Potential roles for performance support tools within library systems

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Abstract
Purpose – The aim of the research was to design and evaluate a prototype electronic performance support system (EPSS) for libraries.

Design/methodology/approach – Based on the theory of performance support and usability problems identified in the use of academic libraries, a performance support system for using the Dewey Decimal Coding system was designed, implemented and evaluated. The system embedded two components: a tutorial to develop knowledge and two games to develop skills. An experimental evaluation was conducted with three groups of students to assess the effects of the two components.

Findings – The study found that students found the system useful. There was a large difference in confidence in own knowledge (in favour of the groups who studied the tutorial component), approaching statistical significance. Although no major usability problems were identified, some specific problems surfaced that should be addressed in future work. Results from staff (who also used the system) confirmed the findings from students and also highlighted the scaffolding function of the EPSS.

Research limitations/implications – This research has shown the viability of performance support for academic libraries. However, it identified issues for future research, including the inclusion of sound and speech, dynamic adaptability of content to make the system more suited to specific libraries and academic disciplines, and integration with existing library systems and virtual learning environments.

Originality/value – The study has extended the concept of performance support to the domain of academic libraries. Given its wide applicability, the system should be valuable to academics and students worldwide.

Keywords Software tools, Academic libraries, Classification schemes

Paper type Case study

Introduction
As a result of the many different activities that human beings participate in, they now generate very significant amounts of data, information and knowledge. Indeed, as a consequence of technological progress, each individual (on average) now generates
and/or accumulates more material than was ever the case previously. For example, word-processing systems make it much easier to create text-based (and multimedia) documents, and digital cameras provide an easy mechanism for creating large quantities of image data. Similarly, the ease with which digital sound files can be produced and manipulated means that individuals can also accumulate large amounts of sound material, for example voice recordings and MP3 digital music. In addition to these “traditional” sources of electronic material, many new “data producing” devices are becoming available. For example, various types of mobile device based on the global positioning system (GPS) are able to create large volumes of tracking data that enable information and knowledge relating to people’s movements to be derived.

The developments outlined above have emphasised both the established and growing importance of libraries as access points to stored collections of information and recorded knowledge. This important role of libraries is illustrated schematically in Figure 1.

**Figure 1.**
The role of libraries in providing access to recorded knowledge
For centuries, libraries have played an important role in the lives of academics. They also offer many useful services and facilities for those who are less interested in the academic pursuit of knowledge. Indeed, many library users may be more oriented towards just “keeping abreast” of what is happening in the world at large, or may wish to use a particular service provided by a library. However, having said this, there is some evidence to suggest that conventional libraries, in general, are becoming increasingly less used (overall) and, within libraries, printed materials are used less than they were previously (Select Committee Report, 2005, pp. 13-14, 19). The falling use of print-based materials may be due to the effect that the internet is having as an access mechanism to recorded knowledge (Figure 1). Of course, “preference trends” are only one issue that libraries need to consider. The “usability” of services and facilities is also important.

As the number of services and facilities offered by a library increases, the “system image” (Norman, 1998) projected towards its users, of necessity, becomes more complex. This will undoubtedly influence the overall usability of a library. Increasingly, with the advent of digital electronic communication networks, many libraries are becoming integrated into regional or national infrastructures. This means that resources held at one physical location can be accessed by users based at many other remote locations. Such an arrangement is illustrated schematically in Figure 2, in which four libraries (denoted as L1, L2, L3, L4) are interconnected by means of an appropriate electronic communication network.

The integration of library resources often brings with it increased complexity from the perspective of end-users' knowledge of what is available and their understanding of how to use the various resources that are provided. This is particularly true of students who are new to using academic libraries and people (in general) who might have had hardly any contact with a library facility since leaving full-time education. This can mean that library users often find it very difficult to use their local library and also access the facilities available in a networked system similar to that shown in Figure 2. Indeed, the results of a large-scale study (of undergraduates, graduate students and faculty members from a wide range of academic institutions) conducted by Friedlander (2002; cited by Curtis, 2005, p. 318) indicated that 38.4 per cent of respondents believed...
that having insufficient training on how to search for information was an impediment. This naturally poses the question of how best to provide appropriate education and training for library users.

In a recent study that we undertook at our university library (see www.tees.ac.uk/lis), we found that our students also had great difficulty in using many of the library facilities. Many students were also unaware of the type and nature of the services provided by the library system (Famakinwa, 2004; Barker et al., 2005). As discussed below (and later in this paper), one of the main areas of difficulty was understanding the principles of classification and using “shelf marks” (as obtained from the online catalogue) in order to locate books within the confines of the library. In order to overcome the difficulties that students were encountering, we designed and built an electronic performance support system (EPSS) called “Epsilon” in order to act as an educational scaffold for students while learning to use the library facilities. Normally, an EPSS would be built from various “support components”, some of which might embed different types of learning object (LO), various types of knowledge object (KO) and relevant objects relating to performance enhancement (PO). The way in which the Epsilon system was intended to support library users is illustrated schematically in Figure 3.

Within Figure 3, collections of objects of a given type are denoted by expressions of the form \{XX\}, where XX is a two-letter code that is used to reflect the type of EPSS object that is being referred to.

The role of EPSS facilities as a mechanism for improving the acceptability and usability of computer-based systems is well documented in the literature (Gery, 1991; Barker, 1995; Banerji, 1995; Bezanson, 2002; Barker et al., 2003; Reeves and Raven, 2002). The theory of EPSS use is rooted in the belief that inherent human limitations (with respect to skill and knowledge acquisition and task performance) can be

![Figure 3](image_url)

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

<table>
<thead>
<tr>
<th>Key</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>LO: Learning Objects</td>
<td>PO: Performance Objects</td>
</tr>
<tr>
<td>KO: Knowledge Objects</td>
<td>IO: Information Objects</td>
</tr>
<tr>
<td>DO: Data Objects</td>
<td></td>
</tr>
</tbody>
</table>
overcome by the design of appropriate support aids. Cagiltay (2006) has discussed various scaffolding strategies in relation to EPSSs. We have used this technique successfully in a number of projects intended to provide students with easier access to educational resources (see, for example, Barker and Banerji, 1995; Barker, 1995; Beacham, 1998; van Schaik et al., 2002; Barker et al., 2005). Our most recent study of the utility of EPSS as a scaffolding tool has concentrated on its application for supporting students who have difficulties in using the various facilities provided by academic libraries (Barker et al., 2005). As was mentioned above, we designed the Epsilon EPSS facility to meet the requirements of students as identified by a needs analysis study. The EPSS therefore consisted of a number of different components, each of which was designed to address a particular performance limitation.

A controlled evaluation of the Epsilon system revealed that the student cohort that used our EPSS system outperformed those in the control group in nine of the ten evaluation tasks that they were asked to undertake (Barker et al., 2005). As mentioned above, one of the areas of difficulty that students encountered was understanding the book classification system – which was based on the Dewey Decimal Classification (DDC) scheme – and using DDC shelf marks to locate the books that they wanted. Hull (2000) has also documented this problem. This aspect of students’ difficulties was therefore addressed within the Epsilon system by means of two pedagogic activities: a didactic online tutorial (for knowledge development) and an interactive game-playing activity (for skill development). It is this pedagogic aspect of our performance support system that is described in this paper. The following sections of this article describe the design and implementation of the two EPSS components (and their embedded learning objects) that we used, their evaluation, and the implications of our findings for future research and development within the context of EPSS applications in library systems.

**System design and implementation**

In order to use libraries in an effective way, students need to develop appropriate library skills and knowledge – such as how to use a classification system and how to go about locating sought-after information in the most efficient way. Developing the required skills and knowledge to use a library typically involves having to participate in suitable teaching and learning activities that are organised by library staff. However, because of the increasing demands placed on such staff, computer systems are increasingly being used to help students acquire the necessary skills. Indeed, interactive computer software (that involves active participation by students) has been found to be an effective way of achieving the required skill and knowledge transfer. Interactive courseware can often embed a “gaming” element. Games have significant potential as a mechanism for learning and skill development because the simulated (“virtual”) environments that they can create can provide engaging experiences in which users can experiment and explore at their own pace – and make mistakes without undue consequences (Prensky, 2001a, b).

Bearing in mind what has been said above, when designing our system, we were therefore influenced by the advantages of employing games. The advantages of doing this include:

- the ability to produce courseware that would appeal to both young and mature students;
- the scope for creating challenging and engaging activities for users;
As mentioned earlier, in realising these objectives, two additional components to the EPSS for library services (Epsilon) were developed:

1. a tutorial component for knowledge development; and
2. a gaming component for skill development.

**Designing the tutorial**

In designing the tutorial component we were influenced by the need to impart to students knowledge about how libraries are organised and how best to find books in a library using the available services and facilities. This could involve the use of a classification and cataloguing system and the various signs that are distributed throughout a library building. Within the EPSS that we built, these requirements had to be accomplished in a visually appealing, interactive and engaging way. These objectives were achieved using static pictures, animations and online activities, augmented with textual information (which was kept to a minimum). The material was also organised in a way that ensured it was delivered in simple language and in small manageable units for quick and easy assimilation. These principles are illustrated in Figure 4.

In order to make learning experiences engaging and challenging, interactive content was designed into the tutorial. For concepts that were deemed to be complex, animations were used that allowed their embedded ideas to be assimilated at the users’ own pace. More advanced features were also designed into the tutorial in the form of

**Figure 4.**
Typical screen layout for the tutorial component showing the use of the DDC system

*Note: The authors have added explanatory annotations in bold*
activities that a user could carry out. An example of this is the activity of ordering decimal numbers. A typical computer screen-shot taken from this learning activity is illustrated in Figure 5.

Designing the games
As a result of using the tutorial component, a user should have gained sufficient knowledge to enable him/her to locate a book in a library that uses the DDC scheme for classification. The gaming component was designed to allow each user to put into practice his/her knowledge of this activity. This component consisted of two games: the first (Game 1) allowed a user to find a book in a “simulated” (virtual) library system, while the second (Game 2) involved arranging a set of books into the correct shelving (ascending) order (using each book’s individual classification number or shelf mark).

At the start of Game 1, each user was provided with the classification number or shelf mark of a book that he/she had to find in the library. Based on the signs provided in the virtual library (and using their acquired knowledge of classification), each user had to make decisions about how to go about locating a given book. This involved deciding upon which floor (in the physical library) they would begin their search. They also had to determine the shelving area, the specific shelf and, finally, the position on the shelf where the sought-after book should be located. At the end of the search activity, each user was presented with the time he/she took to complete the task, as well as the number of attempts taken to locate the book on the shelf. Obviously, this approach introduced an element of challenge into the game in order to encourage users to try again and improve their skill. The simulated library used in this study was based on the University of Teesside’s Learning Resource Centre (LRC). However, instead of using actual shelf marks, the shelf marks produced at the start of each game were randomly generated. For each randomly generated shelf mark, the integer part fell within the valid DDC range (000 through 999) and the length of the decimal part was varied, having a length of between one and four decimal places.

Figure 5.
Screen dump showing the activity of arranging decimal numbers into their correct order
The screen shots shown in Figures 6-8 depict some of the situations encountered by a user while playing Game 1. In Figure 6, the picture at the top shows the opening screen; this specifies which book the user has to find. Beneath this, the second picture illustrates how a user can choose which floor of the library on which to begin his/her search. Having decided on which floor to begin a search, the next step involves identifying the aisle wherein the sought-after book should be found. Figure 7 illustrates how this was done. In Figure 8, the picture at the top of the diagram shows the shelf view that would be displayed to a user after selecting the relevant aisle. The final steps necessary to locate the sought-after book would now involve selecting a shelf (the upper diagram in Figure 8), and then indicating the position, within the selected shelf, at which the book should be located (the lower diagram in Figure 8).

The second game (Game 2) was geared towards testing and developing its user’s skill in handling decimal numbers. At the start of the game a user would be presented with a screen view similar to that shown in Figure 9. This depicts, in a schematic way, five books on a “virtual” shelf. These books have to be arranged in ascending order. This can be achieved by “dragging and dropping” individual books into their correct positions. The classification numbers generated for the books were designed to challenge the user and emulated those numbers that students would be likely to have most difficulty with (Hull, 2005). The same integer part was generated for all the decimal values. However, the fractional parts were of different lengths and followed pre-determined rules that were known to confuse students. We thought that this teaching strategy would help users to handle real classification numbers when encountered in libraries.

**System implementation**

The tutorial module was implemented using Microsoft’s PowerPoint presentation package. This software environment was chosen because of its rapid prototyping capabilities. These included ease of laying out the design elements on the pages, and built-in support for static images, sound files and animations. It was also possible to include interactive features developed in external applications such as Macromedia’s Flash. Although PowerPoint has a scripting engine (based on the Visual Basic for Applications programming and runtime environment), it lacks many features that would have allowed for a richer learning environment. For example, PowerPoint lacks a robust “event-handling” model that would allow scripts to monitor and react to end-users’ interaction with the pages that make up an application. Other tools therefore had to be used in order to overcome this limitation. For example, Macromedia’s Flash was used to develop the decimal-number ordering activity in the tutorial module. The code developed using Flash was then imported into PowerPoint using Macromedia’s Shockwave/Flash player ActiveX control.

Dynamic HTML (DHTML) comprising the use of JavaScript and HTML and cascading style sheets (CSS) were selected as the software environment in which the games were implemented. Other alternatives considered were Macromedia Flash and Microsoft Visual Basic. Eventually DHTML was selected, as the necessary skills and experience with this technology were readily available within the project team. The end-user interface was built using Macromedia Fireworks, an image editor designed for producing web graphics. Most of the images were obtained from actual pictures from the LRC. These were then edited using Macromedia Fireworks in order to produce
Figure 6. Sequence of initial screens used in locating a book in Game 1
the final images. This editing suite was also used to convert parts of the images into hyperlinks which could invoke appropriate functions in the JavaScript library.

**Evaluation**

Two separate evaluations were conducted: a user test and an assessment by staff.

**User test**

**Method.** Research design. A three-group, pre-test/post-test design was used to establish the effect of using the two EPSS components. Group 1 only studied the tutorial component, Group 2 only played the game component and Group 3 studied both the tutorial component and played the game component. Outcome measures included knowledge of the library classification system, confidence in knowledge, and speed and efficiency of task performance of game play.

Participants. There were 20 students, with six in Group 1, and seven in both Groups 2 and 3. Their mean age was 23 (SD = 4.04) and 14 were male. A total of 17 were students, 14 of whom were full-time, with seven postgraduate, nine undergraduate and one pre-university. All had more than one year of experience in computer use and 17 used a computer more than once a day.

Materials and equipment. For the purpose of the evaluation, a computer-based experiment was programmed in PowerPoint, which included studying the tutorial and/or playing game components (depending on experimental group). From time to time the experimental software requested participants to enter information into a printed workbook. Every participant had an individual workbook, which included
Figure 8.
Screen shots showing final stages involved in locating a book in Game 1
instructions for using the tutorial component and playing the games, a pre-test and post-test for measuring knowledge (and their confidence in this knowledge), and pages for recording task performance on the games. A questionnaire was also included in the workbook, which requested demographic information and measured system acceptance and participants’ experience of using the EPSS components.

Procedure. Once participants were each seated at an individual personal computer, they were given a consent form to read and complete. Following this, they worked through the computer-based experiment. This included studying the tutorial and/or playing the games, and completing sections of the workbook when appropriate. Participants took between 20 and 60 minutes to complete the evaluation.

Results. Knowledge. Mean knowledge scores (pre-test and post-test) were around 60 percent (see Table I). Analysis of covariance (ANCOVA) was used to establish the effect of EPSS component (tutorial, game, tutorial and game) on post-test knowledge after statistically controlling for pre-test knowledge. A prerequisite for ANCOVA, the assumption of parallel regression slopes, was not violated, $F(2,14) = 1.57, p > 0.05$. The covariate, pre-test knowledge, was significantly related to post-test knowledge, $F(1,14) = 18.24, p < 0.05, r = 0.65$. There was no effect of EPSS component on post-test knowledge after controlling for pre-test knowledge, $F < 1$.

![Figure 9. Screen shot showing drag and drop activity in Game 2](image)

Table I.
Knowledge as a function of EPSS component

<table>
<thead>
<tr>
<th></th>
<th>Tutorial (Gp1)</th>
<th>Game (Gp 2)</th>
<th>Tutorial and game (Gp 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>60.00</td>
<td>65.71</td>
<td>65.71</td>
</tr>
<tr>
<td></td>
<td>(16.73)</td>
<td>(22.99)</td>
<td>(16.18)</td>
</tr>
<tr>
<td>Post-test</td>
<td>66.67</td>
<td>58.57</td>
<td>62.38</td>
</tr>
<tr>
<td></td>
<td>28.05</td>
<td>(16.76)</td>
<td>(22.00)</td>
</tr>
</tbody>
</table>

Note: Mean values with SD in parentheses
Confidence in own knowledge. Mean confidence scores (pre-test and post-test) varied widely from 67 to 92 per cent (see Table II). The assumption of parallel regression slopes was not violated, $F(2, 14) = 2.76, p > 0.05$. The covariate, pre-test confidence, was significantly related to post-test confidence, $F(1, 14) = 19.90, p < 0.05, r = 0.74$. The effect of EPSS component on post-test confidence after controlling for pre-test confidence was approaching significance, $F(2, 14) = 3.42, p = 0.06, \omega^2 = 0.27$, which represents a large effect size. This result reflects the relatively high confidence in Groups 1 and 3 compared to Group 2.

Task performance. Task performance in terms of speed (time to task completion) and efficiency (number of attempts) were largely similar between Groups 2 and 3 (see Table III) and $t$ tests showed no significant differences between groups: $t(11) = 1.23$ for efficiency on Game 2, and $|t| < 1$ for efficiency on Game 1 and speed on both games.

Acceptance. Reliability analysis was conducted on the various acceptance measures included in the questionnaire. Only the items for perceived usefulness of the tutorial component (Cronbach’s alpha = 0.97) and the game component (alpha = 0.87) formed reliable scales. Overall scores were calculated by averaging over items. With possible scale values ranging from $-3$ through $+3$, the 95 per cent confidence intervals were [1.08; 1.81] with mean = 1.45 and [0.45; 2.26] with mean = 1.35 for the tutorial and games, respectively.

Experience. The most salient and frequent answers regarding the experience of using the EPSS components are reported. Overall, participants did not encounter major usability problems. Nonetheless, the tutorial component lacked consistency of navigation between pages. The games suffered from a lack of instructions and, in the

<table>
<thead>
<tr>
<th></th>
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<th>Group (Gp)</th>
<th>Tutorial and game (Gp 3)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Pre-test</td>
<td>Post-test</td>
<td></td>
</tr>
<tr>
<td></td>
<td>79.67</td>
<td>91.67</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(18.38)</td>
<td>(15.81)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>66.87</td>
<td>79.74</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(8.04)</td>
<td>(10.29)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>69.64</td>
<td>90.08</td>
<td></td>
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<tr>
<td></td>
<td>(16.36)</td>
<td>(7.88)</td>
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</table>

**Note:** Mean values with SD in parentheses

<table>
<thead>
<tr>
<th></th>
<th>Game (Gp 1)</th>
<th>Group (Gp)</th>
<th>Tutorial and game (Gp 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Speed (sec.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Game 1</td>
<td>96.14</td>
<td>84.22</td>
</tr>
<tr>
<td></td>
<td>(45.75)</td>
<td>(15.20)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Game 2</td>
<td>10.31</td>
<td>12.64</td>
</tr>
<tr>
<td></td>
<td>(2.10)</td>
<td>(8.51)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Efficiency</td>
<td>1.71</td>
<td>1.72</td>
</tr>
<tr>
<td></td>
<td>Game 1</td>
<td>(0.76)</td>
<td>(1.12)</td>
</tr>
<tr>
<td></td>
<td>Game 2</td>
<td>2.95</td>
<td>3.47</td>
</tr>
<tr>
<td></td>
<td>(0.68)</td>
<td>(0.85)</td>
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</table>

**Table II.**
Confidence in knowledge as a function of EPSS component

**Table III.**
Accuracy and efficiency in playing the game component

Note: Mean values with SD in parentheses
case of the second game, from a lack of feedback when users did not produce the correct solution.

Positive aspects included that, overall, the EPSS components were enjoyable and easy to use, and information and diagrams were clear and precise. Participants felt that the tutorial was short, easy to understand and easy to follow. In addition, the animations and (in particular) the interactive features were very effective in conveying tutorial content. Furthermore, the games were fun to play, visually appealing and interesting.

Regarding negative aspects of the tutorial, many felt that there was insufficient interactivity. Furthermore, there was a lack of spoken narrative to attract and maintain attention and to increase appeal. The quality of graphics was poor in places and the linear nature of the tutorial did not allow users to control navigation. The games were felt to lack challenge and quickly became boring and repetitive.

Participants recommended the following changes for improvement. In general, electronic support should also be provided for using the electronic library catalogue. The tutorial could be enhanced by making it more interactive, including sound as well as more graphics and animation, and increasing its visual appeal. The games could be improved by allowing users to search for their own books. The second game could be made easier by dragging and dropping books (from one shelf to another) rather than the present design, which involves sorting them on the same shelf (as is currently the case): at times, this could be confusing.

**Assessment by staff**

*Method.* A total of 15 members of staff took part in a separate evaluation. Their mean age was 44 (SD = 7.94), six were males and were selected to be representative of the university’s academic and library support staff. Five came from the Library and Information Services Department, three each from the School of Social Sciences and Law and the Centre for Learning and Quality Enhancement, two from the School of Computing and Mathematics, and one each from the School of Science and Technology and the School of Health and Social Care.

Participants read and signed a consent form and a brief introduction of the EPSS was given by the authors of this paper. Participants then worked through a computer-based experiment (programmed in Microsoft’s PowerPoint) which included both studying the tutorial component and playing the game component. Following this, they completed a set of open-ended questions about the value of the EPSS for use by students. Finally, a group discussion was held, based on the same questions, where staff shared the issues that they felt were most salient.

*Results.* The most salient and frequent responses regarding the EPSS components are reported. In terms of usefulness, it was felt that the EPSS components could enhance students’ confidence in finding materials in the library and thus spending less time finding the correct shelf. The EPSS components would provide a safe environment within which students could practise at their own pace and fail safely.

The most commonly mentioned positive aspect was that the games and interactive puzzles would appeal to students. It was also felt that clear graphics and information were provided in a very simple language. Self-paced courseware was delivered in a user-friendly interface and was easy to use. The tutorial was short and provided information in helpful chunks. Moreover, students would become more “self-sufficient” in using the library and less dependent on others, such as the staff.
Negative aspects included the generic nature of the content of the EPSS components and therefore this was not directly linked to a particular local university or any particular subject area. The tutorial component was too linear, which could encourage just “clicking through” and did not letting users control their navigation. It was felt that the tutorial component could be boring and in places gave too much information on a single page. Navigation through the pages was not consistent and some of the labels used in describing controls were not self-evident. The component also suffered from a lack of sound. The games lacked context-sensitive assistance and, while playing, users might experience difficulties; furthermore, users could not choose which book to search for.

Regarding changes for improvement in general, staff felt that the tutorial and games should be more directly linked to the local university and to particular subject areas. In addition, the decimal-ordering tutorial and games should be expanded to show the author suffix of a DDC (e.g. “NOR” in 620.82NOR) and how it affects the ordering of books on a shelf. The tutorial component could be improved by having more interactive features – particularly, the use of the electronic library catalogue should be covered. The component should be expanded to include search strategies, particularly keyword searches. Sound and voice-overs should be introduced as well as a tour of the library. However, staff also realised that expanding the system could occur to the detriment of simplicity and ease of use.

Discussion
Users found both EPSS components useful. However, there was generally a lack of difference in the effects on outcome measures between EPSS components. The exception was a large difference in confidence in own knowledge (in favour of the groups who studied the tutorial component), which was approaching statistical significance. These results are not surprising, considering the fact that most users were students who were, at least to some extent, familiar with the library. Moreover, given the small sample size, statistical power was low. Despite this, the effect size for confidence in knowledge was large in terms of effect size conventions (Cohen, 1988), indicating the potential of the online tutorial to increase users’ confidence.

Overall, users found the EPSS components easy to use, with effective and attractive presentation of tutorial content and games that were enjoyable to play. However, interactivity, sound and control were lacking in the tutorial. In addition, the games were basic with a lack of variety and instructions were lacking in places. Major improvements suggested by users focused on extending the scope of electronic support to the electronic library-catalogue, increased and improved interactivity, and enhanced use of media for information presentation.

Results from staff confirmed these findings, but also highlighted the scaffolding function of the EPSS. In addition, the nature of the system would mean that students could practise and become independent library users. The generic and basic nature of the EPSS meant that it was not adapted to use in a specific university library or specific subjects. In addition, staff suggested extensions to the system functionality and making the system more specific.

General discussion
Overall, the evaluation results showed that the EPSS was well received by student users and staff. The results also suggest that users found both EPSS components
useful, and various suggestions for system enhancement were made. Furthermore, our findings indicate that there is a potential for the tutorial component to enhance users’ confidence in their own knowledge. However, the effectiveness of the tutorial in increasing students’ knowledge has not yet been demonstrated. The effectiveness of the EPSS would have been confirmed if its use had improved students’ use of the library (as part of their programme of studies) and, at the same time, enhanced their academic performance. This could be measured in terms of increased efficiency of library use, a reduction in requests for help in the library building and improved quality of sources used in their coursework.

Future developments with the system will involve introducing audio into both the EPSS components described in this paper. This feature was particularly missed during the evaluation and it was noted that students (especially disabled students, such as those suffering from dyslexia) would benefit immensely from the judicious use of sound. Another issue that we intend to study is the dynamic adaptability of content. This would involve making both components more suited to the specific libraries and academic disciplines from which students originate. An appropriate framework of templates would be required to facilitate this requirement. As the online interactive activities employed in the tutorial component were well received, more activities of this sort will be developed in subsequent work. In particular, these will involve the actual use of a typical library’s electronic cataloguing system to ascertain whether a book is available within the library in question.

Currently, the Epsilon EPSS is a stand-alone system. In future designs of our EPSS, we believe that more integration with the library’s existing facilities and services will be required. Students should be able to receive support at any point of need, while within the physical library or at any other of place of access. It is important that the support they receive should not distract them from any other goal in which they are involved. Beyond the library, students are increasingly using virtual learning environments (VLEs). Our EPSS could be integrated into a VLE and then made available to students to use at their convenience. Of course, this would go beyond just providing assistance with using a library’s facilities and services. It would also support students in research activities related to their coursework. This could lead to an increase in the quality of the materials that students have access to, and might also achieve marked improvements in the quality of their coursework.

Conclusion
Obviously, the future is unknown. However, one thing seems certain: conventional libraries (containing real books and real people) will continue to exist for many years to come. Hence, the relevance of the work described in this paper is likely to maintain its usefulness and currency for the foreseeable future.

However, in many traditional libraries there are some significant new developments taking place, for example, in the use of tagging technology – particularly in the area of radio frequency identification (RFID). Many libraries are now exploring the use of RFID tagging for monitoring the movement of books into and from a library. Of course, it is not unrealistic to think that this technology could also be used to enable users of libraries to locate the books that they are searching for. Undoubtedly, there will be many interesting developments taking place in this area in the next few years.
Another important consideration that has to be made is the increasing trend towards providing digital services (McMenemy and Poulter, 2005; Curtis, 2005) and the growing impact that digital libraries (and the classification and retrieval techniques that they embed) are having on conventional library systems. We anticipate that many libraries will be strongly influenced by the digital movement and, as a result, will become hybrid libraries containing a mixture of both physical and virtual library artefacts (see Figure 1). Most academic libraries in the UK (and elsewhere in the world) are already at this stage of development at the present time (see, for example, http://digital.library.upenn.edu). Bearing this in mind, it is important to consider the relevance of the work that we have described (relating to the use of DDC) with the developments that are taking place within digital library systems such as those that have been created by organisations such as the Association for Computing Machinery (see http://portal.acm.org/dl.cfm), the IEEE Computer Society (see www.computer.org/portal/site/csdl/) and the Association for the Advancement of Computing in Education (see www.aace.org/dl).

An important limitation of DDC is that it cannot easily be expanded to accommodate the rapid expansion of knowledge that has been taking place within areas such as computing and electronics. For this reason, digital libraries (such as those listed above) have designed their own subject-specific taxonomies. For example, the ACM Digital Library allows its users to find publications by searching using keywords, as well as (b) by navigating the ACM classification system “tree”. When arriving at a “leaf” of a tree (representing the most detailed classification within the particular tree) a user is presented with (all) available publications in the digital library that match the particular (most detailed level of) classification. For example, the following trail through the classification tree produced 1,619 publications as search results (as of October 10 2005):

H. Information Systems
   H.5 INFORMATION INTERFACES AND PRESENTATION (I.7)
   H.5.2 User Interfaces (D.2.2, H.1.2, I.3.6)
   Subject: Evaluation/methodology

Similarly, in the IEEE Computer Society Digital Library, there are three main routes to accessing stored information:

1. browse by titles;
2. browse by subjects; and
3. using a keyword-driven search facility.

However, the classification system is qualitatively different (reflecting a different subject domain) and smaller and has only two levels. In a similar fashion, the AACE Digital Library also allows both searching and browsing. In summary, all three digital libraries allow users to search and offer the use of a classification system by navigating a classification tree, which does not require users having to remember the system. However, the systems differ in terms of the complexity of the hierarchical navigation trees that are provided – very simple in the case of the IEEE library but much more refined in the case of the ACM library.

Naturally, we believe that the work we have described in this paper has practical relevance to real, conventional libraries in which the DDC scheme is used. However, it also has to be considered within the much broader context of knowledge management.
Nowadays, as we outlined in the introduction to this paper, most people are confronted with problems related to the significant volumes of data, information and knowledge that they are acquiring. It is imperative that a sound understanding of archiving, classification and retrieval processes are imparted to students. We see the DDC scheme that is used in our academic library as both an introduction to these processes and a starting point from which students can embark upon a more general consideration of these topics. Eventually, students will proceed to designing their own archiving and classification schemes that are more relevant to the knowledge management problems that they are likely to encounter later in their careers.

References


Further reading


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