



Contents lists available at ScienceDirect

Computers & Education

journal homepage: www.elsevier.com/locate/compedu

Assessing effects of information architecture of digital libraries on supporting E-learning: A case study on the Digital Library of Nature & Culture



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ARTICLE INFO

Article history:

Received 3 January 2013

Received in revised form

5 February 2014

Accepted 6 February 2014

Available online 20 February 2014

Keywords:

Human–computer interface

Interactive learning environments

Teaching/learning strategies

Architectures for educational technology system

ABSTRACT

Modern digital libraries not only contain rich digital resources, they are also required to provide an environment which integrates collection provision, information services, and academic activities to support effective learning. This work chose the Digital Library of Nature and Culture established by the National Museum of Natural Science in Taiwan to investigate whether the design of the information architecture of a digital library influences learning performance and whether learners with different learning styles have different information usage behaviors and learning performance when they use the digital library to support e-learning. This work suggested that e-learning supported by a digital library resulted in excellent learning performance. Regarding the influence of information architecture on learning performance, this work found that the organization system was crucial to learning performance. Further, learners with different learning performance exhibit different behaviors when they use the information architecture of the digital library. Another finding was that the learning performance of global learners was better than that of sequential learners. Global learners and those learners with superior learning performance relied more heavily on the organization system, while sequential learners and those learners with inferior learning performance relied more heavily on the search system.

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1. Introduction

Present digital libraries not only digitize resources, they also offer integrated environments with collections, information services, and academic activities for preserving knowledge and effectively supporting learning. Lynch and Garcia-Molina (1995) regarded digital libraries as electronic information access systems that provide organizational, selective, and well-managed information. The information architecture of digital libraries is clearly superior to that of general Internet resources because digital libraries contain well-planned metadata and expert-confirmed digital archives. In terms of e-learning and instructions, digital libraries provide quality learning resources that effectively support e-learning and present tremendous potential for use in developing instructional applications (Fuchs, Muscogiuri, Niederée, & Hemmje, 2004). Currently, there have been several examples of digital library-supported e-learning. For example, the website of National Science Digital Library (NSDL) (<http://nsdl.org/>) in the USA contains a series of science-related teaching materials for teachers utilizing through the Internet and for students proceeding autonomous learning. Moreover, the Digital Library for Earth System Education (DLESE) (<http://www.dlese.org/library/index.jsp>) established by NSDL contains earth science materials compiled by a group of educators, students, and scientists aiming to improve the teaching and learning quality of earth science for learners in different levels, and offers high-quality educational resources and archives for instructors (Arko, Ginger, Kastens, & Weatherley, 2006). Additionally, the Chemical Education Digital Library (ChemEd DL) (<http://www.chemeddl.org>), a sub-project supported by National Science Foundation, collects the interactive resources between teaching and learning in chemistry with which learners could rapidly acquire the learning resources marked by the teachers through online searching and browsing. The British Library (<http://www.bl.uk/>) also provides e-learning websites with rich digital

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resource collections for students, teachers, and lifelong learners. The website presently contains thousands of digital resources, images, voices, and maps for use as teaching materials (Brindley, 2005). Additionally, the Taiwan Ministry of Education developed the Digital Education and E-learning – Integrating Digital Archives into Instructions (<http://idatp.moe.edu.tw/index.aspx>) to support the use of digital archives in the curricula of elementary and junior high schools, providing teachers with teaching resources, and enhancing the teaching quality for exquisite instruction. Apparently, digital library-supported e-learning has been gradually emphasized. However, e-learning is still in the stage of developing and providing supporting learning materials. The design of information architectures for digital libraries that support e-learning and models for effective learning have been neglected.

To explore how digital libraries effectively support e-learning and enhance learning performance, the interaction between learners and digital libraries during the learning process must be clearly understood. Digital libraries should present quality information organization and strong information retrieval systems for the convenience of learners when they search and browse digital collections to gain knowledge through reading and learning. Nevertheless, for any digital library, designing an information architecture that effectively supports learning is very challenging (Chen & Chen, 2010). Arms, Blanchi, and Overly (1997) therefore proposed to organize digital libraries so as to confirm the users' demands and to design organization system, labeling system, navigation system, and search system with the concept of information architecture for learners searching and retrieving information. Dong and Agogino (2001) also argued that well-organized information can help learners create, integrate, and manipulate knowledge rather than simply accepting knowledge passively. Beiers (2000) considered the conformity of information architecture to learner demands and the provision of a user-friendly environment for learners concentrating on specific subjects to minimize obstacles to the use of information. Moreover, personal information management (PIM) refers to user activities related to acquiring, organizing, retrieving, and processing information in their personal information spaces (Indratmo & Vassileva, 2008). Studies of practical PIM for well-organized information systems provide insight into how information organization affects individual human life. This aspect also has positive impacts on the information architecture of digital libraries, particularly when designing appropriate organization systems for individual users. As a result, the information architecture of digital libraries is a primary concern for learners, and the excellence and integrity of the information architecture should be considered when designing digital libraries so as to meet learner demands and to enable digital libraries to provide high-quality digital resources.

Based on the above research background and our literature review, this work found that studies of e-learning support in digital libraries are still insufficient; most focus on evaluating the usability of digital libraries rather on whether they effectively support learning. To fill the research gap, the first research dimension in this work examined the effectiveness and usage behavior of digital libraries for assisting learning from the perspective of the information architecture of digital libraries (i.e., organization systems, navigation systems, and search systems). In addition to discussing the effects of the information architecture of digital libraries on learning performance, this study also investigated how the personal traits of learners affect learning performance. Keefe (1979) discussed the effects of learning styles on learning performance, including the interacting effects of cognition, emotion, and psychological behaviors in learning environments. Moreover, Felder and Silverman (1988) proposed that learning styles depend on how learners receive and deal with information and indicated that learning retardation was likely to appear when not offering learners with the preferred learning styles. In this case, the design of information architecture for digital library-supported e-learning should also provide suitable support and services to accommodate individual differences in learning styles. Therefore, from the perspective of information architecture in digital libraries, the second research dimension in this work was to compare information usage behaviors and learning performance in learners with different learning styles and learning proficiency levels in the context of e-learning with digital library support. Finally, the third research dimension in this work was to examine whether significant behavioral transfers occur in learners with different learning styles and learning proficiency levels in the context of e-learning with digital library support.

2. Literature review

2.1. Digital library-supported e-learning

The rapid development of information and communication technologies as well as the demand for improvements in conventional instruction modes have gradually led to changes in teaching and learning methods. Libraries have a long history of use for assisting learning and have at least three roles in supporting learning (Marchionini & Maurer, 1995), including physically sharing rich and valuable resources, preserving and organizing antiques and thoughts culturally, and gathering people and thoughts socially and intellectually. Compared to conventional libraries, digital libraries provide users with more opportunities for information access and informal learning so that knowledge could be conveniently obtained by autonomous learning. Through digital libraries, learners do not acquire knowledge by instruction from teachers. Rather, they ubiquitously absorb new knowledge through the rich archives in digital libraries. This leads to an ambiguous boundary between teaching and learning. Therefore, conventional libraries began providing virtual or digital support for e-learning and began providing learners with customized services and resources (Sharifabadi, 2006). To address these changes, Sharifabadi (2006) proposed that digital libraries should reconsider how to develop, manage, and deliver digital resources for effectively supporting e-learning. Kovel-Jarboe (2001) also claimed that digital libraries should develop e-learning environments and innovative methods for enhancing teaching and learning experiences.

Kuhlthau (1997) pointed out that the main advantage of learning supported by digital libraries is to provide a convenient learning environment where learners can identify relevant and useful resources, organize information, and solve problems by using the abundant resources in digital libraries. An effective digital library should also support knowledge construction by users and self-learning. Lee (2001) concluded that the benefits of digital library-supported e-learning include improving proficiency, increasing comprehensive education resources, and providing students and educators with easy access to digital library resources. Sumner and Marlino (2004) proposed that digital libraries can be considered cognitive tools for supporting learning and sense-making activities so that users can self-learn and self-construct knowledge with the support of rich digital resources in digital libraries. They also argued that digital libraries are component repositories that provide rich digital resources for educators and learners and they enable course designers to construct new teaching materials by reallocating the digital resources in digital libraries. The authors also suggested that digital libraries are knowledge networks that support users in constructing and sharing knowledge through interaction.

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