study of Levels of Integration

Funding Source:

Protocol #: 1207011110

Expiration Date:

The above-referenced protocol amendment, as itemized below, was reviewed by the Chairperson/designee of the Wayne State University Institutional Review Board (B3) and is APPROVED effective immediately.

- Advertisement – Advertisement for WSU Pipeline, WSU Libraries website, library public computers, library building signs, and library tables updated to reflect change in participation time.
- Protocol – Changes to data collection methods and/or instruments which include several minor adjustments, the addition of a choice of "can't determine" to the list of responses, minor changes to instructions, and the addition of two questions. Other change includes adjusting the time required for participation (from 30-45 minutes to 20-25 minutes) based on observations and data collected during the study pilot. These changes do not affect risks to participants.
- Information Sheet (dated 11/26/12) – Research Information Sheet updated to reflect revised time required for participation.

Electronic Performance Support Systems: Comparison of Types of Integration Levels on Performance Outcomes

Research Information Sheet

Electronic Performance Support Systems:
Comparison of Types of Integration Levels on Performance Outcomes

Principal Investigator (PI): Sharon Phillips
College of Education, Instructional Technology Department
734-516-6986

Purpose
You are being asked to participate in a research study to examine the impact of different types of electronic performance support systems (EPSS) on the ability of library users to perform a series of tasks when using the Wayne State University Libraries online catalog. An EPSS is an online help tool that works in combination with a piece of software, such as the library catalog to provide assistance and guidance while you are performing a task. You are being asked to participate in this study because you are a student at Wayne State University. This study is being conducted at Wayne State University.

Study Procedures
If you take part in the study, you will be asked to complete a series of basic library research tasks using the University Libraries' online catalog, and using an EPSS as a support tool. Participation will require one session of 20 to 30 minutes in length to complete the study procedures. The session will consist of completing a brief pre-task demographic questionnaire, which should take about 3 to 5 minutes; completion of the task scenario should take approximately 20 to 25 minutes. You will have the option of not answering any of the questions and may withdraw from the study at any time.

Benefits
As a participant in this research study, there may be no direct benefit for you; however, information from this study may benefit other people now or in the future.

Risks
There are no known risks at this time to participation in this study.

Costs
There will be no costs to you for participation in this research study.

Compensation
For taking part in this research study, for your time and inconvenience, you will be eligible to participate in a drawing for a $50 Visa gift card.

Confidentiality
There will be no list that links your identity with test results.

Electronic Performance Support Systems: Comparison of Types of Integration Levels on Performance Outcomes

Voluntary Participation /Withdrawal
Taking part in this study is voluntary. You are free to not answer any questions or withdraw at any time. Your decision will not change any present or future relationships with Wayne State University or its affiliates

Questions
If you have any questions about this study now or in the future, you may contact Sharon Phillips or one of her research team members at the following phone number 734-516-6986. If you have questions or concerns about your rights as a research participant, the Chair of the Human Investigation Committee can be contacted at (313) 577-1628. If you are unable to contact the research staff, or if you want to talk to someone other than the research staff, you may also call (313) 577-1628 to ask questions or voice concerns or complaints.

Participation
By completing the project you are agreeing to participate in this study.

APPROVED

NOV 30 2012

WAYNE STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD

WAYNE STATE UNIVERSITY
LIBRARY SYSTEM

Advertising for Library public computers, Pipeline, and flyers

APPENDIX B: EMAIL LETTER OF INVITATION

WAYNE STATE UNIVERSITY
LIBRARY SYSTEM

Dear fellow WSU student:

As a PhD candidate in the Instructional Technology program at Wayne State and a member of the Wayne State University Libraries staff, I'm writing to ask for your participation in my doctoral dissertation study. The study will work to improve the library catalog for our users by testing several types of help tools that we've designed to help you with different research tasks while using the Wayne State library catalog.

If you take part in the study, you will be asked to complete a series of basic library research tasks using the University Libraries' online catalog. Participation will require one session of 45 minutes to one-hour in length. The study takes place entirely online and it is not necessary to visit the library to participate in this project. You may access the study materials online through the link below, from any location. To participate in this study, please access the study Instruction Sheet through the link below.

www.lib.wayne.edu/researchstudy

For your time and valuable input, you will be eligible for a drawing for one of five $50 Visa gift cards. Your assistance with this study will help the Wayne State University libraries devise a more user friendly catalog, and make your use of library resources more effective and convenient. Thank you for your consideration.

Sincerely,

Sharon Phillips

PhD Candidate

APPENDIX C: PARTICIPANT INSTRUCTIONS

WAYNE STATE UNIVERSITY
LIBRARY SYSTEM

You are being asked to participate in a research study to examine the usefulness of different types of tools, called electronic performance support systems (EPSS), in assisting library users to perform a series of tasks when using the Wayne State University Libraries online catalog. An EPSS is an online help tool that works in combination with a piece of software, such as the library catalog, to provide assistance and guidance while you are performing a task. You are being asked to participate in this study because you are a student at Wayne State University. This study is being conducted at Wayne State University.

If you take part in the study, you will be asked to complete a series of basic library research tasks using the University Libraries' online catalog. You will have the option of not answering any of the questions and may withdraw from the study at any time. Participation will require a forty-five to sixty minute session to complete the study procedures. The session will consist of a brief pre-task demographic questionnaire, which should take about 5 to 7minutes, and completion of a library task scenario, which should take approximately 30 to 45 minutes.

To participate, click the link below, which will provide you with the Information Sheet. By clicking the link below, you are indicating your willingness to participate in the study.

www.lib.wayne.edu/researchstudy

It is not necessary to come to the library to participate in this project. You may access the link from any location.

For taking part in this study, upon completion, you will have the ability to participate in a drawing for a $50 Visa gift card. Thank you for your assistance with this research project.

APPENDIX D: WSU DEAN OF STUDENTS OFFICE LETTER OF SUPPORT

WAYNE STATE UNIVERSITY
DEAN OF STUDENTS OFFICE

August 28, 2012

This letter expresses the support of the Wayne State University Dean of Students Office for student participation in the research study, "Electronic Performance Support Systems: Comparison of Types of Integration Levels on Performance Outcomes." I support the purpose of this study, which seeks to improve usability of the WSU library catalog by WSU students. Because of its pertinence to enhancement of student scholarship and critical thinking skills, authorization is granted to the researcher, Sharon Phillips, Associate Dean, University Libraries, to utilize the Dean of Students Office student distribution list for recruitment of participation in the study.

Sincerely,

David Strauss
Dean of Students

APPENDIX E: STUDY ADVERTISEMENT

WAYNE STATE UNIVERSITY
LIBRARY SYSTEM

Advertising for Library public computers, Pipeline, and flyers

APPROVED

NOV 30 2012

WAYNE STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD

APPENDIX F: WSU LIBRARY SYSTEM LETTER OF SUPPORT

WAYNE STATE UNIVERSITY
LIBRARY SYSTEM

Letter of Support

June 7, 2012

This letter expresses the support of the Wayne State University Library System for recruitment of student participation in the research study, "Electronic Performance Support Systems: Comparison of Types of Integration Levels on Performance Outcomes." Specific authorization is granted to the researcher to utilize library communication channels for recruitment of participation in the study. This includes utilization of "wallpaper" space on the Libraries public computer desktops, use of the Libraries Pipeline communication channel, use of the Libraries Website News section, and library social media communication channels.

Sincerely,

Sandra Yee, Dean
University Library System

APPENDIX G: PRE-TASK QUESTIONNAIRE

WAYNE STATE UNIVERSITY

LIBRARY SYSTEM

Please take a moment to provide us with information about yourself. This information will be used to help us interpret study results.

1. What is your academic status?
    a. Undergraduate student
    b. Graduate student
2. What is your general academic discipline?
    a. Humanities
    b. Social Sciences
    c. Sciences & Technology
3. Please identify your general age within the following ranges
    a. 18 – 25 years of age
    b. 26 – 35 years of age
    c. 36-45 years of age
    d. Over 45 years of age
4. Please indicate your gender
    a. Female
    b. Male

5. Which of the following best describes your previous knowledge about using the library catalog? (Please check only one)
    0. I have had no library training, and have never consulted with a librarian
    1. I have met with a WSU librarian about how to perform library research
    2. I have used one or more online tutorials provided by the WSU library
6. Which of the following statements best describes you? (Please check only one)
    0. I have never used the library catalog
    1. I have used the library catalog a few times
    2. I have used the library catalog frequently
    3. I consider myself an expert in using the library catalog
7. OPTIONAL: Please provide your email address if you would like to enter a drawing for a gift card.
    1. ____

APPENDIX H: LIBRARY CATALOG SCENARIO

WAYNE STATE UNIVERSITY
LIBRARY SYSTEM

You are a taking a class in American history. For extra credit, you have volunteered to assist your instructor with her research. She is preparing to write a book on political dissent. She has asked you to assist by going through the library catalog to locate a number of items. Please perform the tasks listed, and select the best answer to the question. In performing the tasks, please feel free to take advantage of any help features offered on the task screen.

1. Locate a children's book about nonviolent protest by Susan Terkel.

    a. What is the call number?
        i. 315.78 M496d
        ii. 303.61 T272p
        iii. 303.625 B313
        iv. 501.25 P42t
        v. Can't determine

2. Is there another book on the same topic?

    a. Who is the author?
        i. Haskins
        ii. Lynd
        iii. Pearlman
        iv. Kurlansky
        v. Can't determine

    b. What is the call number?
        i. HM 1281 .K87 2006
        ii. HD 509 .C48 2008
        iii. HM 278 .L9 1995
        iv. 920 H273r
        v. Can't determine

3. Is there another children's book by Terkel?

    a. What is the call number?
        i. HD 1281 .K87 2006

ii. 920.13 T36t
iii. 362.7 T272f
iv. HS 275 .T45
v. Can’t determine

4. Is there a book in the Purdy Kresge Library giving Abraham Lincoln’s views on civil disobedience?

   a. What is the call number?
      i. E 185 .S87
      ii. JC 328.2 .O52
      iii. JC 368.6 .L29
      iv. E 457.2 .G875 2009
      v. Can’t determine

5. Your instructor wishes to find out how many titles are there in the catalog on the broad topic of Civil Disobedience?
      i. 528
      ii. 1198
      iii. 123
      iv. 27
      v. Can’t determine

6. Of these, your instructor only wants the most relevant titles. How many titles can you find meeting those criteria?

      i. 147
      ii. 63
      iii. 11
      iv. 27
      v. Can’t determine

7. Of these, how many <u>books</u> are located in the Undergraduate Library?

      i. 27
      ii. 47
      iii. 4
      iv. 8
      v. Can’t determine

8. She believes there is a book on this topic that is located in a special collection donated by someone by the name of Wise.

   a. What is the title of the book?

i. A System of rights
ii. Why not everyman?
iii. Blessed are the peacemakers
iv. I am Rosa Parks
v. Can't determine

b. What is the call number of the book?
i. 192381
ii. 147349
iii. Wise 0089
iv. Wise 2763
v. Can't determine

9. Your instructor recalls a book of poetry about protest by Arlene Stone. She cannot recall the title.

a. What is the title?
i. Immigrants, welfare reform, and the poverty of policy
ii. The shule of Jehovah: A narrative poem
iii. The image maker: poems
iv. At the gates of hell
v. Can't determine

b. What is the call number?
i. PS 3569 .T6294 S65 1994
ii. 162566
iii. 912381
iv. 147349
v. Can't determine

c. Where is it located?
i. Purdy Kresge Library
ii. Law Library
iii. Storage
iv. Undergraduate Library
v. Can't determine

10. Your instructor is interested in reading an essay by Faith Berry about civil protest. She believes Berry wrote an intro to a book of protest writings by Langston Hughes written in the 1970s and would like you to find it.

a. What is the call number?
i. PS 3515 .U274 Z617
ii. H 874 .W3 2002

iii. H 874 .M3
iv. PS 3515 .U274 G6 1973
v. Can’t determine

b. Where is the book located?
i. Storage
ii. Undergraduate Library
iii. Purdy Kresge Library
iv. Law Library
v. Can’t determine

This concludes the task scenario portion of this exercise. Please answer the following questions about the usefulness of the help tools provided within the catalog.

11. How frequently did you use the help tools provided during the exercise?

i. Not at all
ii. 1 – 4 times
iii. 5 – 9 times
iv. 10 or more times

12. If you did not use the help features, why not?

APPENDIX I: EPSS LIBRARY CATALOG SCENARIO RUBRIC

WAYNE STATE UNIVERSITY
LIBRARY SYSTEM

		Answer	Correct	Incorrect	Completed/ Not completed
	Find a children's book nonviolent protest by Terkel.				
	a. What is the call number?	303.61 .T272p			
	Find an additional book on the same topic.				
	a. Who is the author?	Haskins			
	b. What is the call number?	920 H273r			
	Is there another children's book by Terkel in the library?	Yes			
	a. What is the call number?	362.7 T272f			
	Is there a book in the Purdy Kresge Library giving Abraham Lincoln's views on civil disobedience?	Yes			
a	What is the call number?	JC 328.2 .O52			
	How many titles are there in the library on the broad topic of Civil Disobedience?	123			
	Of these, your instructor only wants the most relevant titles. How many titles can you find meeting those criteria?	27			
	Of these, how many books are located in the	4			

	Undergraduate Library?				
8	Locate the title of a book in a special collection donated by someone by the name of Wise.				
a	What is the title of the book?	A system of rights			
b	What is the call number of this book?	Wise 0089			
	Locate a book of poetry about protest by Arlene Stone.				
a	What is the title?	At the Gates of Hell			
b	What is the call number	162566			
c	In which building/collection is it located?	Storage			
0	Locate a book of protest writings by Langston Hughes written in the 1970s, 1st edition in which Faith Berry wrote an introduction.				
0a	What is the call number?	PS 3515 .U274 G6 1973			
0b	In which building/collection is it located?	Purdy Library			

APPENDIX J: PILOT STUDY POST-TASK QUESTIONNAIRE

WAYNE STATE UNIVERSITY
LIBRARY SYSTEM

Please take a moment to provide feedback on your experience. This will help us to identify any areas of the task scenario or help features that were unclear or otherwise in need of improvement.

1. How helpful did you find the assistance provided in using the library catalog?
    a. Very helpful
    b. Neutral
    c. No helpful
2. How would you rate the task scenario in terms of difficulty?
    a. Too difficult
    b. Too easy
    c. About right
3. How comfortable did the help features make you feel?
    a. Very
    b. Somewhat
    c. Neutral
    d. Not helpful
4. What improvements would you recommend?
5. Please share any additional thoughts you may have.

REFERENCES

Aleven, V., Stahl, E., Schworn, S., Fischer, F., & Wallace, R. (2003). Help seeking and help design in interactive learning environments. *Review of Educational Research, 73*(3), 277-320.

Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. In K. W. Spence & J. T. Spence (Eds.), *Psychology of learning and motivation* (pp. 89-195). New York: Academic Press.

Barker, P., & Banerji, A. (1995). Designing electronic performance support systems. *Innovations in Education and Training International, 32*(1), 4-12.

Barker, P., Van Schaik, P., & Famakinwa, O. (2007). Building electronic performance support systems for first-year university students. *Innovations in Education and Teaching International*, *44*(3), 243-255.

Bartholome, T., Stahl, E., Pieschl, S., & Bromme, R. (2006). What matters in help seeking? A study of help effectiveness and learner-related factors. *Computers in Human Behavior*, *22*, 113-129. doi: 10.1016/j.chb.2005.01.007

Bastiaens, T., Nijhof, W., Streumer, J., & Abma, H. (1997). Working and learning with electronic performance support systems: An effectiveness study. *International Journal of Training and Development, 1*(1), 72-78.

Binder, C. (2010). Measurement, evaluation, and research: Feedback for decision-making. In J. L. Moseley & J. C. Dessinger (Eds.), *Handbook of improving performance in the workplace* (Vol. 3, pp. 3-24). San Francisco, CA: Pfeiffer.

Brown, J., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher, 18*(1), 32-42.

Butler, R. (1998). Determinants of help seeking: Relations between perceived reasons for classroom help-avoidance and help-seeking behaviors in an experimental context. *Journal of Educational Psychology, 90*(4), 630-643. doi: 10.1037/0022-0663.90.4.630

Carroll, J. M. (1987). The paradox of the active user. In J. M. Carroll (Ed.), *Interfacing thought: Cognitive aspects of human interaction* (pp. 80-111). Cambridge, MA Bradford Books.

Cavanagh, T. B. (2004). The new spectrum of support reclassifying human performance technology. *Performance Improvement 43*(4), 28-32. doi: 10.1002/pfi.4140430408

Chabrow, E. (2005). Wireless revs up vehicle production: RFID and other technologies help manufacturers slash millions from production costs. *Information Week* (1056), 100.

Chang, C. C. (2004). The relationship between the performance and the perceived benefits of using an electronic performance support system (EPSS). *Innovations in Education and Teaching International, 41*(3), 343-364.

Clark, R. (1992). EPSS: Look before you leap: Some cautions about applications of electronic performance support systems. *Performance & Instruction, 31*(3), 22-25.

Clark, R. C. (2006). Evidence-based practice and professionalization of human performance technology. In J. A. Pershing (Ed.), *Handbook of human performance technology* (pp. 873-898). San Francisco, CA: Pfeiffer.

Clark, R. C., & Mayer, R. E. (2010). Instructional strategies for directive learning environments. In K. H. Silber & W. R. Foshay (Eds.), *Handbook of improving performance in the workplace* (pp. 329-360). San Francisco, CA: Pfeiffer.

Clark, R. C., & Nguyen, F. (2008). Behavioral, cognitive and technological approaches to performance improvement. In J. M. Spector, M. D. Merrill, J. Van Merrienboer & M. P. Driscoll (Eds.), *Handbook of research on educational communications and technology* (3rd ed., pp. 507-524). New York: Lawrence Erlbaum Associates.

Clark, R. C., Nguyen, F., & Sweller, J. (2006). *Efficiency in learning: Evidence-based guidelines to manage cognitive load*. San Fransisco: Pfeiffer.

Clark, R. E., & Estes, F. (2002). *Turning research into results: A guide to selecting the right performance solutions*. Atlanta, GA: CEP Press.

Cody, R. P., & Smith, J. K. (1997). *Applied statistics and the SAS programming language*. Upper Saddle River, NJ: Prentice-Hall.

Cohen, J. (1977). *Statistical power analysis for the behavioral sciences*. New York: Academic press.

Darabi, A., Nelson, D., & Mackal, M. (2004). Instructional efficiency of performance analysis training for learners at different levels of competency in using a web-based EPSS. *Performance Improvement Quarterly, 17*(4), 18-30.

DeRosa, C., Cantrell, J., Cellentani, D., Hawk, J., Jenkins, L., & Wilson, A. (2005). *Perceptions of library and information resources: a report to the OCLC membership.* Dublin, Ohio: OCLC Online Computer Library Center.

Duncan, C. S. (1985). Job performance aids. Job aids really can work: A study of the military application of job aid technology. *Performance & Instruction, 24*(4), 1-4.

Dworman, G., & Rosenbaum, S. (2004). *Helping users to use help: Improving interaction with help systems*. Paper presented at the CHI 2004 Conference on Human Factors in Computing Systems, Vienna Austria.

Ellis, P. D. (2010). *The essential guide to effect sizes: Statistical power, data analysis, and the interpretation of research results*. Cambridge: Cambridge University Press.

Emmanouilides, C., & Hammond, K. (2000). Internet usage: Predictors of active users and frequency of use. *Journal of Interactive Marketing, 14*(2), 17-32.

Famakinwa, O., & Barker, P. (2010). Information access. In P. Barker & P. Van Schaik (Eds.), *Electronic performance support systems: Using digital technology to enhance human activity*. (pp. 127-145). Burlington, VT: Gower Publishing.

Gagne, R. M. (1983). *Conditions of learning and theory of instruction*. New York: Holt, Rhinehart & Winston.

Gagne, R. M. (1985). *Conditions of learning and theory of instruction* (4th ed.). New York: Holt, Rhinehart & Winston.

Gal, E., & Nachmias, R. (2011). Online learning and performance support in organizational environments using performance support platforms. *Performance Improvement*, *50*(8), 25-32. doi: 10.1002/pfi.20238

Gery, G. (1991). *Electronic performance support systems: How and why to remake the workplace through the strategic application of technology*. Tolland, MA: Gery Performance Press.

Gery, G. (1995). Attributes and behaviors of performance-centered systems. *Performance Improvement Quarterly, 8*, 47-93.

Gilbert, T. F. (1978). *Engineering worthy performance*. Amherst, MA: HRD Press.

Grassian, E. S., & Kaplowitz, J. R. (2009). *Information literacy instruction: Theory and practice* (2nd ed.). New York: Neal-Schulman Publishers, Inc.

Grayling, T. (1998). Fear and loathing of the help menu: a usability test of online help. *Technical Communication, 45*(2), 168-179.

Grayling, T. (2002). If we build it, Will they come? A usability test of two browser-based embedded help systems. *Technical Communication*, *49*(2), 193-209.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis*. Upper Saddle River, NJ: Prentice Hall.

Hinkle, D. E., Wiersma, W., & Jurs, S. G. (2003). *Applied statistics for the behavioral sciences* (5th ed.). Boston: Houghton Mifflin Company.

Hudzina, M., Rowley, K., & Wager, W. (1996). Electronic performance support technology: Defining the domain. *Performance Improvement Quarterly, 9*(1), 36-48.

Huet, N. (2011). The influence of achievement goals and perceptions of online help on its actual use in an interactive learning environment. *Computers in Human Behavior, 27*(1), 413-420. doi: 10.1016/j.chb.2010.09.003

Huff, D. C. (2007). *The effects of EPSS selection controls on incidental learning, performance time and task accuracy.* Doctoral dissertation. Proquest Dissertations and Theses Online database. (3243082)

Huglin, L., Johnsen, L., & Marker, A. (2007). Research priorities in performance technology: A delphi study. *Performance Improvement Quarterly, 20*(1), 79-86.

Hung, W., & Chao, C. (2007). Integrating advance organizers and multidimensional information display in electronic performance support systems. *Innovations in Education and Teaching International, 44*(2), 181-198.

Jansen, B. J. (2005). Seeking and implementing automated assistance during the search process. *Information Processing & Management, 41*(4), 909-928. doi: 10.1016/j.ipm.2004.04.017

Keller, J. M. (1979). Motivation and instructional design: A theoretical perspective. *Journal of Instructional Development, 2*(3), 26-34.

Keller, J. M. (1987). Motivational design of instruction. In C. M. Reigeluth (Ed.), *Instructional theories and models: An overview of their current status* (pp. 383-434). New York: Lawrence Erlbaum.

Krauth, J. (2000). *Techniques in the behavioral and neural sciences: Experimental design: A handbook and dictionary for medical and behavioral research*. New York, NY, USA: Elsevier Science & Technology.

Laffey, J. (1995). Dynamism in electronic performance support systems. *Performance Improvement Quarterly, 8*(1), 31-46.

Lindsay, P. H., & Norman, D. A. (1972). *Human information processing: An introduction to psychology*. New York: Academic Press.

Mao, J. Y., & Brown, B. (2005). Effectiveness of online task support versus instructor led training. *Journal of Organizational and End-User Computing, 17*(3), 27-46.

Maracy, M. (2011). Estimating dose-response effects in psychological treatment trials: the role of instrumental variables. *Statistical Methods in Medical Research, 20*(3), 191-215. doi: 10.1177/0962280208097243

McGraw, A. (1993). The performance support system as a training solution: Cost benefit considerations. *Journal of Instruction Delivery Systems, 7*(4), 7-5.

McKay, J., & Wager, W. (2007). Electonic performance support systems: Visions and viewpoints. In R. A. Reiser & J. V. Dempsey (Eds.), *Trends and issues in instructional design and technology* (pp. 147-172). Upper Saddle River, NJ: Pearson Education.

McNeil, K. A., Newman, I., & Kelly, F., J. (1996). *Testing research hypotheses with the general linear model*: Southern Illinois University Press.

Milheim, W. (1997). Instructional design issues for electronic performance support systems. *British Journal of Educational Technology, 28*(2), 103-110. doi: 10.1111/1467-8535.00014

Miller, G. A. (1956). The magical number seven, plus or minus two: some limits on our capacity for processing information. *The Psychological Review, 63*, 81-97.

Murdock, B. B., Jr. (1961). The retention of individual items. *Journal of experimental psychology, 62*(6), 618-625. doi: 10.1037/h0043657

Nguyen, F. (2009). The effect of performance support and training on performer attitudes. *Performance Improvement Quarterly, 22*(1), 95-114.

Nguyen, F. (2010). Electronic performance support systems. In R. Watkins & D. Leigh (Eds.), *Handbook of improving performance in the workplace* (Vol. 2, pp. 325-343). San Fransisco, CA: Pfeiffer.

Nguyen, F., & Hanzel, M. (2007). Linking versus searching: A case study of performance support use. *Performance Improvement, 46*(10), 40-44.

Nguyen, F., & Klein, J. (2008). The effect of performance support and training as performance interventions. *Performance Improvement Quarterly, 21*(1), 95-114.

Nguyen, F., Klein, J., D. , & Sullivan, H. (2005). A comparative study of electronic performance support systems. *Performance Improvement Quarterly, 18*(4), 71-86.

Paino, M., & Rossett, A. C. (2008). Performance support that adds value to everyday lives. *Performance Improvement, 47*(1), 37-44.

Puustinen, M., & Rouet, J.-F. (2009). Learning with new technologies: Help seeking and information searching revisited. *Computers & Education, 53*, 1014-1019.

Raybould, B. (1995). Performance support engineering: An emerging development methodology for enabling organizational learning. *Performance Improvement Quarterly, 8*(1), 7-22.

Raybould, B. (2000). Building performance-centered web-based systems, information systems, and knowledge management systems in the 21st century. *Performance Improvement, 39*(6), 32–39.

Richey, R., Klein, J., & Tracey, M. W. (2010). The instructional design knowledge base: Theory, research and practice. New York: Taylor & Francis.

Rossett, A., & Schafer, L. (2006). Job aids and performance support: The convergence of learning and work. *International Journal of Learning Technology, 2*(4), 310-328.

Rossett, A., & Schafer, L. (2007). *Job aids and performance support: Moving from knowledge in the classroom to knowledge everywhere*. San Francisco, CA: Pfeiffer & Co.

Rowan, T. C. (1973). *Improving DOD maintenance through better performance aids.* Springfield, VA: National Technical Information Service.

Rubin, J., & Chisnell, D. (2008). *Handbook of usability testing: How to plan, design and conduct effective tests* (2nd ed.). Indianapolis, IN: Wiley.

Seel, N. M. (2008). Empirical perspectives on memory and motivation. In J. M. Spector, M. D. Merrill, J. Van Merrienboer & M. P. Driscoll (Eds.), *Handbook of research on educational communications and technology* (pp. 39-66). New York: Lawrence Erlbaum

Sherry, L., & Wilson, B. (1996). Supporting human performance across disciplines: A converging of roles and tools. *Performance Improvement Quarterly, 9*(4), 19-36.

Shute, V. J., & Gluck, K. A. (1996). Individual differences in patterns of spontaneous online tool use. *The Journal of the Learning Sciences, 5*(4), 329-355. doi: 10.1207/s15327809jls0504_2

Slack, F. E. (1991). *OPACS: Using enhanced transaction logs to achieve more effective online help for subject searching.* Doctoral thesis, Manchester Polytechnic.

Sperling, G. (1960). The information available in brief visual presentations. *Psychological Monographs: General and Applied, 74*(11), 1-29.

Stahl, E., & Bromme, R. (2009). Not everybody needs help to seek help: Surprising effects of metacognitive instructions to foster help-seeking in an online-learning environment. *Computers and Education, 53*(4), 1020-1028. doi: 10.1016/j.compedu.2008.10.004

Stolovich, H., D. (2007). The development and evolution of human performance technology. In R. A. Reiser & J. V. Dempsey (Eds.), *Trends and issues in instructional design and technology* (2nd ed., pp. 134-146). Upper Saddle River, NJ: Pearson Education.

Sweller, J., Van Merrienboer, J., & Paas, F. (1998). Cognitive architecture and instructional design. *Educational Psychology Review, 10*(3), 251-296.

Tessmer, M., & Richey, R. C. (1997). The role of context in learning and instructional design. *Educational Technology Research and Development, 45*(2), 85-115.

Van Schaik, P. (2010). Psychological perspective. In P. Barker & P. Van Schaik (Eds.), *Electronic performance support: Using digital technology to enhance human performance* (pp. 31-54). Burlington, VT: Gower Publishing

Van Schaik, P., Barker, P., & Famakinwa, O. (2007). Making a case for using electronic performance support systems in academic libraries. *Journal of Interactive Learning Research, 18*(3), 411-428.

Van Schaik, P., Pearson, R., & Barker, P. (2002). Designing electronic performance support systems to facilitate learning. *Innovations in Education and Teaching International, 39*(4), 289-306.

Van Tiem, D. M., Moseley, J. L., & Dessinger, J. C. (2012). *Fundamentals of performance improvement*. San Francicso: Pfeiffer.

Whitney, K. (2005). Terry Bickham Jr.: Cataloging learning at the Library of Congress. *Chief Learning Officer, 4*(11), 44-47.

Wilmouth, F. S., Prigmore, C., & Bray, M. (2010). HPT models: An overview of the major models in the field. In R. Watkins & D. Leigh (Eds.), *Handbook of improving performance in the workplace* (Vol. 2, pp. 5-26). San Francisco, CA: Pfeiffer.

ABSTRACT

ELECTRONIC PERFORMANCE SUPPORT SYSTEMS: COMPARISON OF TYPES OF INTEGRATION LEVELS ON PERFORMANCE OUTCOMES

by

SHARON A. PHILLIPS

August 2013

Advisor: Dr. James Lee Moseley

Major: Instructional Technology

Degree: Doctor of Philosophy

Selecting appropriate performance improvement interventions is a critical component of a comprehensive model of performance improvement. Intervention selection is an interconnected process involving analysis of an organization's environment, definition of the performance problem, and identification of a performance gap and identification of causal factors. When the performance gap relates to a lack of knowledge or information on the job, instructional approaches such as training have been traditionally used; however, non-instructional interventions such as electronic performance support systems (EPSS) have gained increasing attention as alternatives to training interventions.

Electronic Performance Support Systems (EPSS) use computing technology to support task performance on demand, any time, any place, at the point of need with a minimum need for in-person intervention such as instructors, peer mentors or supervisors. Providing on-demand access requires that the EPSS be integrated into the performer's work environment. However, performance support tools can be integrated into a work environment in a variety of ways. In

particular, research suggests that if an EPSS interface design is too complex, it diminished performance, and may not be accepted by users.

The purpose of this research study was to investigate whether progressively increasing the level of integration – external, extrinsic or intrinsic - would make a difference in a user's performance outcomes. According to the EPSS design literature, performance accuracy should increase, and completion time should decrease, along with the level of integration, due to fewer pauses in workflow and more immediate access to support. However, research data to support this assumption has not provided definitive guidance.

The current study sought to determine whether these assumptions can be used as reliable design principles for those seeking to employ an EPSS as part of a performance improvement solution. To this end, an experiment was conducted that compared the performance outcomes of users of three levels of EPSS integration using a library catalog to perform library research tasks. Study participants were randomly assigned to one of four treatment groups representing progressive levels of integration – external, extrinsic or intrinsic, along with a control group. Upon completing a series of library tasks, participants indicated the frequency with which they used the EPSS took to perform their tasks. They also received scores for task accuracy and task completion. Finally, the EPSS system measured participants' time on task with each EPSS type.

Study results indicated that increasing the level of EPSS integration can produce improvement in performance accuracy, but had no effect on task completion, frequency of use or time on task. In fact, the data suggest that time on task may actually increase with the level of integration. A further notable observation from the findings was that overall usage of the EPSS tool was relatively low; on average, 67% of study participants did not use the EPSS tool at all.

Implications for instructional designers include the recommendation that for situations in which performance accuracy is the primary goal, designers can feel confident in recommending an Intrinsic EPSS. However, in situations where speed of performance is a key issue, a less integrated EPSS should be considered. From the perspective of Library and Information Science, the study results support the use of EPSS as a promising tool for enhancing the ability of library users to locate and connect with library resources, and open opportunities to further explore the performance improvement approach in library settings.

From the performance improvement perspective, low usage of a performance support intervention raises questions concerning user acceptance. While critical, selecting an appropriate performance intervention must be done as part of a comprehensive performance improvement approach featuring through performance and cause analysis, and effective planning for implementation and change management. Integral to this approach must be the collection and use of reliable evidence which can be shared with stakeholders to achieve buy-in and extend understanding of the performance improvement process throughout the organization. While more data is needed to extend the reliability of the performance improvement knowledge base, results from the current study have highlighted avenues along which further evidence can be developed.

AUTOBIOGRAPHICAL STATEMENT

Sharon A. Phillips

Dr. Phillips is the Associate Dean for the Wayne University Library System in Detroit, Michigan. In this role, she oversees all aspects of library operations and administrative services and leads library initiatives related to staff and organizational development, process improvement and online library instruction. She has served on and led a number of University committees related to learning technologies, including chairing the campus Teaching, Learning, and Technology Roundtable for a number of years. Prior to joining Wayne State University, Ms. Phillips served for twenty years as Director of Library and Technology Support Services at Oakwood Hospital & Medical Center in Dearborn, Michigan.

Dr. Phillips has achieved recognition within the library profession as a Distinguished Member of the Academy of Health Information Professionals of the Medical Library Association, and has been a two time recipient of the Medical Library Association's Annual Research Award. She has served on and chaired a number of national committees, including election as president of the 10-state Midwest Regional Chapter of the Medical Library Association. At the state and local level, she has held numerous leadership positions within the Michigan Health Sciences Libraries Association, Michigan Library Consortium and Metropolitan Detroit Medical Library Group.

Dr. Phillips has spoken and published on a range of library management topics, including editing a 2001 library management textbook by invitation of the Medical Library Association. She has published numerous articles and book chapters on a range of library issues, and has spoken widely at national, state, regional and local professional meetings and conferences.