CHAPTER 2

LITERATURE REVIEW
2.1) REVIEWS RELATED TO DIGITAL LIBRARIES

The creation of the Multimedia Educational Resource for Learning and Online Teaching (http://www.merlot.org/Home.po) in 1997 by the California State University Center for Distributed Learning positioned it to be one of the ancestors of educational digital libraries. It has an extensive collection of links to online resources for undergraduate faculty and students in mathematics, science, and technology as well as links to art, business, education, humanities, and social studies. These resources range in size from entire websites to individual activities. Part of the strength of MERLOT is its emphasis on community. Individual members and faculty from member institutions have contributed to both the development of this digital library as well as the ongoing peer review of resources in its collection.

Visitors to MERLOT can use a basic search, advanced search, or browse lists of resources by subject term. Users can choose to limit search returns based on an advanced search query that makes use of up to 20 metadata fields. Members of the MERLOT community, either the authors or fans of the resources, have contributed the resources in the MERLOT collection.

From the MERLOT catalog record of a resource, the user can connect directly to the resource or link to the peer reviews, contact the authors, or locate other resources with similar topics. The catalog record has a description of the resource and other metadata such as technical format, rights, and primary audience. Member comments or peer reviews written by faculty serving on editorial committees are often associated with the catalog record. Users can contribute "assignments," descriptions of how a particular resource can be used, which can help other users envision the variety of ways that they
themselves can use the learning resource. Each visitor to the MERLOT site can establish a personal collection and continually add resources to it. Christel et al (1997) presented usage and evaluation data for abstractions implemented the Info-media Digital Video Library, and discussed implications for video delivery over the Web. Research on video abstractions aided not only users of digital video libraries but also users discovering the increasing amount of digital video material available over the Web. The review by Dillon and Gabbard (1998) restricted learning outcomes of the use of hypermedia in higher education.

Snyder (1998) argued that the use of hypertext makes a different way of learning and teaching possible and simulates active, self-directed, and exploratory learning, in particular. She also pointed out; however, that using potentially innovative technology does necessarily lead to change:

"No technology ...can guarantee any particular change in cultural practices simply by its 'nature'. A hypertext classroom can be used either to support new theories of reading and writing or to promote traditional approaches to the study of text ... The use and effect of a technology is closely tied to the social context in which it appears" (p. 140).

Windschitl's (1998, 2000) work had been a very significant impetus in prompting research questions on the importance of the Web in education. Windschitl particularly emphasized the importance of asking critical questions about the added value of the use of the Web in education.

Digital libraries form a vast area of research & explanation. Being multidimensional by nature, they attract researchers from varied disciplines like education, Technology, Psychology, etc. Researchers in different subjects have discussed issues in the context of digital libraries, such as database of hypermedia, models,
concepts of documents, multimedia database, children’s behavior, usage and evaluation, etc. For example, Wong et al (1999) brought his so-called hybrid approach and specified a DL as a combination of a special-purpose database and a hypermedia-based UI, and used this combination to formulize DLs with the Z language. Lee and Kim (1999) developed a canonical model for information systems; together with a compositional approach they applied to provide a partial solution for interoperability in DLs. Conzett, J. (2000) discussed that reading topic-related articles engenders some degrees of familiarity with particular words. Nevertheless, follow-up learning activities that use the same material, presented through various kinds of individual and interactive exercises, maximized the chance of the word being retained over the long term. He Daging et al described a scheme for supporting content-based language learning with a digital library. Daging, Ming’s paper, based on the integrated functionalities of collecting, organizing, retrieving, and preserving digital objects in a collection, he converted a DL platform into an integrated and interactive e-learning system. The system, called DiLight, concentrated on organization lecturing slides, videos, reading materials and a student comment into meaningful items/documents, and provided multiple retrieval methods that are suitable for student’s varied tasks, needs and references. Students’ initial feedbacks were very positive, and demonstrating the usefulness of DiLight, system in their learning processes. Kristmundsson (2000) stated that for the first time in the history of education it could not be assumed that teachers are ahead of their students in a particular field. He referred to technical computer skills, which many students have a better command of than their teachers did. Teachers did maintain their advantage, he immediately added, when helping students converted information into meaningful
Dong and Agogino (2001) prepared implementation paper that introduced principles for the information architecture of an educational digital library. This work described a concept for a digital library for science, mathematics, engineering and technology education (SMETE), a library with an information architecture designed to meet learners’ and educators’ needs. The authors proposed the specifications for the information architecture and a visual design of a digital library for communicating knowledge to the audience. The design methodology indicated that a scenario-driven design technique sensitive to the contextual nature of learning offers a useful framework for tailoring technologies that help empower, not hinder, the educational sector. Dong and Agogino determined 4 (four) principles as follows: Principle 1: organize information to provide opportunities for students and educators to create, synthesize, manipulate or debate content rather than merely to passively receive instruction. Principle 2: label resources with pedagogical identifies such as age group, teaching method, and academic standards to indicate educational uses. Principle 3: guide the collection and adaptation of learning elements towards individual learning goals. Moreover, principle 4: optimize search to meet the interests, knowledge, understanding, abilities, and experiences of the users in their roles as educators or students. They took about the design and development of an integrated, interactive, and effective e-learning system called DiLight. Todoran Horea (2002) discussed a basic aspect of real multimedia database management systems: the multimedia data types. He had a brief overview of the audio-visual multimedia data types, which he defined and classified. Then, he presented various input and output technologies, which foster the emergence of new multimedia data types, called here “non audio-visual data types”: smell, taste, and touch. Integrating these new
data types in multimedia database systems is a very difficult task. He imagined three incipient steps. In addition, Plass and Homer (2002) examined the preferences of Verbalizers and Imagers in multimedia learning. One hundred and three students using a German multimedia software were allowed to look up visual and verbal annotations for unknown words. The results showed that Imagers performed significantly better on words that reminded them of visual annotations than words that reminded them of verbal annotations, whereas Verbalizers showed the opposite pattern. Furthermore, Imagers performed better on propositions that allowed for visual and verbal annotations than on those that allowed only for verbal annotations, whereas Verbalizers performed well on both types of propositions. Song (2002) discussed ten studies on the interaction between students' learning skills and various forms of hypermedia instruction. Castells Manuel (2003) presented works in the context of a multidimensional language for DLs. They described the concepts of documents developed on the notions of views and versions, metadata formats and specifications, and a first-order logic based language. Druin et al. (2003) described the differences in children's collaborative behavior and dialogue when using two different software conditions to search for animals in the digital library. In this study, half children had to 'confirm' their collaborative activities (e.g. both children had to click on a given area to move to that area). The other half used on 'independent' collaboration technique (e.g. just one mouse click allowed the pair to move to that area). The participants in this study were 98 Second and Third grade children (age 7-9 year old) from a suburban public elementary school in Prince George's County, Maryland. The results of the study showed distinct differences between conditions in how children discussed their shared goals, collaborative tasks, and what outcomes they had in
successfully finding multimedia information in the digital library. For example, Fuentes, C. A. (2003) reported that students’ knowledge of business language was greatly enriched by basing learning on a corpus of business reports and product reviews. The Diognene project developed a Web training environment, based on the ACM Computing Classification Scheme (ACM CCS), for classifying books, journal articles and conference proceedings in the field of computing into a four-level subject hierarch (Vergara et al., 2003). The Courseware Watchdog is an ontology-based tool for finding and organizing learning materials in a decentralized way, in which the ontology servers as the basis for enhancing both the browsing and searching functions inside the system (Tane et al., 2003)).


In the context of digital libraries, research on awareness is scarce. Adams et al. (2005) investigated organizational awareness, referred to awareness of community activities, events, and resources across an organization. They discussed the design and evaluation of a screen saver application as an awareness communication medium in the clinical domain. Ingwersen (1992) and Hansen and Ja"rvelin (2005) described awareness more formally, classifying it as awareness of people, activities, and objects. Awareness of people referred to know about one’s colleagues. Awareness of activities referred to share the same need for information such as search strategies. Awareness of objects referred to access different types of resources such as sharing retrieved objects. Collins et al. (2005) described the design of Science Sifter, a tool that enables researchers and scientists to create and customize information feeds. A unique feature in
Science Sifter is the ability of users to select multiple feeds, aggregate them into one feed, and then use a set of keywords to filter the feed. In this way, Science Sifter had the potential to facilitate efficient information sharing, although no users' studies were reported to validate the effectiveness of the tool.

For example, a clinician would like to be notified with relevant search results whenever there is an important new press release and it is likely that his or her patients make inquiries about this topic. Although these particular studies (and others such as Collins et al. (2005)\textsuperscript{23}) were specific to their unique context, they raised important architectural and temporal issues for designing and evaluating awareness mechanisms for digital libraries. Graff (2005)\textsuperscript{41} examined differences in web browsing strategies between Imagers and Verbalizers. There were 58 participants, who read information in either a hierarchical or a relational hypertext with the expectation of answering questions on this information. The differences observed between Imagers and Verbalizers were that the former visited more pages in the relational architecture whereas the latter visited more pages in the hierarchical architecture. Els Kuiper et al. (2005)\textsuperscript{3} analyzed what research said about the demands that the use of the Web as information resource in education makes on the support and supervision of students' learning processes. They discussed empirical research focusing on the limitations of the actual search strategies of children, as well as theoretical literature that analyzes specific characteristics of the Web and their implications for the organization of education. They concluded that students need support in searching on the Web as well as in developing "information literacy". Based on multiple studies in the UK healthcare domain, in the domain of health informatics, researchers have explored the design and evaluation of alerting services for digital
libraries. Buchanan and Hinze (2005)\(^{14}\) and Hinze, et al. (2006)\(^{40}\) identified the need for clinicians and patients to track medical knowledge. Hinze et al. (2006)\(^{45}\) identified several user requirements for alerting in health digital libraries and go on to describe system-level implementation details.

Digital libraries have an important role to play in language education also. Wu and Witten (2006)\(^{90}\) indicated that digital libraries have untapped potential for supporting language teaching and learning. They described a new scheme for automating topic specific language learning using a specially built digital library. There were exercises of different types are generated automatically from the library content: one that learners undertook individually, one in which learners collaborated in pairs, and one in which a group of learners completed the task. The system aims to foster content-based language learning, which greatly increased students’ motivation, fostered long-time recollection, and can be culturally situated in appropriate ways. They provide genre-specific, focused material that is carefully selected and organized. Subject-specific collections provide the opportunity to encounter key terms and grammatical constructions that rarely occur in general texts.

Digital libraries of multimedia can provide a rich and coherent learning context, which aids retention and reinforces learners’ knowledge of language. They can promote culturally situated learning by working with collections that introduce the target language’s people, history, environment, art, literature, and music. Digital libraries can provide a safe learning community in which teachers share thoughts, tips and lessons plans, and organize collaborative task-based, content-based language projects; and learners meet their peers, exchange learning ideas, and engage in competitive or
collaborative tasks. Pedagogically, tuned search and browse facilities can meet the special needs of individual learners and teachers without bogging them down in fruitless tangential explorations. Earlier, Wu and Witten (2006) developed eight activities that are automatically generated from digital library content and utilize the search and retrieval facilities to illustrate new ways of supporting language study. Supporting language learning with digital libraries is particularly relevant in developing countries where the ability to speak another language can make the difference between poverty and success. Language education traditionally takes place in classrooms, and many students are denied the opportunity because of scarce resources.

Michal Kosiedowski et al. (2007) discussed an approach at the distributed digital library platform that is widely used within the PIONIER optical network. It presented the methodology for building distributed search and accessed to digital publications that allowed creating a national federation of digital libraries and that is now under investigation for possible use within various application fields including medicine, science and education. Currently, there are 9 (nine) regional and 7 (seven) institutional dlibra-based digital libraries which can be used to present, manage and access digital objects consisting of content (text, sound, video, etc) and metadata those digital libraries were there in the PIONIER network and at least 5 (five) more were planned to be available by the end of 2007. Dhakal Sushan (2007) focused on the use of Open Digital Library in present education scenario and the technical description for the architecture. However, this paper presented with the flavor of Foss and Educational Theme, Dhakal discussed the reasons that appear when using open digital library as follow: if there is a single copy of the literature in the library then only a single user can use. In Open DL
numerous users can download the same data object at the same time. The printed copy of the literature is often expensive, unaffordable to the general students of the developing countries. ODLs can solve the problem by giving e-access. Often the libraries of the developing nation are limited in the literature they possess. Nevertheless, in the ODL the same literature can be searched in all repositories connected to it. As such even the e-prints available in the libraries of Foreign University can be made available. There is no time limitation. Any time the resource is available and preservation of rare literature is also possible.

Steven Scott et al. (2007) had the project called Pathway which is improving the quality of physics teaching and the number of available physics teachers by providing virtual expert help on issues of pedagogy and content. Mellon’s Synthetic Interviews and state-of-art digital video library technology with pedagogical advances developed at Kansas State University, and materials contributed by master teachers. Carnegie Mellon’s Informedia Digital Video Library focuses specifically on information extraction from broadcast-quality video and audio content. It operated similarly to a Web search engine but did so by searching on video and audio information. Over forty terabytes, consisting of more than 30,000 hours of online news, documentary, and ethnographic video had been collected, with automatically generated metadata and indices for retrieving videos from this library. The interface had been designed to allow efficient browsing and access to information in spite of errors in the automatically produced descriptors of content, i.e., the metadata, which empirical studies and TREC Video Retrieval evaluations validating the effectiveness of the video library interface.
Enrique Frias-Martinez et al. (2008) examined how users' cognitive styles affect their behavior and perception in digital libraries. Fifty participants took part in this study. Two dimensions of cognitive styles were considered: (a) Field Dependence/Independence; (2) Verbalizer/Imager. The results showed that Intermediate users and Verbalizers had not only more positive perception, but they also completed the tasks in effective ways. Implications for the design of personalized digital libraries were also discussed. Arpit Jain's (2008) work described the design of Intinno, an intelligent Web based learning content management system. The system aimed to circumvent certain drawbacks of existing learning management systems in terms of scarcity of content, lack of intelligent search and context sensitive personalization. The scarcity problem was solved by using Web mining to crawl learning content from the Web. The mined content was then used to automatically generate concept maps. Automatic annotation using the concept maps was used to archive the crawled content into a digital library. Multiparameter indexing and clustering was done to provide intelligent content based search. Finally, algorithms for learning applications like generation of memory maps were proposed.

2.2) REVIEWS RELATED TO EDUCATIONAL DIGITAL LIBRARIES

Some researchers concentrated on specific digital libraries and specific users, in particular, educational digital libraries and learners. Focusing on digital libraries for teaching and learning will enhance students' skills and experience and translate teachers to be the guides of educational processes. Emig (1977) studied various definitions of the learning process by some of the most influential psychologies of the 20th century,
discovered clear correspondences between writing and learning. Furthermore, ‘writing-to-learn’, and specifically the knowledge transforming model (Bereiter & Scardamalia, 1987) had considerable theoretical and empirical backing in educational psychology, as a manifestation of constructivism and creating a variety of opportunities for computing supported collaborative learning. Nelson and Hayes (1988) found that more experienced writers were inclined to employ an issue-driven (writing down preliminary thoughts, looking for supportive sources, reading) rather than a content-driven (exclusive information search, reading, and only then writing) approach. There is also some evidence that at least some successful students tightly integrate information search, reading and writing (Fister, 1992). GeogDL did not provide an environment for active learning (Lebow, 1993); it also adopted a pragmatic approach that recognized the importance and usefulness of examinations especially in the Singapore education system.

GeogDL study conducted to engage a group of intergenerational partners involving secondary school students and usability-trained evaluators for the purposes of reinforcing and refining the initial design of GeogDL. Borgman et al. (2000) conducted formative evaluation in formulating design requirements and summative evaluation in judging learning outcomes. Hill et al. (2000) collected feedback about the users' interaction with the interfaces of Alexandria Digital Library, the problems of the interfaces, the requirements of system functionality, and the collection of the digital library. The study was inspired by Carroll’s (2000) work on the task-artifact cycle, user-centered strategies such as scenario-based design and claims analysis. Yang (2001) examined learners’ problem-solving process in using the Perseus digital library by adopting an interpretive and situational approach. The findings of the study helped
designers develop and refine better intellectual tools to facilitate learners’ performance. Some studies in how scholars actually work, a number of researchers have noted the interweaving of writing with the consulting of resource, and indeed searching activities. Brockman, Neumann, Palmer, and Tidline (2001) noted, “As scholars were finishing one document, they made notes of idea they had to expand for another publication. They ran searches to fill in gaps in their bibliography or quickly checked something, communicated with friends in other places who were helping them gather information, or kept up with departmental discussions about administrative issues.” (p. 27).

They divided scholarly writing into a series of somewhat distinct activities (Searching for the information and Organizing, analyzing, systematizing, synthesizing, obtaining insights, planning the report & Writing the report). In this work they summarized the categorization of highly-cited just-in-time information retrieved agents. Alexandria Digital Earth Prototype System (Smith, Janec, Frew, & Coleman, 2001) provided students with “learning spaces” (Coleman, Smith, Buchel, & Mayer, 2001).

Theng et al. (2001) when examining digital libraries for children, embarked on a similar observational study between children in a physical setting – with findings used as refinements to a prototype of a digital library. Jose et al. (2002) argued that a digital library enabling collaboration between peers needed to be equipped with a common workspace as well as communication tools for the sharing of resources and comments. They began with a system design, refined later through their discussion. Kassim and Kochtiane (2003) performed usability studies of an educational digital library in order to understand user needs, find problems, identify desired features, and assess overall user satisfaction. In addition to usability studies, DL evaluation studies also cover system performance and content. Applying multifaceted approaches to the evaluation of Perseus
Project, Marchionini, Paisant, and Komlodi (2003) concentrated on evaluating learning, teaching, system consisting of performance, interface, and electronic publishing, and content comprising of scope and accuracy. In contrast, Druin et al. (2003), while developing a digital library for children, explored collaborative actions in a physical setting between children in order to suggest collaborative technologies for learning between children.

There has been a growing interest in the importance of studying digital library use in context. For example, Carr et al. (2004) pointed out that DLs should not be just a static archive. Instead, DLs should be aware of user's information need and context. The authors called this a ‘broadening’ view of DLs. This is a natural progression from earlier concentrations on the mechanics of digitization and the collection and aggregation of online resources, the provision of useful search functionalities and the development of better user interfaces.

Some studies use “surrogate users” — subject experts who can better assess features of a DL than the target user population, but who are not usability experts. One example is the work of McCown, Bollen, and Nelson (2005), who recruited eleven teachers to participate in a study comparing the effectiveness of NSDL and Google in terms of the quality of results returned for curriculum-related search expressions. In this case, the evaluation was not of the quality of the interaction or system design, but of the quality of the results returned in relation to the relevant school curriculum. Writing, particularly academic writing can be a challenge for experts and novices alike. Digital libraries have greatly improved the ease with which we can search for information, even from our desktop. It is easier to integrate searching and writing
activities when both are done in different windows on the same computer. Nevertheless, the act of writing remains difficult. The very accessibility of so much of information through ever more complete DLs with ever more sophisticated search functionalities can mean that searching and reading articles turns into something of a displacement activity, postponing the dreadful moment of starting work on the paper. Sadly, this kind of problem is one more likely to be experienced by the more diligent, perfectionist student, a personality trait particularly evident at the graduate level.

Twidale et al. (2007) integrated the potential of a tighter integration between searching for information in digital libraries and using those results in academic writing.

2.2.1) EXAMPLES OF EDUCATIONAL DIGITAL LIBRARIES

Multimedia Educational Resource for Learning and Online Teaching (MERLOT)

Digital Library for Earth System Education (DLESE)

The Digital Library for Earth System Education (http://www.dlese.org/dds/index.jsp) also is a community-based project. Educators, students, and scientists work together to improve Earth systems teaching and learning at all levels. The development of this digital library began with funding from the Award to Facilitate Geoscience Education (NSF 97-174) from the Geosciences Directorate of the National Science Foundation.

DLESE provides access to collections of digital Earth systems resources for teachers and learners, such as lesson plans, images, data sets, assessments, and online courses. A subset of exemplary resources is in the DLESE Reviewed Collection (DRC).
To insure that the resources are high quality, DRC best practices identify criteria such as scientific accuracy, information about pedagogical effectiveness, and the ease of use of the resource.

Users can find resources with the search or browse features that are described accurately and consistently. Earth system educators, scientists, and librarians to ensure accuracy and relevance to the users create the DLESE descriptions. The records have educational descriptors such as grade level and educational standard. Bibliographic descriptors include creator, technical requirements, and resource type.

Users can find resources by browsing the DLESE collection by subject, resource type, or grade level. The reviewed and thematic collections can also be browsed.

**MathDL**

MathDL (http://www.mathdl.org/) is a digital library that is funded by NSF, managed by the Mathematics Association of America, and hosted by Math Forum. MathDL provides access to both the *Journal of Online Mathematics and Its Applications (JOMA)* and a collection of digital classroom resources for undergraduate mathematics teaching and learning. Faculty can become part of the MathDL community by contributing resources, peer reviewing resources, or moderating discussions about resources.

The Digital Classroom Resources (DCR) record contains bibliographic (author and title), educational (intended uses and appropriate courses), and technical (software specifications) information about the resource. It also offers a review based on classroom teaching and peer review. Visitors also can link to a moderated discussion about the resource.
**Communities for Physics and Astronomy Digital Resources in Education (comPADRE)**

The Communities for Physics and Astronomy Digital Resources in Education (http://www.compadre.org/) is designed to help people who belong to or identify with the following institutions: the American Association of Physics Teachers (AAPT), the American Physical Society (APS), the American Astronomical Society (AAS), or the American Institute of Physics/Society of Physics Students (AIP/SPS). Users can find resources from collections focused on the different fields in physics and astronomy. These fields include introductory astronomy, quantum physics, student resources, high school teachers' resources, and public education. When users enter a query in the Physical Science Resource Center on the comPADRE site, they can limit their search by subject, author, and/or organization. It has bibliographic (such as author and cost), educational (such as intended levels and intended users), and technical information (such as format).

At this time, comPADRE is not as some of the other mathematics and science educational digital libraries. Among the comPADRE development plans for the next few years are increasing the depth and breadth of the collections, building on the value of the records of the resources by including professional reviews, and establishing community interactions to promote advancement in physics and astronomy teaching and learning.

**BiosciEdNet (BEN)**

BiosciEdNet (http://www.biosciednet.org/portal/) is a project of the American Association for the Advancement of Science (AAAS) that provides access to life sciences resources for students from preschool through professional and continuing education. When visitors use a basic or advanced search or browse by subject area or resource type,
they can open records that display bibliographic (author, publisher); educational (context); and technical information about the resource.

The MicrobeLibrary

The MicrobeLibrary (http://www.microbelibrary.org/) offers access to a peer reviewed collection of digital resources focused on the microbial world for undergraduate faculty and students in the life sciences. The resources in the MicrobeLibrary can also be accessed through BEN. It is linked to the American Society for Microbiology (ASM) recommended core curriculum for introductory microbiology courses. It offers images, activities, articles from the Focus on Microbiology Education newsletter, and columns and reviews from the ASM News.

The Learning Matrix

The Learning Matrix (http://thelarningmatrix.enc.org) is a digital library collection for undergraduate mathematics and science faculty that was developed at the Eisenhower National Clearinghouse. Its goal is to support the extension of the implementation of the NSES for teaching into the undergraduate setting. It contains resources that have been selected for the collection by mathematics and science content specialists and described in bibliographic, educational, and technical terms. The resources range from entire web sites to individual simulations, images, or articles. Educational fields that describe the difficulty, level of interactivity, and suggestions for use can help faculty in their selection and use of the resource. Users can link directly from the catalog record to descriptions of related resources. Users can use a basic or advanced search as well as a browse feature to locate and access resources. The advanced search allows the
user to narrow their query by up to 14 different types of descriptors. The collection includes both resources for classroom use and faculty professional development.

**iLumina**

Faculty can find undergraduate teaching materials for chemistry, biology, physics, mathematics, and computer science in iLumina (http://turing.bear.uncw.edu/iLumina/index.asp). The resources in this digital library range in granularity from individual images and video clips to entire collections of resources or courses. iLumina catalog records offer bibliographic, educational, and technical descriptions of the resources. Users can use a basic or advanced search feature or browse the resources described in the iLumina digital library. The advanced search allows users to limit their queries by descriptors such as subject, keyword, or level of interactivity. Users can browse by discipline, resource type, structure, media type, or contributor. The catalog record describes the resource in bibliographic, educational, and technical terms. Users also can see a description of different collections such as microscopy images, water mold videos, or calculus Maple worksheets. From the overview description of the collection, users can link to a list of all of the individual resources in the collection.

**The Virtual Skeletons Project**

The Virtual Skeletons Project (http://www.eskeletons.org/) allows visitors to access information about the bones of a human, gorilla, or baboon. The user selects a bone from one of the three organisms and then chooses to see a QuickTime movie about the bone, look at the origin or insertion points, or compare the bone to the same bone in a
different organism. The user also can virtually manipulate the bone into other viewing positions.

2.3) REVIEWS RELATED TO USABILITY OF DIGITAL LIBRARIES

Now a days, the characteristic derived from the Internet which the late twentieth century was marked by the following: a boom of the available information and a fast growth in the number of connected computers. Card et al. (1983)\textsuperscript{15} showed the mouse to be maximally efficient with respect to human information processing for pointing at objects on screen. Therefore, it is essential to consider both cognitive and operational aspects involved in the process of information search and use (Norman et al., 1986\textsuperscript{71}; Dervin & Nilan, 1986\textsuperscript{27}). Gould et al. (1987)\textsuperscript{40} demonstrated the image polarity, screen resolution and anti-aliasing in combination significantly affected reading speed, and any interface that failed to address two-level issues would serve to slow readers of digital documents by as much as 30%. Within Human-Computer Interaction, there is a higher preponderance of qualitative approaches to evaluating interactive systems, although qualitative approaches based on classic experiments (drawing on techniques developed in Psychology) are also common. Such experiments share many features in common with IR approach outlined above (Tague-Sutcliffe, 1992\textsuperscript{86}), in that they involved the identification of independent and dependent variables and the control of confounds that might reduce the reliability of the study. Just as Tague-Sutcliffe (1992)\textsuperscript{86} presented a set of three criteria that any study should satisfy (validity, reliability, and efficiency), so within HCI a set of criteria have been identified. Accepted definitions of usability have focused on multiple usability attributes such as learnability, efficiency, memorability,
error, and satisfaction (Nielsen, 1993)\textsuperscript{72}. There are many issues about documents; especially their stability and multimedia components as well as active elements affect retrieval, presentation, and other DL activities (Levy, 1994)\textsuperscript{59}. Van House et al. (1996)\textsuperscript{91} focused on query form, fields, instructions, results displays, and formats of images and texts in the iterative design process for the University of California Berkeley Electronic Environmental Library Project. DL interface and usability concerns have been central to many efforts at Xerox PARC. Some of the research considers social issues relating to documents (Hearst, 1996)\textsuperscript{61} while other research bridges the gap between paper and digital documents (Hearst, Kopec, Brotsky, 1996)\textsuperscript{62}. The great alterations in all the scopes of human activity have only become possible to the extent that the new technological resources of information and communication have been accessible to people without specialized formation in computer science. As a result of innumerable research projects into this direction, one can note that to guarantee and to add value to the systems implies drawing and projecting products and services centered in the user’s needs and focused on the way users perform their tasks. In 1997, a study at Virginia Tech of four digital library systems concluded that many have serious usability problems (Kengeri et al, 1997\textsuperscript{77}). The Virginia Tech study uncovered an important aspect of the situation, and suggested that it will be years before DL systems are properly understood and used. A pre-test asked about user expectations for a DL, and found that very few have worked with a DL. The post-test showed that user expectations and priorities for various features changed dramatically over the short test period. Thus, it is likely that in general, as DL usage spreads, there will be an increase in understanding, a shift in what capabilities users expect, and a variety of extensions to the interface now considered. Some insight into DL
use may result from actual user observation as well as other measures of what documents are read (Levy, 1997)\(^5\).

Covi and Kling (1997)\(^2\) investigated patterns of use of digital libraries using different groups of users, and how vary they were across academic fields and universities. They focused on interviewing potential users and were concerned primarily with university members, rather than considering the population at large. Their study led them to conclude that the development of effective (useful and use) digital libraries needs to take account of the important roles played by other people within the broader system of use (notable colleagues and librarians). In addition, it also considered the views of end users, as well as those of librarians and computer specialists need to be understood for effective design. Fumas and Rouch (1998)\(^3\) found that in searching for information a “one-shot query” is very rare. More typical is an extended and iterative search, which involves opportunism; that is, the searching evolves over a period of time and relies on users being able to follow new (interesting) paths as they appeared, which may not necessarily have been specified at the start of their search. People do not just search for items in digital libraries, but also browse for them. O’Hara et al. (1998)\(^4\) focused on such writing activities in their studies of PhD students’ use of libraries. They found that reading and writing were inextricably intertwined. Existing Web-based library interfaces did not support any writing activities, so subjects in this study saved and printed relevant articles, for future organization and annotation. Citing in human-computer interaction research by Shneiderman (1998)\(^7\), human-computer interaction/interface criteria were discussed regarding usability, functionality, efforts as well as task appropriates and failures. Within the DL evaluation criteria, usability is the one that has been most
investigated. One important finding about reading activity Adler et al. (1998), Bishop (1998) and Marshal et al. (1999) declared that people do not simply read articles from beginning to end, but rather move between levels of information — for example, from authors and titles to reading the conclusion.

Jones et al. (1999) characterized this distinction as follows: Browsing – users traverse information structures to identify required information; Searching – users specify terms of interest, and information matching those terms is returned by an indexing and retrieval system. Users in turn may browse these results in an iterative manner. Gutwin et al. (1999) discussed the browsing in digital libraries, but tend to focus on how user interfaces they develop can support browsing, rather than considering what browsing is. However, in their discussion of browsing support they did categories the purpose of browsing as follows: Collection evaluation – what is in this collection? Is it relevant to my objectives? Subject exploration – how well does this collection cover area X? In addition, Query exploration – what kind of queries will succeed in area X? how can I access this collection? Dillon (1999) proposed a qualitative framework (termed TIME) for designers and implements to evaluate usability of digital libraries which focuses on user task (T), information model (M) and the ergonomic variables (E).

Bishop’s (1999) consideration was of the use of digital libraries by people from different social and economic backgrounds. Her studies indicated that people from different backgrounds (low-income and academic) can easily be put of using digital libraries — small problems tend to be magnified until they deter potential users, and lack of awareness of library coverage often prevents users from understanding what they could get out of the libraries. Marchionini (2000) suggested applying existing
techniques and metrics to evaluation digital libraries, such as circulation, collection size and growth rate, patron visits, reference questions answered, patron satisfaction, financial stability. Based on data from the early 2000s, Elaina Norlin and Winters (2001) provided a brief overview of usability testing; suggested Web site guidelines; discussed how to get buy-in from others; and how to plan, prepare, and conduct usability testing. They concluded with an actual case study. Nicole Campbell (2001) provided an overview of usability testing methods and then covered eight case studies illustrating different aspects of usability testing and reported results of evaluations of specific library Web sites. Usability was also extended to performance measures, such as efficiency of interactions, avoidance of user errors, and the ability of users to achieve their goals, effective aspects, and the search context (Blandford & Buchanan, 2002). Cherry and Duff's (2002) focused on how the digital library was used and the level of user satisfaction with response time, browsing capabilities, comprehensiveness of the collection, print function, search capabilities, and display of document pages. The most evaluated DL services are reference services. For instance, Carter and Janes (2000) analyzed logs of over 3000 questions sent to the Internet Public Library regarding how those questions were asked, handled, answered, or rejected. Electronic journals service of the digital library is another area for evaluation. Researchers like Castells (2003) and Levy, Pierre (2003) had argued about the social, economic and political changes originated by the use of the new technologies of information and communication for the net connected society. Blandford and Buchanan (2003) also examined the classical usability attributes in the context of digital libraries, and they suggested adapting many of these attributes to the evaluation of digital libraries. Some of them, such as learnability,
need to be modified because users treat the library system as a tool, not as an object of the study. They are more concerned with building a user perspective into the design cycle than with final evaluation. Ryan (2003) and Thompson (2003) suggested establishing policies and how to integrate usability testing into library Web site development.

Pamela & Sandra (2003) and Jennifer Ward & Hill (2003) were encouraged library staff to evaluate their Web sites. Leslie Johnston (2005) reported on the development and assessment of the public discovery and delivery interface for the Fedora repository system. She covered internal review of the design, classroom testing, and usability testing with faculty and staff. She included a process model for assessments of future library projects.

Claudia Roda et al., (2005) used participatory design techniques to enhance the development of a digital image library of sites of the art history department of the American University of Paris. The project team was composed of students, professors, IT managers, librarians, and administrators. Activities included workshops within the design teams, observations of the slide use in classes, user interviews, and reactions to paper prototypes of Web sites. The authors found that team formation had a high turnover impact on usability design; collection management influenced the usability of the final design; and usability and resource reuses were severely reduced if the services were limited to the classical digital libraries. Judy Jeng (2005a, 2005b) concluded that usability is a multidimensional construct. She further proposed an evaluation model for assessment of the usability of digital libraries by examining their effectiveness, efficiency, satisfaction, and learnability. User satisfaction covers ease of use, organization of information, labeling, visual appearance, content, and error correction. The evaluation
Barbara Cockrell & Jayne (2002) and Elahe Zoni-Sabihi et al. (2006) reported the results of usability testing, often case studies.

In these studies, the evaluation emphasizes more on characteristics of users and their usage patterns related to preferred databases, preferred electronic journals, and their frequency of use (Monopoli, Nicholas, Georgiou, & Korfiati, 2002; Atilgan & Bayram, 2006).

Zani-Sabihi, Ghinea and Chen (2006) reviewed definitions of digital libraries. They focused on two digital collections: Science Direct (www.sciencedirect.com) and the classical Music Library (www.alexanderestreetpresses.com/clmu.html). They asked participants (n=48) to find information on each Web site. Based on their experiences and analysis of the data, the researchers reported on the functionality features (n=10), interface/usability characteristics (n=6), and content (n=2) that they would like to see in these Web sites. Next, they compared the suggestions by types of users (novice, intermediate, and advanced).

Ann Blandford et al. (2007) shifted the focus to considering how IR systems, and particularly digital libraries, can be evaluated to assess (and improve) their fit with users' broader work activities. They presented the PRET A Rapporter framework for structuring user-centered evaluation studies and illustrated its application to three evaluation studies of digital library systems.

Xie (2008) investigated user's use, their criteria and their evaluation of two selected digital libraries. Nineteen subjects were recruited to participate in the study.
They instructed to keep a diary for their use of the two digital libraries, rated the importance of digital library evaluation criteria, and evaluated the two digital libraries, their perceived important evaluation criteria and the positive and negative aspects of digital libraries. Finally, the relationships between use of digital libraries and evaluation of digital libraries as well as user’s preference, experience and knowledge structure on digital library evaluation are discussed. Xie illustrated the structure and summarization of the results (see Xie 2008).

Teal Anderson and Sayeed Chouhdury (2008) at the Digital Knowledge Center, Sheridan Libraries, and John Hopkins University supported enhancing the usability testing of digital libraries. Their research agenda includes: using quantitative measures; conducting remote testing with users; testing with users; testing with diverse user populations; testing part on whole digital library collections; testing in natural and laboratory settings; and balancing decisions between user feedback and librarian expertise.

2.4) HYPOTHESES

Based on literature review and the explorative studies seventeen main hypotheses have been formulated. They describe the supposed correlation between the learning assessment, usability, activities, active learning and their components. In order to determine the specific usability and learning activities benefits, the correlation with effectiveness, efficiency, satisfaction, learnability, active consuming, information seeking, and information gathering will be discussed using different techniques (Nielsen, 1993; Fox et al., 1995; Jayawardana, 2001; Nielsen 2003; Judy Jeng, 2005a, 2005b; and Adams et al., 2005).
These hypotheses are as follow:

H01: The levels of effectiveness (of digital libraries) will have a significant impact on learner’s efficiency and satisfaction.

H02: The levels of efficiency will have a significant impact on learner’s satisfaction.

H03: The levels of effectiveness will have a significant impact on learner’s satisfaction.

H04: The levels of learning activities and usability will have a significant impact on ease of use of the digital library.

H05: The levels of learner’s experience will have a significant impact on using the Internet.

H06: The levels of digital library learnability will have a significant impact on ease of learn of the digital library.

H07: The levels of time spend using the digital library will have a significant impact on learner’s satisfaction.

H08: The levels of steps to reach the digital library materials will have a significant impact on learner’s satisfaction.

H09: The levels of learning activities will have a significant impact on the learner’s satisfaction.

H010: The levels of learning activities will have a significant impact on the digital library learnability.
2.5) STRUCTURAL EQUATION MODLING HYPOTHESES

H011: The levels of activities will have a significant impact on active learning.

H012: The usability will have a significant impact on the levels of time spent.

H013: The usability will have a significant impact on the levels of steps.

H014: The usability will have a significant impact on the levels of satisfaction.

H015: The usability will have a significant impact on the levels of learnability.

H016: The active learning will have a significant impact on the levels of information seeking.

H017: The active learning will have a significant impact on the levels of active consuming.
REFERENCES


