Education and training for digital librarians
A Slovenia/UK comparison

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Abstract

Purpose – To determine and compare approaches to the education and training of librarians for work in digital libraries. More precisely, to identify – in general terms, rather than specifically – the important competencies required by information professionals in creating and managing digital libraries, and in facilitating their use, and to assess how these competencies are treated in LIS education and training, and therefore how the capacities of the information professions are being developed.

Design/methodology/approach – Literature analysis of the skill sets required by librarians working with digital materials. Evaluation of formal education and of professional development programmes in the UK and in Slovenia, to assess how these needs are being met.

Findings – Both formal education and continuing development training are adapting to cover aspects of the digital library environment, both in the UK and in Slovenia. This is happening as part of the normal process of the redesign of degree programmes and of training courses. Digital library skills and knowledge – embodying conceptual, semantic, syntactic and technical aspects – are being included in existing courses, for the most part, rather than in entities labelled "digital library". This approach has strengths and also weaknesses. While there is some agreement on core topics, there is much variation in how they are presented, and in the relative importance given to them.

Research limitations/implications – Based on comparison of education and training programmes in two countries, the UK and Slovenia.

Practical implications – Recommendations for curricula are made.

Originality/value – Provides an insight into education and training needs in a developing and important area.

Keywords Digital libraries, Education and training, Professional education, International standards, United Kingdom, Slovenia

Paper type Literature review

Introduction

Library and information science has always been concerned with the collection, organization, storage and retrieval of materials and information, in order to respond to users' queries. It has also often been noted that new technologies for the generation, distribution, processing and storage of information have brought changes in the nature, volume, and format of that information. The digital library is only the most recent of these.

A question which arises is how these developments influence the demands that are made of information professionals and, consequently, what this means for their education. In order to be effective and efficient in their job:

> [T]oday's information professionals need to learn more about computerised information retrieval, but at the same time they need to learn the theory, tools and techniques behind the traditional approaches to organizing and processing information, much of which will be applicable in the storage and retrieval of electronic information in digital libraries (Chowdhury, 1999, pp. xv).

And, as Deegan and Tanner (2001, p. 225) point out:

> In developing skills for managing, creating and providing services in the digital environment, training and education will become ever more important. There will be increased need for educational organizations to inform students of the new realities and the new skills that they will need in the digital environment.

The skills and competences required for the digital library have been discussed by a number of authors, including Sreenivasulu (2000), Chandler (2001), Prytherch (2001), and Chowdhury and Chowdhury (2003). They are wide-ranging, including: creating search strategies; evaluating web sites; guiding and training users; integrating networked sources; analysing and interpreting information; creating metadata; imaging and digitising; designing interfaces and portals; project management; and many more.

The fact is that there are parts of the "traditional" library school's curriculum that are still very much relevant in today's fast changing computerized information world. The role of digital librarians may still be, as Marcum (2003, p. 276) puts it, "stewards of the world's intellectual and cultural heritages".

In this paper we try to identify these "perennial" topics, and to connect them to the contemporary issues and technologies, which should, in our opinion, be reflected in the education of information professionals, at present and in the future. The paper has two main aims:

(1) to identify – in general terms, rather than specifically – the important competencies required by information professionals in creating and managing digital libraries, and in facilitating their use; and

(2) to assess how these competencies are treated in LIS education and training, and therefore how the capacities of the information professions are being developed.

The digital library

Another current debate is that about the meaning of "digital library" itself. The term is used to denote a number of concepts and situations, and also has a number of more-or-less synonymous terms: electronic library, virtual library, library without walls, networked library, complex library, etc. (see, for example, Bawden and Rowlands 1999).

A useful pragmatic explanation of the term is that used by the UK's INSPIRAL project, which investigated the linking of virtual learning environments with digital libraries (http://inspiral.cdlr.strath.ac.uk):

> A digital library provides digital resources and services. The resources may be in various digital formats. The services are based on traditional library skills, enabling materials to be evaluated, organised, stored, retrieved and used. In some cases, preservation of special

collections and access to those collections is part of their remit. Unlike hybrid libraries, digital libraries are not dependent on any physical location, but they do provide a single online access point, and provide access to remote resources as well as to their own collection.

This explanation neatly encapsulates the link between skills required in the traditional, and the digital, library.

For the purposes of this paper, however, we will make use of a more complex two-part definition of a digital library, which is given in the material from a workshop on the social aspects of digital libraries (Borgman *et al.*, 1996):

> Digital libraries are a set of electronic resources and associated technical capabilities for creating, searching, and using information. In this sense, they are an extension and enhancement of information storage and retrieval systems that manipulate digital data in any medium (text, images, sounds; static or dynamic images) and exist in distributed networks. The content of digital libraries includes data, metadata that describe representation, creator, owner, reproduction rights, and metadata that consist of links or relationships to other data or metadata, whether internal or external to the digital library.

> Digital libraries are constructed – collected and organized – by [and for] a community of users, and their functional capabilities support the information needs and uses of that community. They are a component of communities in which individuals and groups interact with each other, using data, information, and knowledge resources and systems. In this sense they are an extension, enhancement, and integration of a variety of information institutions as physical places where resources are selected, collected, organized, preserved, and accessed in support of a user community. These information institutions include, among others, libraries, museums, archives, and schools, but digital libraries also extend and serve other community settings, including classrooms, offices, laboratories, homes and public spaces.

Such definitions are useful in grounding discussions of digital library issues see, for example, Chowdhury (2004, ch. 22), Borgman (2003), Marcum (2003), Bawden and Rowlands (1999), and Rowlands and Bawden (1999). They are used here as the basis for a discussion of the competences required by information professionals working in such environments.

The main differences between these and "traditional", or pre-digital libraries, as we see them (following Rowlands and Bawden 1999), are:

(1) *A change from ownership to access.* The library no longer only provides materials which it owns, besides this it provides access to digital networked resources beyond its physical location. This immediately brings with it the changed nature of the library as a physical setting. Also the librarian's competences change, including, besides the traditional competences (e.g. knowledge organization, metadata), the competences connected with the information and communication technology (e.g. knowledge about the structure and functioning of the computerized systems, like internet searching, techniques for evaluation of information, web pages design, etc.).

(2) *A change from known item access and physical browsing to search and navigation, both in collections and in individual items, and in the nature of the library as a "place".* Within the context of the digital library it is no longer possible to physically browse through a library collection or an individual book. This means that the librarian needs additional competences besides those connected with knowledge about the physical arrangement of library collection

and kinds of information resources (e.g. bibliographic aids). This requires competences about information retrieval systems, their structure, retrieval levels, commands and retrieval techniques, etc.

Different information resources can appear very similar due to the same interface (e.g. that of a browser), which has a "homogenising" effect. For a librarian it is important to help users to distinguish between different kinds of information resources, especially their functions and purposes. This is particularly so as new forms of resource – web rings, blogs etc. – appear.

As libraries become "more digital", it is also necessary to re-think the idea of the library as a place. Does the idea of a library imply a physical location if so, what is this used for? A store or archive? A quiet place for study and reflection? A stimulating place for creative innovation? There are many possible answers, and the best solutions still have to be worked out.

    (3) *Changing expectations of users.* These issues do not only concern end-users, but are also important from the librarian's point of view carrying with it the changes in the education process. In the past information systems were designed with the expectations that people would adapt to them. However, with the greater emphasis on user friendliness and usability it is no longer so. Borgman (2003, p. 89) says that the users have "higher expectations of information systems", that the systems should be easy to learn, use and relearn, as well as flexible in adapting to a more diverse user population.

User expectations have to be handled carefully. Many users will come to believe that "all information" is available to their PC, can be found through simple Google-like searching, and will always be up-to-date. It is important to convince them that it is worth looking for printed material, and for material available through specialised search systems. It is also necessary to be realistic: digital libraries are often better at providing metadata records, and location information, than at giving full-text of everything. This leads to the important role of the librarian as facilitator and helper; but the facilitation and help must be very realistic.

Borgman (2003) also emphasizes that digital libraries will never be as easy to use as automatic machines or one-purpose technologies, and that working with them effectively requires some learning. Complex cognitive tasks are involved in the work with them. On the one hand "workers, learners and users need to understand a variety of general computing concepts as well as concepts and skills specific to applications" (National Research Council, in Borgman, 2003, p. 99), and on the other there are skills connected with information needs and information seeking behaviour. These are strongly connected with problem solving behaviour which can be divided into four steps, i.e. the four cognitive processes initally identified by Polya (Borgman, 2003):

(1) Understanding the problem.

(2) Planning a solution.

(3) Carrying out the plan.

(4) Checking the results.

Planning a solution is the most complex of these processes, varying according to three factors: degree of problem definition; amount of expertise in the problem domain; and

knowledge about the resources and operations available to solve the problem. Depending on these features, users act as "novices" or "experts". The latter "use a combination of system features, often taking an iterative approach that tests multiple strategies for finding the information sought" (Borgman, 2003, p. 103). They show a sophisticated combination of knowledge and skills, which help them search effectively and efficiently. These techniques can be taught to novices, and can be, to an extent, incorporated into information systems as functions (e.g. pre-coded search tactics and pre-defined search limiters or expanders).

On the basis of these considerations, Borgman (1986, 1996) proposes a model for knowledge and skills the users and/or librarians will need. It includes:

- conceptual knowledge;
- semantic and syntactic knowledge; and
- technical skills.

Conceptual knowledge denotes the user's model or understanding of the type of digital library with which they are dealing. The conceptual knowledge of the search process is used for translating an information need into a plan for executing the search. The success of searching in digital libraries depends heavily on the user's ability to construct a mental model of the given information space (Dillon, 2000; Dillon and Gabbard, 1998).

In contrast with the conceptual knowledge which is used to plan and refine searches, semantic and syntactic knowledge is more concerned with details and with individual systems or applications. Semantic knowledge means knowledge of the operations available to execute a search plan. Shneiderman (1992) defines syntactic knowledge as the user's understanding of the commands or actions in a specific system. The expert user possesses the following semantic and syntactic knowledge:

- understanding of the general characteristics common to most information systems;
- understanding of the features characteristic for specific kinds of information systems; and
- ability to become familiar with the features of a new system, and then to adapt the search strategy to these features.

By "technical skills" it is meant those basic computer skills which are prerequisite for developing conceptual, syntactic, and semantic knowledge, within the context of a digital library. These skills include knowing how to use computer devices and being familiar with the digital conventions, e.g. screen display. It is important to be aware that the levels of these skills in the population are very diverse, and also that different applications and systems require very diverse levels of these skills. Borgman (2003, p. 109) states that "as digital libraries are designed for more general audiences, a broader range of skill levels will need to be accomodated in many applications".

Analysis of the programmes of formal and continuing education in Slovenia and in the UK

In order to assess how the knowledge and skills required for the digital library, as identified and categorised above, are currently encapsulated in LIS education and

training programmes, a comparative study was carried out. This compared the situation in the UK and in Slovenia[1], as represenative of a relatively large country with a long tradition of LIS education from a variety of providers, and a small and relatively newly independent country with a more limited range of provison. The study was based on a qualitative analysis of courses, in order to:

- analyse the contents of education and training offered in both countries;
- identify the digital library contents in the curricula; and
- derive from these the competences for the digital library in accordance with the Borgman three-part model of knowledge and skills.

This approach looks at what is currently provided, and provides a pragmatic counterpart to the long lists of potentially useful topics and skills mentioned by writers in this area.

Slovenia
We looked at the digital library skills and competences which are incorporated in the curriculum of the Department of Library and Information Science and Book Studies at the University of Ljubljana, and the CPD training courses offered by the National and University Library and the Institute of Information Sciences.

Formal education. In the area of formal education in LIS, the Department of Library and Information Science and Book Studies at the University of Ljubljana is the only institution providing this kind of education in Slovenia. Undergraduate education has had a relatively long tradition, in recent years being extended by postgraduate masters and doctoral studies. We identified seven undergraduate (Table I) and eight postgraduate courses (Table II) offering some digital library content.

Continuing education. Two institutions offer continuing education from the LIS field in Slovenia: the National and University Library in Ljubljana (NUK), and the Institute for Information Science at the University of Maribor (IZUM). They mostly offer one- to two-day courses dealing for the most part with conceptual and syntactic and semantic knowledge:

(1) *NUK.* Six courses were found to offer digital library content (Table III).
(2) *IZUM.* Among the courses four have digital library content (Table IV).

Discussion. Conceptual knowledge is mostly present in the contents of the introductory courses which are aimed at acquiring and shaping the model of the digital library. This kind of knowledge enables the development of competences connected with the planning and refining the use of the digital library, i.e. information problem shaping, and planning and refining the search process.

In the courses where conceptual knowledge has been introduced, it is then possible to extend it to semantic and syntactic knowledge. This means the development of competences for understanding the operations and commands, or actions, to execute a search plan in specific digital library environments.

To be able to achieve this, specific technical skills are taught, e.g. use of keyboard/mouse and other hardware devices, and use of basic computer applications, such as operating system and word-processing and spreadsheet software packages. It should be mentioned that these skills are mostly acquired prior to entering the faculty, therefore not much emphasis is given to them in the curriculum. They are taught only in the first year of undergraduate study.

Year	Course	Content	Knowledge/skills
1	Information technology	Basic computer skills	Technical skills
		Introduction to digital materials	Conceptual knowledge
	Introduction to information science	Introduction to information sources	Conceptual knowledge
		Introduction to information as a phenomenon	Conceptual knowledge
2	Library automation	Use of computer as a support to library operations	Semantic and syntactic knowledge
	Databases 1	Introduction to e-information sources	Conceptual knowledge
		IR techniques	Semantic and syntactic knowledge
3	Special libraries	Presentations of certain e-information sources	Conceptual knowledge
	Databases 2	Introduction to networked information sources	Conceptual knowledge
		Practical application of e-information sources	Semantic and syntactic knowledge
4	Computer communications	Structure and operation of computer networks	Conceptual, semantic and syntactic knowledge

Table I.
Ljubljana University,
undergraduate modules

Courses	Content	Knowledge/skills
Organization of information	Organization and sorting of information with the purpose to increase accessibility	Conceptual knowledge
Theory of information sources and services	Typology of information sources and their practical use	Conceptual, semantic and syntactic knowledge
Theory of information Databases, data structures and basic programming	Information as a phenomenon	Conceptual knowledge
	Organization of data	Conceptual knowledge
	Search techniques in various databases	Semantic and syntactic knowledge
	Basics of programming	Semantic and syntactic knowledge
Database design	Introduction to the process of the creation of databases	Conceptual, semantic and syntactic knowledge
Visual information in digital libraries	Presentation, organization and protection of image data, digital video recordings	Conceptual knowledge
	Retrieval of digital visual materials	Semantic and syntactic knowledge
Information retrieval systems	Sorts of systems	Conceptual knowledge
	Process of systems design	Semantic and syntactic knowledge
Digital libraries	Collections of e-sources and technologies for creation, searching and use of this information	Conceptual, semantic and syntactic knowledge

Table II.
Ljubljana University, postgraduate modules

In postgraduate study, all three kinds of knowledge and skills are present throughout most courses. This requires more complex competences necessary for planning and refining of the retrieval process, and for executing this plan. In addition, postgraduate study also incorporates the development of complex competences for some aspects of the creation of information sources.

In the continuing development area, courses were found to cover conceptual, semantic and syntactic knowledge, but within specific areas, dealing either with a narrow segment of information sources and developing specific competences within these (e.g. use of e-journals or OPAC), or dealing with specific technical skills in connection with the use of computers (e.g. the ECDL course). The continuing education programmes develop specific competences which may not have been emphasized enough in the formal education programmes.

UK
LIS education in the UK is provided on a larger scale than in Slovenia, and a similarly exhaustive study was not possible. A total of 16 undergraduate and 47 postgraduate programmes in 18 universities are accredited by CILIP, the UK's professional LIS professional organisation. Postgraduate course provision at two universities – City University London, and Sheffield University – was examined in detail, while a confirmatory study was carried out from the web sites of other institutions. The

Course	Content	Knowledge/skills
Design and use of information collections and sources	Information sources awareness, use and evaluation for information work	Conceptual, semantic and syntactic knowledge
ECDL course	Basic and specific computer skills	Technical skills
Characteristics and use of e-sources	Identification, description and basic use of e-sources	Conceptual, semantic and syntactic knowledge
Use of internet information sources	Independent searching, evaluation and use of internet information sources	Conceptual, semantic and syntactic knowledge
OPAC	Independent retrieval in OPAC used in Slovenia (COBISS/OPAC)	Semantic and syntactic knowledge
E-journals and libraries	Characteristics of e-journals, their evaluation and use	Conceptual, semantic and syntactic knowledge

Table III.
Ljubljana NUK, CPD
courses

Course	Content	Knowledge/skills
COBISS/OPAC	Introduction to databases included in the COBISS/OPAC, and their use.	Conceptual, semantic and syntactic knowledge
Use of full-text databases	Introduction to full-text databases, and their use	Conceptual, semantic and syntactic knowledge
Use of Web of Science service	Introduction to Web of Science databases (citation indexes), and their use	Conceptual, semantic and syntactic knowledge
Advanced searching in segments COBISS/OPAC and COBISS2/cataloguing	Advanced IR techniques	Semantic and syntactic knowledge

continuing professional development (CPD) programmes of the three leading UK providers – Aslib, TFPL and CILIP – were also examined.

Formal education. Postgraduate courses are a more common route into the LIS profession in the UK than are undergraduate courses, and these were examined for the PG library courses offered at two universities, City University London and Sheffield University. Presented in the same way as for the Slovenian case, those courses (referred to as "modules" in the UK context) with particular relevance to digital libraries are shown in Tables V and VI.

It will be seen that conceptual aspects of digital libraries enter into several courses; technical skills are covered in a basic IT course. A specific "digital libraries" course will be introduced as part of a general redesign of City University's postgraduate programmes in 2004-2005.

Again, conceptual aspects of digital libraries enter several courses.

This picture is confirmed by a less-detailed examination of other UK library courses. No department offers a programme in digital libraries as such, although there are some in related areas, such as "Networked Information Management" at the University of Central England.

All offer courses in topics such as library management, metadata and knowledge organisation, information retrieval etc., which have clear relevance to the digital library, and all offer some form of basic IT skills training, which may be extended into areas such as information architecture and web-based systems.

It is worth noting that programmes other than strictly library-related ones may fit graduates for roles in digital libraries – examples would be Information Systems, Information Management, and Electronic Publishing – but these have not been examined here.

Continuing education. LIS continuing education in the UK is provided by three main providers: Aslib, TFPL and CILIP. All these are one-day or two-day courses, including conceptual, syntactic and semantic aspects, but not usually technical skills. Analysis of their current training programmes shows that none offer any course specfically devoted to digital libraries, but all offer some relevant courses, as follows:

(1) *Aslib*:
   · Organising digital information and knowledge;
   · Metadata;

Principles of knowledge organisation	Organization and sorting of information with the purpose to increase accessibility. Metadata	Conceptual knowledge
Information resources and users	Typology of information sources, including new types of source, and their use	Conceptual, semantic and syntactic knowledge
Libraries, past present future	Types of library and library services, including digital libraries	Conceptual knowledge
Data representation and management	IT basics	Conceptual knowledge
	Organization and manipulation of data. Web-based information	Semantic and syntactic knowledge
		Technical skills
Information law and policy	Aspects of law and policy affecting digital material specifically	Conceptual knowledge
Information retrieval systems	Sorts of systems	Conceptual knowledge
	Effective retrieval techniques	
Semantic and syntactic knowledge		

Table V.
City University London,
postgraduate modules

Academic and research libraries	Includes integration of digital resources, copyright etc.	Conceptual knowledge
Access to information resources	Typology of information sources, including electronic sources, and their use	Conceptual, semantic and syntactic knowledge
Collection management	Includes digitisation and electronic resources	Conceptual knowledge
Practical computing	IT basics. Organisation and manipulation of data. Web-based information	Conceptual knowledge Semantic and syntactic knowledge Technical skills
Libraries, information and society	Aspects of librarianship, including digital libraries	Conceptual knowledge
Information searching and retrieval	Sorts of systems. Effective retrieval techniques. Metadata	Conceptual knowledge Semantic and syntactic knowledge

Table VI.
Sheffield University,
postgraduate modules

- Virtual learning environments and library/information services;
- Electronic serials management;
- Metadata;
- Information literacy;
- Strategic approach to internet research; and
- Intricacies of internet search tools;

(2) *TFPL*:
- Information architecture;
- Internet searching; and
- Library portals;

(3) *CILIP*:
- Metadata.

It is worth noting that several of these courses are new in 2003-2004, and that, for example, Aslib's "Metadata" and "Organising Digital Information and Knowledge" courses have proved so popular that extra sessions have been arranged. This is an example of how a CPD provider can react quickly to meet a new need.

Conclusions and recommendations

We have seen that both formal education and continuing development training is adapting to cover aspects of the digital library environment, both in the UK and in Slovenia. This is happening as part of the normal process of the redesign of degree programmes and of training courses. Digital library skills and knowledge – embodying conceptual, semantic, syntactic and technical aspects – are being "embedded" in existing courses, for the most part, rather than in entities labelled "digital library".

In some ways this can be seen as a strength. It allows for a gradual and incremental development to meet new needs, and avoids the danger that relevant "traditional" skills and perspectives will be ignored.

Conversely, it may lead to a piecemeal and partial approach, which may mean that some courses – and hence some students and participants – will fail to gain an overall appreciation of the topic, and may lack some essential competencies and capacities. The "overall appreciation" aspect is perhaps most important, since it is virtually impossible to cover all of the relevant skills and competencies within any one course. While it is clear that there is considerable overlap and convergence between the courses examined here, there is also considerable divergence, which may neither be planned nor positive.

It seems clear that there is general agreement that certain general topics are of importance: typology of resources and domain analysis; computer/network literacy and retrieval skills; analysis of information; user characteristics and behaviour; consciousness raising and information literacy; new forms of metadata; etc. But there is considerable scope for choosing which of these to focus on, and how to present them. While it is not desirable to recommend, still less impose, a closely-defined curriculum, some guidance might be helpful.

One useful contribution could be for a generally agreed template or checklist of topics and competencies for the digital library to be drawn up, as a way of consolidating the several lists which have been published. This might best be done by national professional bodies, who might be expected to be able to adapt general principles to their local situation. More broadly, it might be a task for an international body such as EUCLID (the European Association for Library and Information Education and Research).

Note

1. Based on a paper presented at Libraries in the Digital Age (LIDA) 2004 (Bawden, 2004).

References

Bawden, D. and Rowlands, I. (1999), "Digital libraries: assumptions and concepts", *Libri*, Vol. 49 No. 4, pp. 181-91.

Bawden, D., Vilar, P. and Zabukovec, V. (2004), "Competences and capacities for the digital library", paper presented at Libraries in the Digital Age (LIDA) 2004, Dubrovnik, 26 May.

Borgman, C.L. (1986), "Why are online catalogs hard to use? Lessons learned from information retrieval studies", *Journal of the American Society for Information Science*, Vol. 37 No. 6, pp. 387-400.

Borgman, C.L. (1996), "Why are online catalogs still hard to use?", *Journal of the American Society for Information Science*, Vol. 47 No. 7, pp. 493-503.

Borgman, C.L. (2003), "Designing digital libraries for usability", in Bishop, A.P., Van House, N.A. and Buttenfield, B.P. (Eds), *Digital Library Use: Social Practice and Evaluation*, MIT Press, Cambridge, pp. 85-118.

Borgman, C.L., Bates, M.J., Cloonan, M.V., Efthimoadis, E.N., Gilliland-Swetland, A.J., Kafai, Y.B., Leazer, G.H. and Maddox, A.B. (1996), "Social aspects of digital libraries", available at: http://dlis.gseis.ucla.edu/DL/UCLA_DL_Report.html (accessed 26 November 2003).

Chandler, Y.J. (2001), "Reference in library and information science education", *Library Trends*, Vol. 50 No. 2, pp. 245-62.

Chowdhury, G.G. (1999), *Introduction to Modern Information Retrieval*, Library Association, London.

Chowdhury, G.G. (2004), *Introduction to Modern Information Retrieval*, 2nd ed., Facet Publishing, London.

Chowdhury, G.G. and Chowdhury, S. (2003), *Introduction to Digital Libraries*, Facet Publishing, London.

Deegan, M. and Tanner, S. (2001), "Digital librarians: new roles for the information age", in Deegan, M. and Tanner, S. (Eds), *Digital Futures: Strategies for the Information Age*, Chapter 9, Library Association Publishing, London, p. 9.

Dillon, A. (2000), "Spatial-semantics: how individual users perceive shape in information space", *Journal of the American Society for Information Science*, Vol. 51 No. 6, pp. 521-8.

Dillon, A. and Gabbard, R. (1998), "Hypermedia as an educational technology: a review of the quantitative research literature on learner comprehension, control and style", *Review of Educational Research*, Vol. 68 No. 3, pp. 322-49.

Marcum, D. (2003), "Requirements for the future digital library", *Journal of Academic Librarianship*, Vol. 29 No. 5, pp. 276-9.

Prytherch, R. (2001), "Digital library skills", *Information Management Report*, Vol. 29 No. 5, p. 104.

Rowlands, I. and Bawden, D. (1999), "Digital Libraries: a conceptual framework", *Libri*, Vol. 49 No. 4, pp. 192-202.

Shniderman, B. (1992), *Designing the User Interface: Strategies for Effective Human-Computer Interaction*, 2nd ed., Addison-Wesley, Reading, MA.

Sreenivasulu, V. (2000), "The role of a digital librarian in the management of digital information systems", *Electronic Library*, Vol. 18 No. 1, pp. 12-20.