

CHAPTER 3

EDUCATION USING DIGITAL LIBRARIES

Jerry M. Mendel

INTRODUCTION

Is there any one among us today who does not believe that education and learning are lifelong pursuits? As one of our hosts in Japan commented “They [education and learning] will be the huge market for digital libraries when distributed digital libraries and information work technologies are available to content creators.” Distributed digital libraries also have the potential to revolutionize education and learning, so there is a healthy symbiotic relationship among education and learning and digital libraries, a relationship that is in its infancy.

Upon returning to the United States, after visiting Japan as a member of the WTEC panel, this author undertook a modest literature search to learn more about U.S. efforts in education using digital libraries. It was found that a lot is happening in the United States, whereas, based on the panel’s trip to Japan, it seems that not as much is happening there. This chapter first reviews what is happening in education using digital libraries in the United States, after which the same is done for Japan. The chapter then draws some conclusions.

EDUCATION USING DIGITAL LIBRARIES IN THE UNITED STATES

This section summarizes what was found in the literature search, and in discussions with some educators at the University of Southern California, by answering the following questions:

1. What are the roles that digital libraries can play in education?
2. What are some unique characteristics of online materials and some important reasons for excitement about digital libraries and education?
3. Will digital libraries mean education and learning as usual; or, can digital libraries change the ways in which people are educated?
4. Are there fundamental questions regarding guidelines and design standards for teaching and learning materials to support inquiry using digital libraries, or through other online resources?
5. What are the technical problems that need to be overcome to make education using digital libraries a reality?
6. Are there any cautionary messages?

While some would argue that the Web is not equivalent to digital libraries, it is generally agreed that the Web is and will be the deliverer of digital libraries to people; hence, at some point the distinction between digital libraries and the Web blurs. This is especially true when the definition of digital libraries is broadened to

include digitized materials not found in any “conventional” library, e.g., NASA’s remote sensing records, student-generated articles that result from using already-existing digital libraries, etc. Hence, some of the following comments are taken from articles that focus a lot on the Web and digital libraries.

What Are the Roles That Digital Libraries Can Play In Education?

There seems to be general agreement that digital libraries can play three roles in education (e.g., Masullo and Mack 1996):

- as a resource for teaching (curriculum development)
- as an environment for learning (student experience)
- as an authoring space (again, in support of student experience)

What Are Some Unique Characteristics Of Online Materials and Some Important Reasons for Excitement About Digital Libraries and Education?

The University of Michigan Digital Library Web page (UMDL n.d.) and Wallace, et al. (1996) succinctly summarize the following six important features of digital libraries that make them significantly different from traditional libraries in ways which support student learners:

- content is current
- content can be from primary resources
- content is comprehensive
- resources are presented in various formats
- student can publish them online
- content is readily accessible

To this list can be added re-use of teaching resources. This is the feature being focused on by the EduPort project, whose goal is to support re-use of teaching resources by reflecting teachers’ experiences with materials acquired from digital libraries (Masullo and Mack 1996). Masullo and Mack maintain that “real value added comes from reuse. Teachers do excellent work of bridging materials to create rich learning experiences. It is very difficult, however, to share the results with other teachers, and only a handful of students receive the benefits of unique exemplary teaching in each case. Opened and networked digital libraries offer that opportunity.”

Hoadley and Bell (1996) maintain that “... structuring Web pages based on ‘content’ (through keywords or topics) and ‘context’ (e.g., social group who produced it, discussion that gave rise to the ideas) may prove to be one of the most important features digital libraries could afford. Currently, traditional libraries and social networks coexist, but are not the same, intersecting primarily through authors’ names. In the future, these information networks and social networks may be more deeply integrated, allowing us not only to follow our favorite author, but trace works that have influenced him or her, institutions that an individual participates in, and so on.”

Edelson and Gordin (1996) mention that “NASA ... has a number of ongoing efforts to make their extensive online databases of remote sensing data into a valuable resource available to education at all levels.” They then ask the question, “*Why would [this] be good for education?*” Their answer includes:

- “Students could investigate authentic scientific questions using real, complex data.
- Students would have the opportunity to study their world in order to explore policy options.
- The activities that these resources support could help students to develop a view of science as inquiry unlike more conventional classroom activities.

- Resources such as this can provide students with a common ground that links them to the community of practicing scientists.”

According to Edelson and Gordin, the “goal ... of the adaptation of expert resources for learners is: *Take resources that enable experts to extend their knowledge and turn them into resources that enable learners to develop some of the knowledge possessed by experts by performing personally meaningful tasks.*”

So we see there are many reasons to be excited about the interplay between digital libraries and education.

Will Digital Libraries Mean Education and Learning as Usual; or, Can Digital Libraries Change the Ways in Which People are Educated?

The National Research Council’s 1996 report, *National Science Education Standards*, states that “Inquiry into authentic questions generated from student experiences is [should be] the central strategy for teaching science.” Constructivists (Honbein 1996) maintain that this should be the basis for teaching just about everything. Wallace et al. (1996) state: “Digital libraries offer a unique and unprecedented resource through which teachers can facilitate student inquiry.” In the recent National Research Council publication quoted above, “... emphasis on inquiry is pervasive. Yet, when it comes to textbooks and curricula as they exist today, the clear emphasis is on learning science content disconnected from experience. Although digital libraries can’t change pedagogy or textbooks, they can make it possible for students to have access to scientific information and data which interests them, a fundamental requirement for authentic inquiry. Digital libraries can provide teachers with a feasible way to let students pursue their own interests within the bounds of the curriculum and without creating an enormous amount of extra work in providing students with materials to support their investigations.”

The Wallace article explores the ways in which digital libraries can support inquiry learning. It concludes “... in themselves, digital libraries will not make a change in education without changes in the tasks students are asked to perform and in the support provided to students and teachers.” The UMDL Web page (UMDL n.d.) also claims that online inquiry materials may also share the following important learning characteristics with inquiry based materials: authentic questions (i.e., the questions must be meaningful and important to the student for learning), flexible questions, and open-ended and divergent answers.

Soloway (1996) mentions that as of 1996, the National Research Council’s new standards for science education resonate with those recently put forth by the American Association for the Advancement of Science, namely: “the emphasis in science classrooms needs to be on inquiry, rather than on didactic instruction and memorization; rather than being exposed to a broad range of content materials, students need to pursue a few science topics in depth.” He then goes on to say that “... the still evolving concept of a *digital library* may well be the missing piece [for accomplishing this], bringing networked collections of digital resources (e.g., primary sources, current information, multimedia formats) together within a coherent and accessible framework. Still further, unlike their physical cousins, *digital* libraries afford students the highly motivating opportunity to publish their findings for all to review.”

Although a lot of research into how digital libraries can be used in education is directed at science, there is also a substantial effort directed towards the humanities. Tally (1996) states that “the Library [of Congress] has asked [the] CCT [Center for Children and Technology] researchers and curriculum designers to help them understand what roles these kinds of online resources can play in history and social studies classrooms, and what kinds of support teachers and students need to use them well.” He notes that “On-line historical archives invite teachers and students to confront new kinds of materials, new perspectives on historical events, and a new need for historical context. Ultimately, using these resources to advance a more dynamic, inquiry-based approach to history teaching and learning will require creative teachers to collaborate with each other—perhaps using the Web itself—and share lesson plans, teaching approaches, and assessment methods.”

Humanities Web sites have been collected (<http://edsitement.neh.fed.us>) on “Top Humanities Web sites,” where they are cataloged under four categories: literature, art history, foreign language, and history. Many of the Web sites that appear under each category are cross-listed in two or more categories. History, for example, had a list of 16 Web sites as of April 15, 1998, including one called *The Digital Classroom*,

established by the National Archives and Records Administration (NARA). Its stated purpose is “to encourage teachers of students at all levels to use archival documents in the classroom.” It “... provides materials from NARA, methods for teaching with primary sources, and sample lesson plans.”

Are There Fundamental Questions Regarding Guidelines and Design Standards for Teaching and Learning Materials to Support Inquiry Using Digital Libraries, or Through Other Online Resources?

According to the UMDC Web site “The University of Michigan Digital Library (UMDL) Project provides guidelines and design standards for teaching and learning materials to support science inquiry through on-line resources.” (For additional discussions on the UMDL approaches to inquiry-based learning see Atkins et al. 1996). Although their work seems directed at public schools and public libraries, and science education, they raise questions that are so fundamental that this author believes they are applicable to all levels and types of education (K-12, higher education, and continuing education) and all types of libraries. The questions are grouped into four categories: structure of the online materials, student learning, teacher use, and implementation issues. Because of the fundamental nature of these questions, they are repeated, slightly modified, here (as given in UDML n.d.). In some of the questions parentheses have been added around the word “science.” Doing this does not seem to change the fundamental nature of these questions.

Structure of the Online Materials

Digital resources provide students with unprecedented access to information, but unstructured material may result in information overload; hence, these questions must be considered:

1. How are the large amounts of information structured in the digital library in order for students to take the most advantage of it?
2. How can information searching be embedded as part of a learning environment to promote inquiry?
3. What kind of information is best represented in various media?
4. How do the media complement each other to help students learn?
5. What are the types of scaffolding that are most appropriate for digital library technology?
6. What are the issues in developing interfaces that implement such scaffolding strategies?
7. When should scaffolding be folded as student expertise in using the digital library increases?
8. How does one avoid the exponential learning curve typical of technology?
9. Because the digital library will be used as an integral part of classroom activities, what scaffolds are needed to make this use effective?
10. How are students enabled to publish their own documents in the digital library and share them with others?

Student Learning

One needs to study carefully the influence of using the digital library on student learning; hence, the following questions:

11. Does the use of online teaching materials help students develop deep understanding of (science) content and process?
12. What understanding of (science) concepts do students develop by using the digital library?
13. How does student motivation toward learning (science) change by using the digital library?
14. How does student thoughtfulness change by using the digital library?
15. How do students use online learning materials?
16. What types of artifacts are created and published on a digital library?

17. What types of interactions occur as a result of online publishing and what types of changes result?

Teacher Use

The use of digital resources has the potential to change classroom practice and the way in which teachers go about the practice of teaching; hence, the following questions:

18. How do teachers use online teaching and learning materials?
19. How do teachers make use of the various media and different parts of the digital library?
20. How does the digital library influence practice?
21. How can online inquiry be embedded as part of inquiry-based learning?
22. How does the use of online projects impact teaching?

Implementation Issues

Although the use of digital resources has the potential to change classrooms, past experience and research has shown that just giving teachers access to the materials or telling them how to use them is not enough. Teachers, too, need to be active learners in the process; hence, the following questions:

23. What initial supports do teachers need to use online resources?
24. What continued support is necessary for teachers to effectively use online materials?
25. What types of hardware configurations allow for effective use of online resources?

Again, these 25 questions have been taken from UMDL Web page (n.d.).

What are the Technical Problems that Need to be Overcome to Make Education Using Digital Libraries a Reality?

According to Masullo and Mack (1996), "... key problems are capturing ... material in digital form (e.g., digitized videos, scanned text, descriptions of videos and images), organizing it so it can be found, and developing some level of tools for re-using this material in new pedagogically relevant ways." Wallace et al. (1996) note that, "Current search engines and Web browsing software are not adequate for learning environments. Web browsers encourage breadth-first searches, and are often extremely frustrating for students." Tally (1996) states that "The most commonly discussed challenges of teaching with online resources are practical—access to good quality information, speed of downloading, the time necessary to find and make good classroom use of the material. All of these hurdles must be faced with electronic primary source archives."

Other chapters in this report focus on all these technical issues, but do so outside of the context of what is probably the most important application for digital libraries: education. Education has its own special needs, as captured by the 25 UMDL questions just given. Technical solutions for scanning texts, describing videos and images, etc., must therefore be driven by educational requirements.

Edelson and Gordin (1996) state that "The value of digital libraries is in the authentic activities that they can allow learners to engage in... To capitalize on their potential, these digital libraries need to be made accessible for learners through a variety of *bridging strategies*. ... supportive interfaces, activities design, resource selection and organization, and documentation ... designed to provide learners with enough of the hidden context and knowledge that experts bring to their tasks to enable students to use the digital resources as learning resources. These bridges require additional effort above and beyond the construction of experts' digital libraries, but they take the form of value-added support that leverages the initial investment. The addition of these bridges can transform these resources into invaluable resources for education, and can make digital libraries a common ground that provides a meaningful link between scientific researchers or other expert practitioners and the educational community. Creating such a common ground will increase the likelihood that the graduates of our educational system will be prepared to make sound decisions informed by results from the scientific community. ... The key to adapting digital libraries designed for experts is creating

a *bridge* between the learner's goals, abilities, and knowledge, and the requirements for productive use of the digital resources." Once again, the problems seem to involve a strong interplay between technology and education.

Any Cautionary Messages?

Wallace, et al. (1996) caution against using the digital libraries to answer very specific questions, because students become frustrated sifting through lots of material looking for a single piece of information; these can be answered more easily using an encyclopedia.

As an aside about encyclopedias, some are already available either online or in CD-ROMs, and incorporate text, audio, graphics and video. They serve a very useful purpose, in that they present "knowledge" as distinct from "information." They also come in different varieties for different age groups. Their possible drawback is that some group has made the decision about what is knowledge versus what is information, and the group's extracted knowledge may very well be presented from its biases or those of the publisher of the digital encyclopedia.

Digital libraries may someday contain source materials from which anyone could create a digital encyclopedia, although this may not be very practical. What may be more practical is for the companies that already have a digital encyclopedia to tap into the vast resources of digital libraries, making their existing products even better, by including links into television sound-bytes, news reports, journal articles, etc.

Hoadley and Bell (1996) note that "Multimedia representations did not lead students to cite more 'correct' scientific ideas, although it did encourage them to cite more ideas in general, which can be helpful in encouraging a group of students to brainstorm and consider alternative explanations for phenomenon."

No doubt, there are other cautionary messages that can be found in the literature, but the search performed did not find them. Certainly, one of the most important considerations is one already mentioned in Chapter 2 of this report by Raj Reddy: authenticity/veracity of material found on the Web.

EDUCATION USING DIGITAL LIBRARIES IN JAPAN

The panel did not meet with any Japanese K-12 educators, nor did it meet with any faculty from schools of education at Japanese universities. Also, no Japanese Web pages were checked to see if there are online journals comparable to *D-Lib Magazine*. Even if there were such journals, this author would not have been able to read them, since he does not read Japanese. So the reader of this chapter must take the comments made below, regarding the state of Japanese education and digital libraries, as perceptions of that state, perceptions gleaned from speaking with a very small number of people in Japan. To get a more thorough sense of education using digital libraries in Japan would require focusing on Japanese educators, either through another visit, or by collaboration with the most knowledgeable ones. In short, more work needs to be done.

In Japan the emphasis today appears to be in getting content online, with the main emphasis on rare books and manuscripts, theses and journal articles. University-level educational research is and will be possible, because university libraries will be the repositories of this information. Until sharing across digital libraries is possible, it is not likely that there will even be such research across universities. In the United States the concept of sharing is agreed upon; in Japan, it does not seem to be.

In the United States, there is also a big recognition of the interplay between education and the digital library. That same recognition does not appear to be so prevalent in Japan. Digital libraries do not appear to be making an impact in K-12 education. The Ministry of Education (MIE) is providing resources so that every elementary and middle school will have 20 computers, and every high school will have 40 computers; but the MIE is reluctant to provide resources for communications (e.g., Internet connections). This means that it is very problematic that students will be able to go online and make use of the digital libraries.

In Japan, it is very prestigious and important for a student to be admitted into an important university, such as Tokyo University or Kyoto University. So a market exists for companies to prepare students to take university entrance exams, for which students' parents will spend a lot of money. There is no market for K-12 students while they are in K-12, however, which is one of the reasons that Nikkei, a company that is very heavily involved with digital information, is not interested in this student population.

At Keio University, there is the Humanities Media Interface Project (HUMI project), which was launched in Spring 1996 with the aim, among others, of digitizing major rare books and manuscripts—Western, Japanese and Chinese—in the Keio collection, including the Keio Gutenberg Bible. The HUMI Project has been supported by the Ministry of Education, Science, Sports and Culture (*Monbusho*), the Information-Technology Promotion Agency (IPA), which is attached to the Ministry of International Trade and Industry, and Keio University. The library has a very large collection of rare books, including 8,000 Western rare books. The project managers seem to have a very progressive view of digitization of books, namely that, once digitized, the books can be examined or reassembled any way a person wants. The Keio Gutenberg Bible has played a very important role in the HUMI Project. The Bible was acquired not just for possession of an important article of Western cultural heritage, but because Keio University believes that modern research libraries should possess works significant enough to be digitized for the benefit of today's scholars. The university also wishes to promote the greater goal of preserving these treasures for posterity without further decay. For more discussions about the visit to Keio University, see the site report in Appendix C.

The HUMI Project is a clear indication that some very serious work is indeed occurring in Japan regarding education and digital libraries, and suggests that much more may indeed be occurring than we had the opportunity to observe directly. Prof. Naohito Okude (Keio University) sent this author some important observations about the digital library in education, in an e-mail message. Professor Okude's comments are paraphrased below, because not only are they somewhat visionary, but because they are also very optimistic about education using digital libraries:

Contrary to the general assumption that hypermedia obliterates the past, digital technology is radically reconfiguring our understanding of history. Being digital in a research library requires designing a post-Gutenbergian research model for the humanities. Digital technology forces us to recognize that texts are not higher than images. Computers rid us of the assumption that sensory messages are incompatible with reflection. Once digitized, fleeting images become available to anyone who "reads" them on a graphics computer. Imaging becomes a rich and fascinating mode for communicating ideas.

In order to conduct a professional image search within the humanities, serious training in visual proficiency is needed. The image search is an activity of focusing on cross-disciplinary problems in arts, graphics, film, video, media production and their different histories.

Learning has always been a people-to-people process. Digital library technology will promote a computer-mediated people-to-people learning process. This technology will have to expand from its traditional areas, such as information retrieval and distance learning, to the new frontier of information work application to assist distributed learning and the process of inquiring using a networked system.

Computer-human interface should be a central research agenda item for digital libraries. In addition to keyboards and mice, trackballs and joysticks, as well as gloves, helmets, glasses and body-suits, move an object on a computer screen. These multi-modal interfaces are not only immature in their development status, but they also are not intelligent. Future interfaces will be intelligent and will mediate communication between the researcher and the distributed computer network to make the latter more responsive to the former's wants and needs. New multi-modal intelligent interfaces will let the researcher span the continuum from passive reception of research data to active creation of new research results.

Virtual reality (VR) technology is most appropriate for representation as well as research. Bit-mapped graphics-based supercomputers can run high-speed graphics and track human movements. Immersion, interactivity, and information intensity are the three main characteristics of VR

technology. In the next ten years we can expect a widespread and growing experience of VR in a variety of everyday educational and learning environments.

The real market for digital technology is not the “information market” but the “information work” market. The technologies for information work let a person or a computer program take in information, transform it, and send it out. Today’s content creation technologies do not yet fulfill these functions.

When people and organizations all have computers, and all these computers are interconnected, they will sell and freely exchange information and information services. The digital libraries will then take the role of information managers in the age of the convergence of communication and computation, and new distribution technologies will emerge to link one digital library with other digital libraries, in order to effect digital data assistance. The role of the nineteenth-century library as the custodian of physically printed materials will remain but the digital libraries will also become distributed information managers of the links to other digital libraries. A grand distributed global digital library is the dream and the final goal of the digital libraries endeavor.

Each library will someday offer its collection in electronic form. To users, the collection of worldwide distributed libraries will look like one uniform library. To achieve interoperability of digital data at this level, enhancements of networking capabilities, interface design, and object-oriented databases are needed. Without this open architecture and deployment of distributed object-oriented technology, there is no future for the digital library to scholars and other people who want to use the libraries for their creative activities. Every library around the world should communicate with each other so as to contribute a consolidation of diverse human knowledge and experience.

Education and learning will be the huge market when the distributed digital libraries and the information work technologies are available to the content creators. Education and learning are lifelong pursuits. Within a few decades, people in Japan will come to the university at irregular times and will take more than four years to graduate. They will study for more years and will study more. This fragmented and discontinuous pattern is more of an expectation than the norm now, but students in the future will attend in broken times, and will often learn from more than one institution. This knowledge consumer market is the digital libraries’ business domain.

CONCLUSIONS

As noted in the introduction to this chapter, distributed digital libraries may well revolutionize education and learning, but this will require resources, resources, and more resources.

Resources are needed to digitize vast amounts of materials. Hoadley and Bell (1996) state that “Education is often held up as a prime beneficiary of digital libraries. However, the obvious benefits, such as distance education or literally global text search, fall short of justifying either the lofty expectations for an educational revolution or the enormous cost of putting everything on-line.” Perhaps, a demand-driven model should be used to establish priorities for what is digitized. These priorities could be established by professional educational societies and educational arms of technical societies. Then, educational representatives of higher-level National Academies could meet to prioritize across fields. Using this approach, there is a high likelihood that whatever is digitized would indeed be used by a large number of people, thereby justifying the large costs associated with digitization.

Resources are also needed to solve the myriad of open technical problems that have been discussed in other chapters of this report, but subject to the constraints of education. This, of course, means that the educational constraints are known. Unfortunately, that is not the case today. One must work through the 25 UMDL questions in order to establish all of the constraints. Resources are therefore needed to develop effective ways for teaching and learning using the digital libraries. If such resources are not made available or found, then it is indeed foolhardy to believe that digital libraries will make much of an impact, if any at all, on education.

Without computers available to students, it will not be possible for the digital libraries to make a significant impact on education. Today in the United States only 35% of all college students own a computer, and only 50% of all faculty do (Market View 1998). No doubt, the numbers of K-12 students and their teachers who own a computer are much smaller. Resources must be found to bring these percentages up to much higher values, or else digital libraries will not benefit all students. Instead, they will be an important benefit only to those who can afford to own and maintain a computer.

It seems that more resources are being directed at the myriad of problems associated with digital libraries in the United States than in Japan.

In conclusion, we may indeed be at the very beginning of a “dawning of an age of Aquarius” in education, because of digital libraries. The concept and its ramifications are breathtaking. Time will tell.

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