POTENTIAL ROLES FOR ELECTRONIC PERFORMANCE SUPPORT SYSTEMS IN LIBRARIES

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ABSTRACT
Electronic performance support systems provide a powerful mechanism for helping end-users comprehend complex systems. This paper describes and discusses some research we have undertaken in order to explore their potential within academic library systems.

KEYWORDS
Electronic performance support, EPSS, library systems, library tasks, networking, evaluation

INTRODUCTION

Nowadays, most people are familiar with the concept of a 'library'. For example, individual people can collect particular types of book that they like to read - or CDs that they like to listen to. These items can be aggregated into collections that they refer to as their '*personal library*'. Indeed, one of us (PGB) has a substantial library of CDs on classical music; he also has a large library of electronic images that he has taken (over the years) with his various digital cameras. On a larger scale, most towns and villages have one or more 'local' libraries from which people (that is, 'the public') can borrow items of interest. Similarly, most organisations (such as universities, schools, business units, public bodies, and so on) each have one or more discrete libraries that cater for the information and knowledge needs of their users. The notion of a library as a discrete individual entity serving the needs of its user community is depicted schematically in Figure 1.

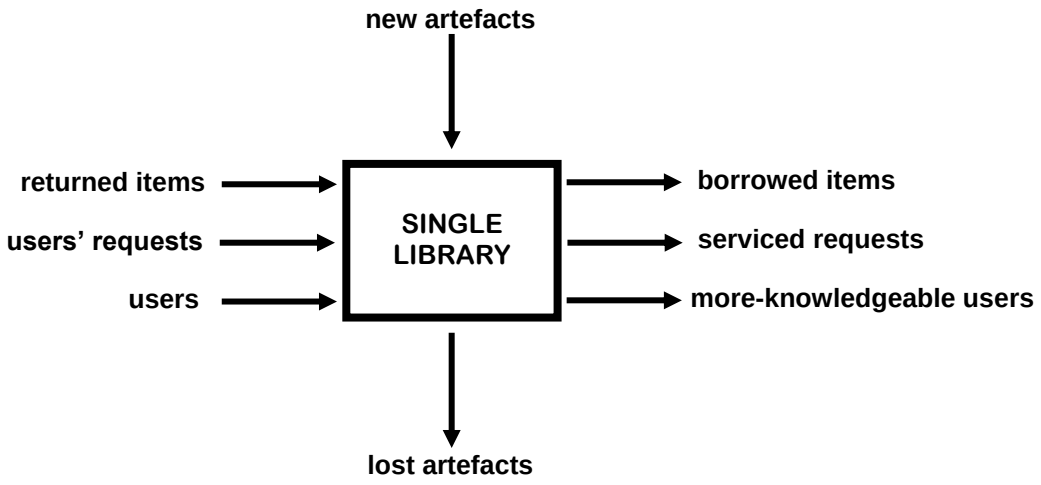


Figure 1. An individual library acting as an archive for sharable artefacts.

In figure 1, the term 'artefact' is used to refer, in a general way, to any of the different types of *information product* that a library houses within its collection. Examples of such artefacts include books, newspapers, journals, CDs, audio tapes, DVDs, data archives, software items, and so on. In principle, any of the items within a library's collection will be 'borrowable'. However, many library users will not necessarily wish to borrow items, they may wish only to consult some of the artefacts in order to become more knowledgeable about particular topics that interest them.

Naturally, a very important issue that has to be addressed when making use of any form of library is making sure that users can *retrieve* the details of (and can *locate*) the various items that are of interest to them. A range of different *retrieval tools* is available for achieving sought-after items. However, considerable skills are usually needed in order to use these tools in an effective way. As we discuss later, it is therefore important to consider how people gain the skills needed to use these tools.

Although individual libraries can often meet the general information requirements of most of its users, there will always be situations in which a library's stock of items will not fulfil particular specialist needs. Furthermore, the range of any given library's stock of items may be severely constrained by the financial budget within which it has to operate. The sharing of items between libraries would therefore seem a useful strategy to adopt in order to overcome problems of this sort. It would therefore seem reasonable to want to build a '*networked library*' facility in which items held in one library can be shared by other libraries. This concept of sharing is depicted schematically in Figure 2.

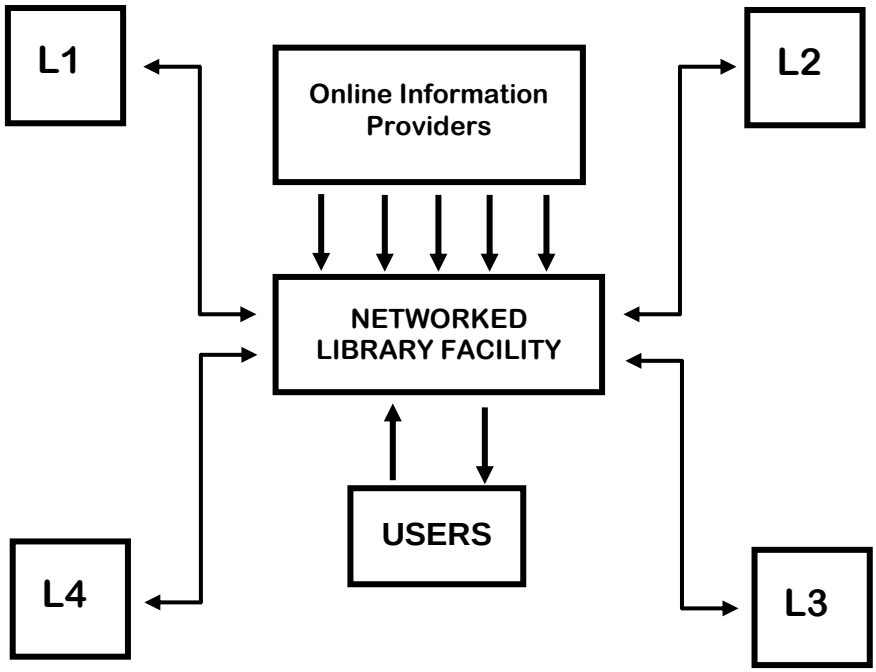


Figure 2. A networked library facility as a mechanism for sharing resources.

With the advent of global electronic communication networks (such as, for example, the Internet), the task of interconnecting individual libraries with one another is becoming increasingly easy. This is particularly so when an individual library holds some (or all) of its resource collection in digital format - see, for example, *http://www.aace.org/dl*.

Naturally, for an end-user of a system such as that depicted in figure 2, there is a number of additional problems that he/she is confronted with - over and above those associated with using a particular individual library (as depicted in Figure 1). For example, each of the resource centres (libraries L1, L2, L3, L4, and so on) depicted in the diagram is likely to have a wide range of different *resources* and

services available. Gaining *familiarity* with what is available at each location is therefore an important issue that has to be addressed. Another important problem that has to be considered is the fact that each individual library may be use different *tools*, *protocols* and *procedures* for allowing users to access its resource collection. This again, adds to the growing complexity of an end-user's interaction with a library facility.

With the increased use of digital technology within library systems, these organisations are undergoing a fundamental paradigm shift (Barker, 1997). They are moving away from being just '*storehouses of human endeavour*' towards becoming '*centres of learning and knowledge sharing*'. This is particularly so in the case of academic libraries within schools, colleges and universities. Secker (2004) has discussed, at some length, the impact that this paradigm shift is having on university libraries. Of course, as non-academic, traditional libraries change their brief, in order to become centres for lifelong learning, they too are likely to undergo this paradigm shift.

Bearing in mind what has been said above, it is important to realise that end-user interaction with a library system - be this in a face-to-face context, through a personal computer or a workstation facility - is likely to become more and more complex as time progresses. It is therefore imperative that we devise and provide library users with appropriate tools to help them overcome the problems that they are likely to encounter. The types of tool that we advocate in this paper are based on the application of electronic performance support technology (Gery, 1991; McGraw 1994; Stevens and Stevens, 1995; Bezanson, 2002; Reeves and Raven, 2002).

Over the last decade we have had substantial experience in designing and applying the theory and practice of electronic performance support systems (EPSSs) to the problems of helping users of advanced technological systems. Some typical examples of the projects that we have undertaken have been described by Banerji (1995), Barker (1995), Beacham (1998), Flinders (2000), Pearson (2000) and van Schaik et al (2002).

The theoretical basis for performance support is rooted within the belief that many innate human limitations can be overcome through the appropriate design and use of performance aids. These may be of a cognitive, intellectual, physical, mechanical, electronic or bio-technical nature. One important approach to the effective use of EPSS technology is its application to the development of 'scaffolding environments' (Cagiltay, 2005). Such an environment is essentially a supportive infrastructure that people can use while they are learning about and acquiring new skills and competencies - for example, learning how to use a specialised search tool for locating particular items of interest within a digital resource repository.

As has been mentioned previously in this section, our current EPSS research has been oriented towards studying how we can use performance support technology to provide a supportive infrastructure for library users (Famakinwa, 2004). We have therefore designed, tested and evaluated a prototype EPSS facility in order to help library users overcome some of the difficulties that they encounter when using academic libraries. The functional role of this EPSS facility is depicted schematically in Figure 3.

The setting for the research and development work that we have undertaken was provided by the academic library facility at the University of Teesside (*http://www.tees.ac.uk/lis*). This is a very modern, highly computerised library environment that provides access to a large range of resources - both conventional and electronic. In addition to the range of resources that it provides access to, there is an equally broad spectrum of users that it has to serve. It has to cater for undergraduate students from a variety of disciplines (studying for degrees and diplomas), research students and staff from six different schools.

In the remainder of this paper we discuss some of the important issues underlying the design and implementation of our prototype EPSS facility (called '*Epsilon*'). We then outline the nature of the system evaluation that we conducted in order to assess the effectiveness of the performance aids that

were embedded within the system. The final part of the paper discusses the implications of our findings and outlines a future programme of work that we intend to undertake in order to move the system from its prototype stage into a completed operational product. We hope to share the final implementation of this product on a national basis with other university libraries within the United Kingdom.

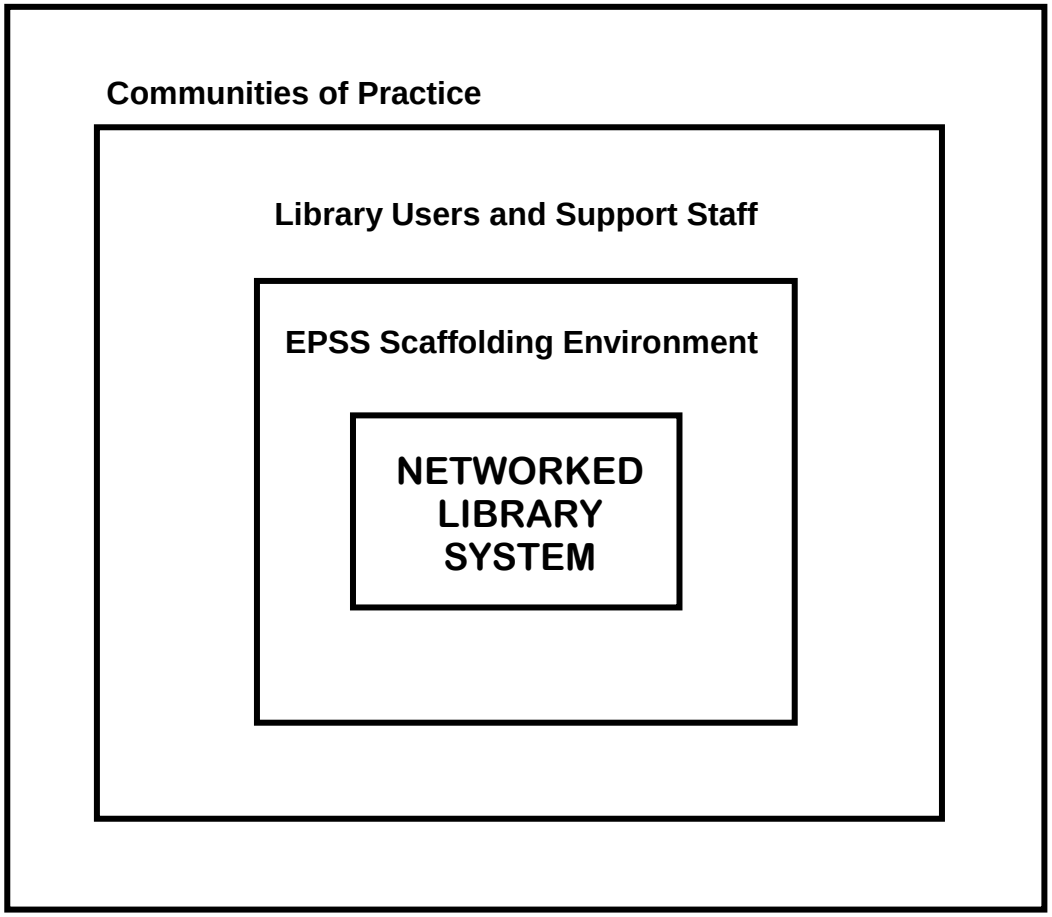


Figure 3. Using an EPSS to provide a scaffolding facility for library users.

SYSTEM DESIGN AND IMPLEMENTATION

Requirements and Needs Analysis

At the commencement of the project a focus group session was conducted with the University of Teesside library personnel. This was undertaken in order to identify problems that users encountered while using library services. The findings from this session revealed that students experienced difficulties with: searching for journal articles and books within *The Catalogue;* understanding and using journal citations; using the online databases and locating books and journals within the library. Discussions were also held with 19 students to further identify user needs. These discussions took the form of one-to-one interviews.

The results from the sessions with the library personnel and students led to the specification of the tasks that the prototype system should support. These tasks selected for support in the prototype included (in decreasing order of importance): searching for information on subjects of interest; locating books and journal articles within the library stock and managing the process of borrowing books. These high-level tasks were each broken down into smaller sub-tasks.

Prototype Design
Based on the requirements and needs analysis, the design specifications for the prototype were produced. The prototype was designed and implemented and extensive formative usability testing was conducted. This was especially important for this project, as it was necessary to integrate several external applications and there were no prior examples on which to base the initial designs.

Content
The major components of an EPSS normally include *online help, an expert system, online learning* and *text retrieval* (Barker and Banerji, 1995). Each component is usually designed to accomplish a particular goal. The characteristics of the type of information or support each provides are therefore different. For this project only the online help and expert system components were implemented. The content characteristics of the online help component had to be designed to provide context-sensitive information (such as basic facts, definitions, procedures and their expected results) in small manageable 'chunks of information'. The expert/advisor system had to provide more dynamic and interactive support for users while they were completing a task. The content for the EPSILON system (which was designed as a series of web pages) was taken mainly from the University of Teesside's Library and Information Services web site.

Navigation
Simplicity and consistency are important factors that can have considerable impact on a user's navigation through a web site. Simple and consistent user interfaces will therefore help novice users quickly become accustomed to an application and allow easy movement between the different sections of the web site. Bearing this in mind, the *global menu system* for the EPSILON system was located at the top of the screen (in the title panel) where users could readily access the home page and various 'personalised services'. From the home page, users could access all the features and services of the system by judicious use of menu items that had collapsible sub-menu items (these were intended to reduce screen clutter).

Visual Design
The page layout design for the web site was based on the use of a template that contained three panes: a *title pane*, an *information pane* and a *help pane*. The title pane was located at the top of the browser window. As mentioned above, it contained the global menu system for the application and also gave users access to the home page and their individual personal areas. In the information pane users could receive specific help in performing any task that they had selected to perform. The help pane was used to provide additional information to assist users with the current task (or sub-task) that was being performed. Clicking on *Help Assistant* links found within the information pane would also update the Help pane with relevant information. The Help pane was collapsible and could thus be hidden from view when not in use.

The advisor component of the system was responsible for providing advice and support for users while performing certain tasks that would require interfacing with external services. The *External Applications User Interface* was the interface that enabled the support of external software applications that could not be readily integrated into the system because their source code could not be accessed. It opened up in another browser window containing two panes. The external service or application was loaded in the lower pane - the application pane - while assistance and support information was presented in the upper pane - the support pane.

Testing the Design
Throughout the design of the user interface, informal usability tests were carried out with people not connected with the project. This allowed the identification of usability issues at an early stage and enabled them to be addressed before too much work had already being committed to the project (therefore making changes difficult). This section documents some of the testing results encountered while designing and building the prototype.

Page Layout
The first drafts of the user interface involved using a display with four-panes. However, early testing of this arrangement established that it was too cluttered and therefore it was reduced to a three-pane display - with the Help pane being collapsible. This greatly enhanced the overall look and feel of the screen. The home page was also re-designed as the initial designs suffered from too many links on the page which confused users. The final design resulted in the use of collapsible menus that hid their sub-menu items until they were clicked. The frequently-used menu items were therefore made visible while less frequently-used ones were hidden.

Even though the Help pane was collapsible, the default state was to have it displayed. Informal usability tests showed that this decision to keep the help pane visible was flawed. All users ignored the help pane while performing tasks; even as far as the users not being aware of its existence. Thus when they did make a request for help by clicking on help topics in the Information pane, they were unaware that the Help pane had being updated with this new information request.

External Applications Interface
The *External Applications User Interface* implemented the Advisor component of the system. It opened up in a new browser window containing two panes (or Internet Explorer frames). The external service or application was loaded in the lower pane while assistance and support information was presented in the upper pane. This design was mandated by the need to integrate an external application with the EPSS system. However, users experienced difficulties with using this system.

Opening a new browser window while performing a task often disoriented and confused users. When they were finished with the use of the Advisor component, they often forgot to close the window to continue with the main task at hand. The size of the upper pane was fixed and so the size of the lower pane was determined by the size of the window. This, however, also meant that on low-resolution screens the window opened was small and so the application pane was often too small to use without excessive scrolling. Users failed to realise that the pane divider could be adjusted.

Implementation
In order to allow for a tighter and more seamless integration with pre-existing web-based library software services (such as *The Catalogue)*, the system was designed to be web-based. The basic tools used were Hypertext Markup Language (HTML), a client-side scripting language (JavaScript) and Active Server Pages (ASP) - or server-side programming.

Book Locator
In the implementation of *The Catalogue* for the University library, after a user had found the details of a book and its associated shelf mark, there was no further information available to show the location within the library where the book could be found. The Book Locator was an EPSS advisor component of the system that provided this information. Using the book's shelf mark, a user could determine which floor in the library a book was located and also where on that floor it was shelved. During the testing of the system this was the feature that students liked most.

Personalised Area
ASP technology is used for producing dynamic web pages. A server generates these as a browser requests them. The personalised area of the system was implemented using ASP technology in combination with the *Microsoft Access* relational database management system. By logging into the system using an appropriate user account, users could access their own personal areas of the system. The account information consisted of a username and a corresponding password. This information was stored in the system's database. If a user did not have an account then one could be created by visiting the account registration page.

The personalised area of the EPSS provided the following services to users: creating notes, saving documents, opening previously created notes and opening previously saved documents.

EVALUATION

An evaluation of the EPSILON system was conducted to establish levels of task performance, efficiency, speed and acceptance, and usability problems, by comparing aided task performance (using EPSILON) with unaided performance (using the LIS web site).

Method

Experimental design

Using an independent measures design, the independent variable was task support (aided using EPSILON, unaided using the LIS web site). Dependent variables were task completion, efficiency and speed of task performance, intention to use of the system and usefulness of the system as measured by psychometric scales.

Participants

There were 20 participants and 15 of these were postgraduate students. The sample consisted of 8 females and 12 males. Of these, 12 were on a science-related programme, 3 on a social sciences programme and 5 were on other programmes. Mean age was 25 years (SD = 3.4).

All participants had some experience of using the World Wide Web. Participants had been using the Web from more than a month to more than a year and the majority (95%) had been using the Web for more than one year. In terms of frequency, many participants (75%) used the Web more than once a day, with the remaining 25% of participants using the Web more than once a week but less than once a day.

The majority of the participants (95%) had some experience with the LIS web site. Participants had been using the web site from less than a month to more than a year and the majority (65%) had been using the web site for more than one year. In terms of frequency, many participants (50%) used the web site more than once a week, with the remaining 45% of participants using the web site less than once a month.

Materials and Apparatus

The experimental group used EPSILON and the control group the LIS web site and the tools and services hosted on it. Although the sites differed in various ways, both made it possible to complete all the tasks that participants were asked to perform. The experiment was carried out on personal computers connected to the Internet in the university's learning resource centre. The questionnaire was divided into several sections: Section 1 measured demographic details and was answered by both groups. The Section 2 was exclusively designed for and answered by the experimental group and measured intention to use and perceived usefulness of EPSILON, using 7-point Likert scale items based on Davis and Venkatesh (1996). This section also included open-ended questions on the usability of EPSILON.

Procedure

Both groups were given an introduction on the features and services available on the site that they would be using. For each of six tasks, a description of the task was first handed out to a participant. Then, after reading the task, the participant performed the task using the site available to them. Accuracy of task performance (correct or incorrect), number of links followed before the end of the task and time-on-task were noted. After the last task, participants were asked to fill out a copy of the questionnaire.

RESULTS

The two sites were compared in terms of level of task performance, efficiency and speed. Details of other results are presented in Famakinwa (2004).

The mean overall correctness of task completion was 75% for the experimental group, compared to 40% for the control group. Figure 4 shows the completeness rates for each task, with the most dramatic differences in favour of the experimental group for Tasks 2 (8 × more successful), 3 (60% successful compared to 0% for the control group), and 5 (> 3 × more successful).

Accuracy was measured as ratio of the optimal number of links followed to the page that contained the correct answer to a task and the actual number of links followed by the participant to perform the task. Mean overall efficiency over correctly performed tasks was 0.88 for the experimental group, compared to 0.59 for the control group. Figure 5 shows efficiency for per task, with the most dramatic differences in favour of the experimental group for Tasks 2 (almost 4 × more efficient), and 5 (> 2 × more efficient).

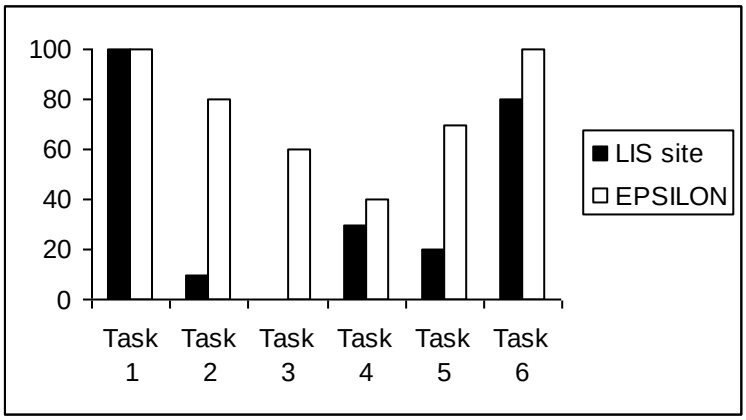
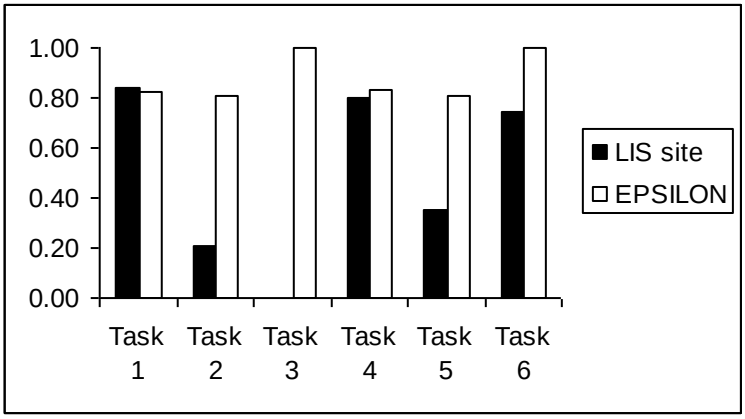


Figure 4: Success of task completion.



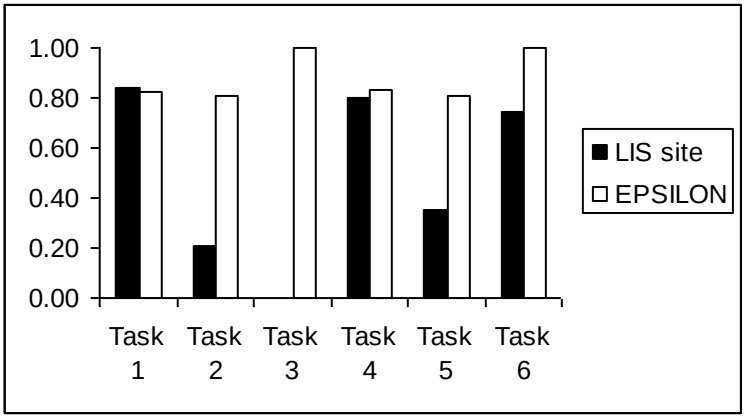
Note. No correct answers were given to Task 3 in the control group.

Figure 5: Efficiency of task performance.

Mean time-on-task over correctly performed tasks was 1.50 minutes for the experimental group, compared to 3.01 for the control group. Figure 6 shows efficiency for per task, with the most dramatic difference in favour of the experimental group for Task 5 (> 4 × more efficient).
In summary, improvements when using EPSILON ranged from 1.5 (for efficiency) to 1.9 (for successful task completion) to 2 (for time-on-task), with exceptional improvement in Tasks 2, 3 and 5.

Participants' answers to open-ended questions about the usability of the EPSS revealed the following positive aspects: ease of use, breakdown of tasks into clearly defined steps, clear description of available facilities and services, help system, user interface and navigation system. Further answers indicated the following negative aspects: inadequacy of help system, colour scheme, look and feel, use

of frames, navigation system, various windows open simultaneously, causing difficulty in using the EPSS. However, 30% of participants identified no negative aspects of the system.



Note. No correct answers were given to Task 3 in the control group.

Figure 6: Time-on-task.

DISCUSSION

The results show that task performance as well as efficiency and speed were improved when aided (using EPSILON), compared to unaided performance. In particular tasks that capitalised on the performance enhancing facility of the system benefited from an enormous improvement.
The control group had a low completion rate on Task 2 because the LIS web site, although having information on the location of books in the Learning Resource Centre (LRC), did not integrate it into the library catalogue facility. It was found during the test that 95% of the participants were not aware of its existence. In this group, Task 3 also suffered because participants did not know where to find in the web site information about what to do in the event they were unable to locate the book or journal article they were looking for within the LRC. Related to Task 5, none of the participants considered the inter-library loan as an option. They were not aware of the inter-library loan service, even though they had heard about it. Therefore, in the control group Task 5 completion rate also suffered as the LIS web site did not readily make available information on how to use this service.

Although our findings demonstrate the performance-enhancing function of EPSILON, various usability problems with the first version of this system were identified. This means that the true potential of aided performance using the system (with improved system usability) is conceivably markedly greater than was achieved in this evaluation. In particular, the usability of the help system, navigation system and windowing will be considered in future design and development work in order to enable the full potential to be unlocked.

CONCLUSIONS AND FUTURE WORK

The findings of our research in the domain of libraries confirm results of previous studies where an EPSS was applied to specific domains to improve job performance. For example, van Schaik et al. (2002) applied EPSS within the domain of quantitative research methods. Barker and Banerji (1995) also demonstrated the application of EPSS within the domain of computer-file transfer. Furthermore, beyond improving performance, there was evidence for system acceptance by the target audience - students - and they would be willing to use the EPSILON system if it were fully developed (Famakinwa, 2004).

In conclusion this project has demonstrated the viability of the application of EPSS to library services. However, there is still an unfulfilled need in terms integrating the many external tools and services already in existence in library web sites. A user interface which seamlessly blends the EPSS and library tools and services would assist in addressing and alleviating the usability problems that were identified in the evaluation.

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