CHAPTER 1

INTRODUCTION
The impacts of information technology have not left any aspect of life, including education. With the advancement of technology the entire pattern, style and pedagogy of education has changed. As a result, research in education has found a new area to explore various aspects related to technology and education.

In this research work, the investigator has tried to explore the new techniques involved in Digital Libraries which are the part of information technology. This chapter will give the details of various concepts, terms, aims and objectives related to the topic in hand.

1.1) DIGITAL LIBRARIES - THE CONCEPT

The term “Digital Library” (DL) is used to refer to a range of systems, from digital library object and metadata repositories, reference-thinking systems, archives, and content management systems to complex systems that integrate advance digital library services and support for research and practice communities (Dagobert, 2008). Dagobert referred to a digital library as “it integrates access to materials with access to tool for processing materials (DL=materials+tools) and supports individual and community information aspects through functionality for selection, annotation, authoring/contribution, and collaboration”.

IBM defined a digital library as follows:

“A machine readable representation of materials which might be found in a University library together with organizing information intended to help users find specific information. A digital library service is an assemblage of digital computing, storage, and communications machinery together with the software needed to produce, emulate, and extend the services provided by conventional libraries based on paper and other material means of collecting, storing, cataloging, finding, and disseminating information. A full service digital library must accomplish all essential services of traditional libraries and also exploit digital storage, searching, and communication”.

Lesk (1997, cited by Malvia, R. N., 2008) defined the digital libraries, as
"D.L.s are organized collections of digital information. They combine the structuring and gathering of information, which libraries and archives have always done with the digital representation that computers have made possible. Digital information can be accessed rapidly around the world, copies for presentation without error, stored, compactly and searched very quickly, a true digital library also provides the principle governing what is included and how the collection is organized" (p.3).

The virtual library is known as digital library or e-library. Terence R. Smith (1997\textsuperscript{136}, cited by Malvia, R. N., 2008\textsuperscript{116}) defined the digital libraries as:

"controlled collection of information bearing objects (IBOs) that are in digital form and that may be organized accessed, evaluated and used by means of heterogeneous and extensible set of distributed services that are supported by digital technology" (pp.2-3).

Waters (1992\textsuperscript{155}, cited by Malvia, R. N., 2008\textsuperscript{116}) digital libraries combine collection and expertise in a seamless interface. Therefore, it requires specialized staff to select, organize, evaluate, interpret, offer intellectual access, preserve the integrity and ensure the persistence over time of digital works so that they are readily and economically available for use by a defined community or set of communities.

D. Keye Gopen (1993\textsuperscript{48}, cited by Malvia, R. N., 2008\textsuperscript{116}) defined the virtual library as:

"A concept of remote access to networked world library and information sources. This is a synergy created by bringing together technologically the resources of many libraries and information services".

Oppenheim and Smithson (1999)\textsuperscript{107} defined the digital library as:

"An information service in which all the information resources are available in computer-process-able form and the functions of acquisition, storage, retrieval, access and display are carried out through the use of digital technologies" (p.97).

The Digital Library Federation provides a more comprehensive definition. It defines digital libraries as follows:

"Organizations that provide the resources, including the specialized staff, to select, structure, offer intellectual access to, interpret, distribute,
preserve the integrity of, and ensure the persistence over time of collections of digital works so that they are readily and economically available for use by a defined community or set of communities” (Walters & Donald, 1998).

Lynch et al. (1995) define “digital libraries are systems providing users with coherent access to a very large, organized repository of information and knowledge” as defined by the Working Group of the US govt’s Information Infrastructure Technology and Application (IITA), Berkeley (1994, cited in Larson, Ray R., 1994) “Digital library is a global virtual library ‘The Library’ of thousands of networked electronic libraries”.

Witten & Bainbridge (2002) define a digital library is an organized collection of information... a focused collection of digital objects, including text, video, and audio, along with methods for access and retrieval, and for selection, organization, and maintenance of the collection.

The history of digital libraries (DLs) is rich and varied because the concept of “digital library” is not new. Digital libraries, now a part of the global infrastructure, are being envisioned to interconnect many computer networks and versions of information technologies around the world, a partial fulfillment of a Bush’s 1945 dream “Memex” of a personal micro-fiche-based system to tackle the problem of information overload.

The “library” metaphor is both empowering and constraining: (i) empowering, because digital libraries automate and extend opportunities offered by traditional libraries, as well as harnessing opportunities not possible on the Web; and (ii) constraining, because the metaphor evokes certain legacy impression, many originating in arbitrary physical constraints (Fox, E.A. et al., 1995). Digital libraries represent a form of information technology in which social impact matters as much as technological
advancement. Table (1.1.1) shows a major (Asian) digital library research and
development milestones (Hsinchun et al., 2005).

Table (1.1.1). Major (Asian) digital library research and development milestones
(Hsinchun et al., 2005)

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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</table>
| 1994 | NSF Digital Library Initiative Phase 1 (DLI-1)  
The First Annual Conference on the Theory and Practice of Digital Libraries, College Station, Texas |
| 1995 | First IEEE Advance in Digital Libraries Conference, McLean, Virginia |
| 1996 | First ACM Conference on Digital Libraries, Bethesda, Maryland |
| 1997 | First European Conference on Research and Advanced Technology for Digital Libraries (ECDL), Pisa, Italy |
| 1998 | The First International Conference on Asian Digital Libraries (ICADL, 1998), Hong Kong, China |
| 1999 | President's Information Technology Advisory Committee (PTAC) Report  
NSF Digital Library Initiative Phase 2 (DLI-2)  
Institute of Museum and Library Services (IMLS) Program  
NSF National Science, Mathematics, Engineering, and Technology Digital Library (NSDL) Program  
ICADL 1999, Taipei, Taiwan |
| 2000 | ICADL 2000, Seoul, Korea |
| 2001 | ICADL 2001, Bangalore, India  
First ACM/IEEE Joint Conference on Digital Libraries (JCDL 2001), Roanoke, Virginia |
| 2002 | ICADL 2002, Singapore |
| 2003 | ICADL 2003, Kuala Lumpur, Malaysia |
| 2004 | JCDL 2004, Tucson, Arizona |

In 1994 the original digital library was initiated (DLI or DLI-1), sponsored by the
NSF, DARPA, and NASA. The original program announcement stated, “The Initiative’s
focus is to dramatically advance the means to collect, store, and make it available for
searching, retrieval, and processing via communication works – all in user-friendly ways.
Digital libraries store materials in electronic format and manipulate large collections of
those materials effectively. Research into digital libraries is research into network
information systems, concentrating on how to develop the necessary infrastructure to
mass manipulate the information on the Net. The key issues are how to search and

In addition to the core DLI-2 and related ITR projects, DLI-2 also sponsors 12 international digital library projects (http://www.dli2/nsf.gov/intl.html), involving partners from the UK (University of Liverpool, Southampton University, King's College Landon), Germany (University Library of Gottingen, University of Trier), China (Tsinghua University, National Taiwan University), Japan (National Institute for Informatics), and Africa (West African Research Center). Several U.S. agencies also began to develop digital library projects that are uniquely tailored to their institution's function. For example, see (IMLS, http://www.imls.gov/about/index.html) for the Institute of Museum and Library Services, which is independent federal agency that fosters leadership, innovation, and lifetime learning. See (http://www.imls.gov/cls_po.asp).

Another significant digital library research program was developing concurrently under the NSF National Science, Mathematics, Engineering, and Technology Digital Library Program (NSDL, http://www.nsd1.nsf.gov/index.html). More than 60 projects have been funded since 1998 in three areas: the collection track for offering contents (e.g., National Biology Digital Library; Digital Mathematics Library; Experimental Economics Digital Library); the service track for providing technologies and services (e.g., University of Arizona's Get smart e-learning concept map system);
and the core integration track for linking all contents and services under a unified framework.

Smith (1998) described that digital libraries consisted of the collections of digitized resources as well as the links or pointers to other digital sources. Witten (2002) called "digital library" as a collection-building tool. Renda & Straccia (2002) presented a personalized collaborative digital library system where users could organize the information according to their own interests as well as exchange information with each other.

The social aspect of digital libraries emphasizes upon the activities people engage in when they create, seek, and use information resources. Research within this area focuses on user studies, usage log analysis, multicultural issues, and language-specific issues (Borgman, 1996). Liew et al. (2000) conducted an empirical evaluation to study the design of e-journals and how users interact with them. Adachi (2000) presented NACSIS-ELS, a digital library system of Japanese academic journals. Zhao et al. (2002) developed a Chinese medical portal, CMedPort, which integrates various techniques such as meta-search, cross-regional search, summarization and categorization.

In India until recently, Internet was accessible to a small group of academic and government users through the Education and Research Network (ERNET) and National Informatics Network (NICNET). Information and Library Network (INFLIBNET) was setup in 1993 by UGC to computerize and network the libraries of the universities and higher education institutes in India. Table (1.1.2) gives the details of information/library network systems in India as shown below:
Table (1.1.2). Information and Scientific Networks in India (S.I. Fazzaludin and Chikkamallaiah, 1996[21])

<table>
<thead>
<tr>
<th>Networks</th>
<th>Network used by</th>
<th>Controlled by</th>
</tr>
</thead>
<tbody>
<tr>
<td>NICNET</td>
<td>Government department and agencies</td>
<td>Planning Commission</td>
</tr>
<tr>
<td>ERNET</td>
<td>Institutions working in frontier areas of science and technology</td>
<td>Department of Electronics</td>
</tr>
<tr>
<td>CALIBNET</td>
<td>Libraries in Calcutta</td>
<td>Under the auspices of NISSAT</td>
</tr>
<tr>
<td>DELNET</td>
<td>Libraries in Delhi</td>
<td>Under the auspices of NISSAT</td>
</tr>
<tr>
<td>BOMNET</td>
<td>Libraries in Bombay</td>
<td>Under the auspices of NISSAT</td>
</tr>
<tr>
<td>MALIBNET</td>
<td>Libraries in Madras</td>
<td>Under the auspices of NISSAT</td>
</tr>
<tr>
<td>HYDLIBNET</td>
<td>Libraries in Hyderabad</td>
<td>Under the auspices of NISSAT</td>
</tr>
<tr>
<td>BALNET</td>
<td>Libraries in Bangalore</td>
<td></td>
</tr>
<tr>
<td>BTISNET</td>
<td>Academic and research biotechnology institutions</td>
<td>Department of Science &amp; Technology</td>
</tr>
<tr>
<td>INFLIBNET</td>
<td>University libraries and specialized R &amp; D institutions</td>
<td>U.G.C.</td>
</tr>
<tr>
<td>DESINET</td>
<td>Defence science laboratories</td>
<td>Department of Defence</td>
</tr>
<tr>
<td>SIRNET</td>
<td>Laboratories under the C.S.I.R.</td>
<td>C.S.I.R.</td>
</tr>
</tbody>
</table>

Many projects have been carried out on digital libraries in different fields in the world; some of them have been presented below:

1-) A PROJECT ON INFORMATION DIGITAL VIDEO LIBRARY:
Located at Carnegie Mellon University; the objective of this project is to develop technologies for full-content search and retrieval from digital video libraries. The project team is creating a test bed to enable K-12 (10+2 level in India) students to access, explore and retrieve science and mathematics materials from the digital video library by combining speech, image and natural language capabilities. It will initially contain 1,000 hours of video. See (http://fuzine.ml.cs.cmu.edu/im/informedia.html).
2-) ILLINOIS DIGITAL LIBRARY PROJECT:

This is located at University of Illinois, Urbana Champaign (http://www.grainger.uiuc.edu/dli). Focus here is on providing comprehensive search and display of complete contents of articles, indexing text, figures, equations and tables to articles from engineering and science journals, obtained in SGML format directly from the major partners in publishing industry.

3-) ALEXANDRIA DIGITAL LIBRARY PROJECT:

Located at University of California, Santa Barbara (http://alexandria.sdc.ucsb.edu/), the goal of this project is to provide access to collections of variety of special information, including digitized maps, images, air photos, and other graphical information, relating to the counties of Santa Barbara, Ventura and Los Angeles in California State. The range of the users includes school children, academic researchers and the general public.

4-) UNIVERSITY OF MICHIGAN DIGITAL LIBRARY PROJECT (UMDL):

This project focuses on earth and space sciences (http://sils.umich.edu/UMDL/Homepage.html).

5-) UNIVERSITY OF BERKELEY DIGITAL LIBRARY PROJECT:

The goal of this project is to develop technologies for intelligent access to massive collections of multi-media documents including satellite images, video, full text documents, comprising of multiple terra byte databases (http://http.cs.berkeley.edu/~wilensky).
6- THE STANFORD DIGITAL LIBRARY PROJECT:

The technology developed in this project will provide the "glue" that will make this worldwide collection usable and unified entity, in a scalable and economically feasible fashion (http://www.diglib.stanford.edu/diglib).

7- UNIVERSITY OF CALIFORNIA CD-ROM INFORMATION SYSTEM:

This system provides online access to a CD-ROM based database, through the Web, consisting of published federal (U.S. govt.) statistics covering 1990 census and foreign trade data, equivalent of about 260,000 books (http://cedr.lbl.gov/cdrom/doc/cdrom.html).

8- CORE PROJECT:

This project covers five years of 20 primary journals published by the American Chemical Society, consisting of about 425,000 pages. The data is mentioned in two forms scanned images stored on Sony WORH jukeboxes and as SGML marked up ASCII files, for each page, stored on a SUN UNIX file server.

9- BRITISH LIBRARY'S INITIATIVE FOR ACCESS:

This is a program of 20 development projects, initiated in 1993, to investigate hardware and software platforms for the digitization and subsequent networking of a range of library materials.

The framework summarizes what are important issues in digital library research and close relation between academic, practitioner, user and policy-making communities. "We should provide a valuable tool for understanding the nature of digital libraries and for comparing and analyzing the results of research and experience of
practice," as stated by Ian Rowlands and David Bawden (1999). See Figure (1.1.1) for understanding the digital library.

To understand the interaction between the digital libraries and society, some examples have been presented as follows: Humanity Development Library, a collection of some 1,200 authoritative books and periodicals, produced by many disparate organizations on various areas of human development, from agricultural practices to economic policies, from water and sanitation to society and culture, from education to manufacturing, from disaster mitigation to micro-enterprises. It contains 160,000 pages and 30,000 images, and occupies a small library book stack. It produced using the Greenstone software, and freely distributed open source project. Collection built with Greenstone offers simple but effective searching and browsing facilities based on metadata and full text of electronic documents. However, the collection maintainer may choose to present the original source document (whether Word, PDF, PostScript, PowerPoint, Excel, a QuickTime movie, an audio file or whatever) (Witten, 2002).
Figure (1.1.1). Understanding digital libraries according to Ian Rowlands and David Bawden (1999)62

The Researching Education Development Library is a project of the Department for International Development (DFID). It has a CD-ROM library containing many education research papers and other documents. The UNAIDS Library contains publications in the “Best Practice” collection (including key materials, case studies, technical updates, and points of view). The Health Library for Disasters is the result of collaboration between the emergency and disaster programs of the World Health Organization (WHO) and Pan American Health Organization (PAHO). It contains more than 300 technical and scientific documents on disaster reduction and public health issues related to emergencies and humanitarian assistance (Witten et al. 2002163). Ismail Fahmi
described various technical and social issues in the development of the Indonesia’s National Digital Library Network (Indonesia DLN). The success of the network was attributed to the use of the Protocol for Metadata Posting (PMP) to allow member institutions without a permanent Internet connection to join the digital library (DL) network. In addition to the use and distribution of open source software, and the application of the network of networks concept that motivated and permitted communities to develop their own DL networks that are integrated to the Indonesia DLN. It is interesting to note that the sustainability of the network is mainly due to the distribution of the code as open source (Purbo, 2004114). Byrne (200319) identified the following factors contributing to the complexity of dealing with digital resources:

- Volume and Selection of Electronic Resources.
- Intellectual Property Considerations.
- Absence of or incomplete bibliographic details.
- To catalog or not to catalog.
- Evolving standards.
- Vanishing URL.
- To download or retain the Virtual format.
- Licensing and Costs.
- IT infrastructure and levels of access.
- Number of staff and Expertise.

Digital libraries are currently envisioned to become effective repositories of global knowledge resources, encompassing “all aspects of human activities, from industries to governments, and from education to research” (Chen, 2003a23, p.1). The current of digital portals results in dramatic increase in usage of databases and other electronic information sources (Hamblin & Stubbings, 200359). For instance:
1. The National Science Digital Library (NSDL) (2007) uses visualization software to group and relate concepts, but also offers a text-based interface to enable browsing. For example, individuals can search the NSDL using a specific term such as "Education Technology" and then click on different subcategories of resources on education technology in order to retrieve links to the resources.

2. The Alexandria Digital Library permits geospatial learning as well as longitudinal/ latitudinal and temporal periods of organization. For example, individuals can click on "California" then "San Diego" and choose different maps, air photos and satellite images of the area from 1950 to the present.

These two have the following in common:

a. Each digital library provides nonlinear access to the resources, contains contextual information in the form of textual and visual cues that guide information seeking,

b. demonstrates the relationships amongst resources and functions as self-contained information space by providing immediate access to its materials,

c. Though the formats vary (e.g., mp3, MS Word, Adobe Acrobat), the resources themselves, including images, audio, and motion picture, can be accessed online.

Digital libraries (Fox E. A., et al., 1995; Levy & Marshall, 1995) have been developed to efficiently organize, store, and provide access to the rapidly increasing amount of digital information. Arms et al. (1997) reported an experimental system developed by the National Digital Library Project (NDLP) at the Library of Congress. The work described how technical building blocks were used to organize collection of
materials and word, PowerPoint, and LaTeX, a Supervised learning based method. Hu et al., (2005) have proposed to identify title of the document using formatting and font features embedded within the document. A digital library for computer and information science, also automatically extracts Dublin Core metadata Cite Seer (Giles, Bollacker, & Lawrence, 1998). At the end of this section the researcher enlists the number of volumes held by major US and global libraries from 1910 or earlier to 2002 that are a brief of digital library history as shown in both the tables (1.1.3) and table (1.1.4) respectively (Michael Lesk, 2005).

Table (1.1.3). Number of volumes held by major US libraries (Michael Lesk, 2005).

<table>
<thead>
<tr>
<th>Institution</th>
<th>1910</th>
<th>1995</th>
<th>2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Library of Congress</td>
<td>1.8M</td>
<td>23.0M</td>
<td>26.0M</td>
</tr>
<tr>
<td>Harvard</td>
<td>0.8M</td>
<td>12.9M</td>
<td>14.9M</td>
</tr>
<tr>
<td>Yale</td>
<td>55M</td>
<td>9.5M</td>
<td>10.9M</td>
</tr>
<tr>
<td>U. Illinois (Urbana)</td>
<td>1M</td>
<td>8.5M</td>
<td>9.9M</td>
</tr>
<tr>
<td>U. California (Berkeley)</td>
<td>2.4M</td>
<td>8.1M</td>
<td>9.4M</td>
</tr>
<tr>
<td>New York Public Library</td>
<td>1.4M</td>
<td>7.0M</td>
<td>11.5M</td>
</tr>
<tr>
<td>U. Michigan</td>
<td>25M</td>
<td>6.7M</td>
<td>7.6M</td>
</tr>
<tr>
<td>Boston Public Library</td>
<td>1.0M</td>
<td>6.5M</td>
<td>7.5M</td>
</tr>
</tbody>
</table>

Table (1.1.4). Number of volumes held by major global libraries (Michael Lesk, 2005).

<table>
<thead>
<tr>
<th>Institution</th>
<th>Earlier</th>
<th>1910</th>
<th>1996</th>
<th>2002</th>
<th>Former name, if any</th>
</tr>
</thead>
<tbody>
<tr>
<td>British Library</td>
<td>240 k(1837)</td>
<td>2M</td>
<td>15M</td>
<td>18M</td>
<td>British Museum Library</td>
</tr>
<tr>
<td>Cambridge Univ.</td>
<td>330 (1473)</td>
<td>500K</td>
<td>3.5M</td>
<td>7M</td>
<td>N/A</td>
</tr>
<tr>
<td>Bodleian (Oxford)</td>
<td>2 k (1602)</td>
<td>800K</td>
<td>4.8M</td>
<td>6M</td>
<td>N/A</td>
</tr>
<tr>
<td>Bibliothèque Nationale de France</td>
<td>250 k(1800)</td>
<td>3M</td>
<td>11M</td>
<td>12M</td>
<td>Bibliothèque Nationale</td>
</tr>
<tr>
<td>National Diet Library</td>
<td>N/A</td>
<td>500K</td>
<td>4.1M</td>
<td>8M</td>
<td>Imperial Cabinet Library</td>
</tr>
<tr>
<td>Biblioteca Alexandrina</td>
<td>533 k (48BC)</td>
<td>240K</td>
<td></td>
<td></td>
<td>Library of Alexandrina</td>
</tr>
</tbody>
</table>
1.2) IMPORTANT FEATURES AND ADVANTAGES OF DL

UNECA (2003)\(^{143}\) has described different features for digital libraries such as:

1. Digital libraries are organizations with specific objectives or goals. Most digital library project's objective is to generate, collect, store, and organize information in digital form, and make it available to defined groups of users for searching, retrieval, and processing via communication networks.

2. Digital libraries have functions and processes being undertaken in order to achieve the objectives and goals of the organization. These include selecting resources to be included in the collection; offering access to resources; distributing the resources, etc. These functions and processes are carried out by a combination of human resources and technological resources.

3. Digital libraries are made up digital collections. Digital libraries store materials in electronic surrogates like bibliographic records (metadata) and indexes in addition to full-text documents, audio files, and images some of which cannot be represented or distributed in printed form. These digital works include both internal and external resources.

4. Digital libraries serve a defined community or set of communities. Digital libraries are set-up to serve users, and the information needs of the target community or set of communities determine the information content and services of the digital library.
5. Users through a single user-friendly interface access digital libraries. The main purpose of the user interface is to perform as an 'access and integration layer' to a managed environment of quality assured information sources in local and distributed environments, which are available from many sources (Thomas, 2000).

The salient features of a digital library according to T. B. Rajasheker (1996) are as follows:

1. It is unique referencing of digital objects.
2. Enable 'link' representation to local/external objects (hypertext).
3. Clearly separates the digital library and the user interface by employing client-server architecture.
4. Supports advanced search and retrieval.
5. Available for a very long time (i.e., should not be dependent on specific hardware and software).
6. Supports traditional library missions of collection, development, organization, access and preservation.
7. Integrate personal, group, enterprise, public digital libraries.
8. Supports publishing, annotation, and integration of new information.

The worth mentioning features of the digital library according to Rama Nand Malviya (2008) are as follow:

1. Documents of a digital library are available in digital format. Therefore, any digitization project has to perform several activities such as
assessment and selection of originals, grant applications and fund raising, feasibility testing, costing and piloting, copyright clearance and rights management, benchmarking, quality assessment, metadata design and creation, delivery and long-term preservation.

2. Since the digital library facilitates immediate access to high-demand and frequently used items, its ultimate success depends on the advanced digital technologies. In other words, the present day librarianship deals both digital as well as non-digital information and both types of information is handled by using Information Communication Technologies.

3. Digital libraries are to be used by individuals working alone. Hence, professionals should have undergone an orientation cum training to enhance their skills to perform better work to render effective services in the digital environment.

4. Digital library is capable of meeting the challenges of the Global resource-sharing phenomenon as it is of transferring data within and outside the countries breaking the physical boundaries of data.

Rama Nand Malviya, (2008) described the advantages of digital libraries as a means of easily and rapidly accessing books, archives and images of various types are widely recognized by commercial interest and public bodies. Rama also discussed the advantages of digital libraries as follows:

1. The user of a digital library needs not to go to the library physically; people from all over the world can gain access to the same information as long as an inherent connection is available.
2. A major advantage of digital libraries is that people can gain access to the information at any time, night or day.

3. A number of users can use the same resources at the same time.

4. Digital libraries provide access to much richer content in a more structured manner.

5. The user is able to use any search terms (word, phrase, title, name, and subject) to search entire collection. Digital libraries can provide very user-friendly interface, giving clickable access to its resources.

6. An exact copy of the original can be made any number of times without any degradation of quality.

7. Whereas traditional libraries are limited by storage space, digital libraries have the potential to store much more information, simple because digital information requires very little physical space to contain them. When a library has no space for extension digitization is the only solution.

8. Particular digital library can provide a link to any other resources of other digital libraries very easily, thus a seamlessly integrated resource sharing can be achieved.

9. The cost of maintaining a digital library is lower than that of a traditional library.

UNECA (2003)\(^4\) introduced the benefits of the digital libraries as follow: The major advantages of digital libraries over traditional (paper-based) libraries including faster additional to the data collection with better quality control, improved search functionality and faster access to information found, but also more freedom and reduced
bureaucracy for individual users (IBM, 1994\textsuperscript{53}). In addition to those, there are other potential benefits of digital libraries. These include the following:

1. A digital library is available wherever there is a personal computer connected to the network. Therefore, it can be accessed at workplaces and in the home.

2. Digital libraries' information resources are available for access to users around the clock.

3. In a digital library environment, it is possible and easier to provide access to information resources in other formats that are not possible in the print format environment, i.e., multimedia formats like video and audio.

UNECA (2003)\textsuperscript{143} discussed the infrastructure requirements for digital libraries. The following are some of the human, financial and technological infrastructure issues that should be taken into account while considering a digital library:

1. Availability of appropriate information and communication infrastructure on which the digital library will be built. This will include appropriate hardware, software, and adequate network connectivity.

2. Availability of human resources with appropriate skills. Skills requirements largely depend on the nature and sophistication of the digital library being implemented and may include: hardware specialists, network administrators, database administrators, programmers, content developers, information manager (librarian) etc.

3. The target community of users should have access to the necessary hardware, software, and network connectivity. In addition, users should
have appropriate information skills relevant to the digital environment. They should be able to access and manipulate information in various digital formats—text, video, audio, and database.

4. Availability of financial resources that support and sustain the development of the digital library since hardware, software, and manpower cost money, and so is the maintenance of the technological infrastructure, licensing of access to external resources payment for copyright, etc.

5. Availability of appropriate legal and technical safeguards to guarantee authenticity and integrity of information and protect privacy, and abuse of intellectual property rights and copyright, where are appropriate. In fact, digital libraries raise more different and complex copyright issues than traditional libraries.

6. Availability of standards, which are managed the digital information resources. For good quality information resources, databases, and effectiveness of information searching and retrieval, electronic information management standards should be employed. Standards such as metadata standard, object data construction, data navigation standard are required.

There has been a progressive trend in recent years towards individualized instruction (Geddes and Sturtridge 1982; Altman and James 1980), and with this has come a desire to give the learner greater responsibility for his own learning.
Nowadays, using technology in education and training is not a new process. Traditional technologies such as flip charts, audiocassettes, and even printed materials have been used since their discoveries (Jonassen, 1996). Therefore, the learning styles are important to diagnose the learning input to manipulate its use with some processes to gain the better output. Hence, the most frequently quoted definition of learning styles is Keefe’s (1979a):

“The learning styles are characteristic cognitive, affective, and physiological behaviors that serve as relatively stable indications of how learners receive, interact with, and respond to the learning environment; the learning style is considered as a fixed pattern responding to the environment” (p. 4).

This definition included both internal and external traits to determine individual learning preference and definition was widely accepted. Keefe (1987) stated that the framework of learning styles consists of three dimensions: (a) the cognitive dimension, which is concerned with perception and analysis of data; (b) the affective dimension, which deals with personality elements; and (c) the physiological dimension, which encompasses human body by variables. Dunn (1983, 1984) and Reinert (1976) identified four basic learners' perceptual learning modalities: (a) Visual learning: reading studying charts; (b) Auditory learning: listening to lectures audiotapes; (c) Kinesthetic learning: experiential learning, that is, total physical environment in which learning happens; and (d) Tactile learning: “hands-on” learning such as building models or doing laboratory experiments. Warschauer (1995) pointed out that (a) repeated exposure to the same material is beneficial or even essential to learning; (b) a computer is ideal for carrying out repeated drills because the machine does not get bored presenting the same material and because it can provide immediate nonjudgmental feedback; and (c) a
computer can present such material on an individualized basis, allowing students to proceed at their own pace, freeing up class time for other activities. In Taiwan, most the educational software was designed by PLATO in order to train students effectively and help students get the higher scores in a short time to pass the difficult exams (Joe & You, 2001; H. C. Liu, 2001; M. Y. Liu & Chen, 2004). To this end the multimedia-networked computer provides a range of informational, communicative, and publishing tools that are potentially available to every student (Barnes, 2000; Carico & Logan, 2004; Hazari, 2004; Im & Lee, 2004; McAlister, Ravenscroft, & Scanlon, 2004; Schultz, 2003).

Generally, the Internet includes many different features for communicating and exchanging information. Many scholars (Chapelle, 2001; Dueme et al, 2002; McDonald, 2002; Morgan & Beaumont, 2003; Warschauer, 1998) noted “three main features of the Internet that can be categorized as (a) asynchronous computer-mediated communication, (b) synchronous computer-mediated communication, and (c) hypertext” (pp. 13). Specially, the best example of hypertext, the third feature of the Internet, is the World Wide Web, which is actually a nonlinear, linked, or layered from of information organization whereby documents in a database are connected via hyperlinks (S. C. Chen, 1996; Chiu, 1997; Frizler, 1995; Groeling, 1999; K. W. Lee, 2000; Pilkington & Bennett, 2000; Salmon, 2000). Students can use the World Wide Web to access multimedia documents with clickable links to other documents and look for any kind of information by using a search engine (Graham & Scarborough, 1999; Warschauer, 1995). In particular, the World Wide Web (WWW), incorporating multimedia, hypermedia, and other valuable resources, have helped teachers generate
more alternative learning instruction and enhance learning activities. In order to integrate the WWW into writing instruction, writing teachers should be mindful of the function and limitation of web-based instruction (Barnes, 20008; Carico & Logan, 200420; Hazari, 200456; Im & Lee, 200464; McAlister et al., 200493).

Like the hyperlink on the Internet, the connection among all participants in collaborative learning brings about active learning in a class (S. C. Chen, 199624; Chiu, 199727; Frizler, 199543; Groening, 199953; K. W. Lee, 200085; Pilkington & Bennett, 2000110; Salmon, 2000125). Collaborative learning occurs when learners work in groups on the same task at the same time, thinking over issues together and dealing with complexities. Interaction in a collaborative class can occur among all the participants: the students, instructors, parents, administrators, and even the researchers (Panitz, 1999108; Poole, 2000112; Salmon, 2000125; Walker, 2004146). To state it differently, students can learn to participate both directly and peripherally in activities within a community in the target learning with a view to becoming fully literate (Barnes, 20008; Green, 1998; Horton, 200199; Jonassen, 199669; Knowlton, 200181; Morgan & Beaumont, 200379).

Collaborative learning or group learning is a learner-centered model that treats the learner as an active participant who constructs knowledge from a wide range of experience, information sources, and interaction with the others. Overall, interaction helps students develop communication skills, promotes reflective thought, and enhances in-depth learning (Groening, 199953; Ho & Swan, 200758; Jonassen, 199669; Kling & Courtright, 200380; Lapadat, 200282; McDonald, 200284). Formulating ideas in their own words and receiving feedback and evaluation from their peers, students learn to construct their own knowledge, thinking skills, and meanings socially (Barnes, 20008; Carico & Logan,
The operation of the Internet and the development of the WWW in computer-based instruction in recent years have provided teachers and students with alternative ways of communication (S. C. Chen, 1996; Chiu, 1997; Frizler, 1995; Groeling, 1999; K. W. Lee, 2000; Pilkington & Bennett, 2000; Salmon, 2000). The WWW has created an environment where meaningful learning is fostered and supported. In addition, many scholars (Barnes, 2000; Carico & Logan, 2004; Joe & You, 2001; McDonald, 2002; Poole, 2000; Walker, 2004) indicated that web-based hypermedia instruction (WBI) applies the attributes of the resources of the WWW. Properly structured, WBI can help learners engage in a series of instructional activities that present information, offer practice, and provide feedback to inform learners of their strengths and weaknesses as well as suggestions for learning enrichment or remediation (Bruce et al., 1993; Green, 1998; Kemp, 1993; Lapadat, 2002; Walker, 2004). While students play active and autonomous roles in learning in WBI, teachers may play a role of facilitator, guide, counselor, and information provider (Bickel & Truscello, 1996; Bruce et al., 1993; Green, 1998; Kemp, 1993; Lapadat, 2002; McDonald, 2002; Pilkington & Bennett, 2000; Schultz, 2003; Walker, 2004). Through WBI the students select the learning materials: text, images, and video clips with subtitles. Wallace & Mutooni, (1999) found that the students in WBI actually showed more positive interest in learning than those in the regular class. Because WBI is more student-centered learning instead of instructor-centered learning, students learn materials interactively from themselves, peers, and Internet in addition to their instructors. Agarwal
and Day (1998) also conducted a comparative study on WBI. The participants in their study used information they located on the WWW to complete Web projects. Results indicate that the Web had a positive influence on these students' learning (Y. C. Cheng, 1999; Garrison, 2003; Ho & Swan, 2007; Kling & Courtright, 2003; Lapadat, 2002).

1.3) THE IMPACT OF TECHNOLOGY ON EDUCATION AND LEARNING

The effective use of technology has been shown to maintain learner's interest for long periods, increase retention, offer distance education possibilities, and provide more opportunities for learner (self) directed learning (Jonassen, 1996; Lim-Youngsook, 1996; McDonald, 1996; Young-Shwu-Ching, 1996). McDonald (1996) studied the impact of multimedia instruction upon students' achievement and attitudes. His findings showed that the use of multimedia technology had a positive effect upon student attitude and achievement. As technology continues to become more widely available, and as it is less expensive and easier to use, technology will likely change the methods for delivering instruction (Florini, 1989; Sliwa, 1994; Wilson, 1991). Technology has the potential to support curriculum and policy reform. However, reform efforts alone will not cause the necessary change. There is a reciprocal relation between reform and technology. As Means (1994) argued, technology drives reform in education, but also "education reform makes a school ripe for technology" (p. xii).


1.4) DIGITAL LIBRARIES AND ONLINE RESOURCES OF EDUCATION

There are studies that supported the creation and organization of online resources for classroom use (Dorward, Reinke, Recker, 2002; Means & Olson, 1997; Recker, Dorward, & Nelson, 2004; Summer & Dawe, 2001). This includes the creation of online resources, repositories (digital libraries) to store online resources, and tools to implement the usage of the resources in the classroom. The National Science Digital Library (http://nsdl.org) is an example of such an educational digital library. The NSF-sponsored NSDL provides access to a comprehensive collection of science, technology, engineering and math (STEM) resources targeting all educational levels-prekindergarten through Grade 12, undergraduate, and life-long learners (Zia, 2001). The NSDL describes itself as

"A digital library of exemplary resource collection and services, organized in support of science education at all levels. Starting with a partnership of NSDL funded projects, NSDL is emerging as a center of innovation in digital libraries as applied to education, and a community center for groups focused on digital library enabled science education" (National Science Digital Library, 2002).

Other examples include the Australian Learning Federation (http://www.thelearningfederation.edu.au), the European Union's Foundation (http://www.ariadne-eu.org), EduSource Canada (http://www.edusource.ca), and the California Berkeley Digital Library (http://www.berkeley.edu). Key objectives of these initiatives are to improve teacher and learner access to high-quality learning resources and to increase their use in order to improve education (Recker et al., 2005; Wattenberg, 1998; Zia, 2001). Teachers have access to innovative curricula and can
customize students' learning by introducing new materials and resources, ultimately improving students' educational experiences. Rather than relying on outdated textbooks, teachers can find the most current information and resources and implement these in their classroom in a variety of ways (Wallace, Soloway & Krajcik, 1998). Furthermore, the instructional technology researchers have turned to online resources as a way to help increase teacher efficiency, improve student learning, and lower development costs (Sumner & Dawa, 2001). The widespread availability of online resources on the Internet is perhaps the most valuable technology available to teachers and students (Becker & Ravitz, 2001).

1.5) THE PROBLEM AND RESEARCH QUESTIONS

Evaluation of digital libraries is essential component for the design of effective digital libraries. Digital libraries are designed for users to use. Users connect through a human-computer interface and interact with the digital library; though in some cases the digital library may be an embedded system that is seen only indirectly, however, most commonly, a digital library has an interface for users to search, browse, follow links, retrieve, and read documents. As can be seen in Figure (1.5.1), that interface may be specialized according to what roles the user plays. However, most of the researches on evaluation of digital libraries have applied criteria from researchers themselves. In particular, these studies focused on the usability studies and some focused on evaluation criteria from users' perspectives. Furthermore, users treat the library system as a tool, not as an object of the study. However, researches are available on usability of digital libraries and active learning in digital libraries separately but such a study, which establishes a relationship between learning assessment and usability of digital libraries, is
not available in Yemen country or abroad. Therefore, a study of such nature was felt. In this study, users (academic users or learners) treat the library system as a tool and an object of the study in the area of Human-Computer Interaction (HCI), Field of Education, and Personalized Information Environment (PIE). This study concentrates on digital library as a technique to enhance learning from users’ perspectives.

Figure (1.5.1). User Direct according to Edward A. Fox (1999)

The research questions examined in this research are as follows:

**RQ1**: Do the effectiveness and efficiency of using the digital library materials have influences on students’ satisfaction?

**RQ2**: Does the efficiency of using the digital library materials have influences on students’ satisfaction?

**RQ3**: Does the effectiveness of using the digital library materials have influences on students’ satisfaction?

**RQ4**: What are the influences of learning activities and usability on the ease of use of the digital library?

**RQ5**: What are the differences between students’ experience and using Internet?
RQ6: What are the influences of the digital library learnability on the ease of learn?

RQ7: What are the influences of the time spent for using the digital library on students' satisfaction?

RQ8: Can the number of steps of using the digital library materials lead to the full students' satisfaction?

RQ9: What are the influences of learning activities on students' satisfaction?

RQ10: What are the influences of learning activities on learnability of the digital library?

RQ11: Do the students' activities have influences on active learning?

RQ12: Does the usability have influences on the levels of time spent?

RQ13: Does the usability have influences on the levels of steps?

RQ14: Does the usability have influences on the levels of satisfaction?

RQ15: Does the usability have influences on the levels of learnability?

RQ16: Does the active learning have influences on the levels of information seeking?

RQ17: Does the active learning have influences on the levels of active consuming?

RQ18: Do the learning activities and usability have influences on students' learning?

RQ19: Do the learning activities and usability have influences on students' activities?
RQ20: Do the learning activities and students’ activities have impacts on the digital library usability?

RQ21: Do the learning activities and usability have impacts upon students’ active learning?

1.6) SIGNIFICANCE OF THE STUDY

The present researcher is interested to work in this field because Digital Library Techniques give a new dimension to education technology, are beneficial for the masses, economical by nature, and have very vast coverage area. In the past, the education depended on the traditional library that has physical places to search the information, reading in the specific places or borrow some books, references, journals, etc. At the same time, problems/queries of students remained unexplained for long time, so the students needed much time to solve those queries and get the answers, but as the time has changed now, with the invention of digital libraries it is possible to solve the queries of the students immediately and simultaneously. However, while using digital libraries techniques they are facing challenges like weak server, problem of access, lack of technical knowledge.

Through this humble attempt, the researcher wants to find out the learning activities of the learner while using digital libraries materials and his level of usability is helping to achieve his learning goals. The importance of digital libraries in the field of education cannot be overlooked. The digital library promotes learning through personal ownership and management of the learning process while connecting the learner with the content and communities of learners and educators. Dong and Agogino (2001) referred to that:
"Content and services provided through the digital library will generally include multimedia courseware, digital problem sets and exercises, educational software applications, related articles and journals, and instructional technology services for educators and students, both commercial and non-commercial — all organized and labeled for the purpose of education and instruction... The tasks of the digital library are to find the learning resources, supply useful tips on applying them to current learning goals, and surface information that would aid in the decision to incorporate the learning elements" (p. 2).

Unfortunately, education species are disappearing today at a faster rate than scientists who are able to use traditional means of collecting and sharing information. The use of information and communication technologies to support learning activities (a field now known as education technology) has fostered the educational digital libraries (EDL). So the digital library can be one of the important means used in the educational field especially in the distance learning when the teachers are absent from the classroom and the education processes, and the students need to get information to do their activities in different area of education and improve their levels of learning by using different materials. Moreover, these materials open new channels for students in educational procedures. Tanyss Munro and Ian Pringle indicated to that:

"Distance education materials tend to have been text-based where print materials are exchanged between learner and instructor/tutor by post, courier or through local distance learning centers. Much use is also made of email, chat rooms and other computer-based tools to support learners. Both synchronous and asynchronous exchanges and discussions may take place to support learning, the latter often within set limits of time (a week or two), allowing learners to contribute when it suits them given their other commitments. Discussions among learners and between learner and tutor are easily managed through email, as are links to libraries and databases. Using text-based materials still presents a barrier for learners with limited experience with formal education and with limited literacy skills, however, and audio and visual media can help to overcome this."
Dr. A. P. J. Abdul Kalam (cited in Rama Nand Malviya, 2008) described the role of digital library, as it is where the past meets the present and creates a future. A digital library provides equitable access to knowledge to all people, irrespective of place, caste, creed, color or economic status. Digital library unites rather than divides. Therefore, there is a need to develop digital libraries, and generate user friendly techniques in this area. Unless the difficulties faced by the learners are searched, how can new technologies be developed that solve their problems?

Digital Libraries are not available in Yemen Country at all because higher education is established only in 1970 under Sana'a University and Aden University, which are the first two Universities in Yemen Country. The total of government universities are nine (10) only [Al-Eman, Alahgaff, Dhamar (Thamar), Hadramout, Hodeidah, Ibb, Sana'a, Taiz, Aden, and Al-Baitha], three (3) private universities [Nation University, Science and Technology University (UST), and Saba University] and some centers such as American Institute for Yemeni Studies, Andalus University For Science and Technology, Center for Arab Language and Eastern Studies, Sana'a (CALES), Duke Islamic Studies Center, French Center for Archeology and Social Sciences in Sanaa, Ministry of Agriculture and Irrigation National Council on U.S. - Arab Relations, Queen Arwa University (QAU), Sana'a Institute for Arabic Language, Sheba Center for Strategic Studies (SCSS), The Middle East and Middle Eastern American Center (MEMEAC) at the Graduate Center at CUNY lists the YCMES as a study abroad program, University of Science and Technology Hospital, Water and Environment Centre (WEC), Yemen American Language Institute, Yemen College of Middle Eastern Studies, Yemen Language Center, Yemen Ministry of Public Health. The Republic of Yemen has
been making consistent efforts to bring its entire people into the educational mainstream. Then only Yemen can be in the forefront of academic development on the global platform. In fact, Yemeni government has successfully outlined a definitive strategy with quite clearly laid out plans about improvement of education in Yemen. President Ali Abdullah Salch has set four priorities for the government. They are: 1) improving living conditions, 2) fighting corruption, 3) reducing poverty, and 4) encouraging foreign investments and globalization. Achievement of these objectives is not possible without streamlining the educational system. However, the educational scenario in Yemen is beset with many problems that strike at the root of the effective implementation of the policies of the government. It is an admitted fact that after the dark age of Imam Yahya, education in Yemen has witnessed an impressive era of expansion. Nevertheless, the quality has suffered to a remarkable extent for the sake of making education accessible to the majority. Yemen shares most of the problems of the third world countries. Some of these are large classes, poor infrastructure, and low level of the learners’ proficiency, mixed abilities classes, poor teacher competence and lack of qualified teachers. In order to combat with the given situation of education, Yemen imported teachers along with courses from abroad. They are involved in the task of preparing curriculum, teachers and textbooks. However, all these acts of advancement are stalled due to some gaps and lapses. The literacy rate in Yemen is low and the women’s literacy rate is still lower. Many of the children are out of school and the dropout rate is still very high. All those who pass out are found to be lacking even in the minimum level of proficiency. There is an “absence of participation expected from the society and the pioneering productive organizations in the decision making councils” (Educational Indicators of the Republic of
Yemen, 2005, -6:43, cited by Rama Kanta Sohu, 2008\textsuperscript{124}). In order to enhance learning outcomes, Yemen establishes the first digital collection of information called National Information Center as first step to construct first digital library in Yemen as shown in Figure (1.6.1) below:

![Figure (1.6.1). National Information Center according to http://www.yemen.nic.info](http://www.yemen.nic.info)

This national information center can not provide education materials such as video, audio, animation, graphics, journals, periodicals, articles, etc. because, it is the collection of documents for theses and dissertations and social resources of information such as tourism etc. So the study of digital library, along with its problems and solutions becomes so important to support the higher education in Yemen that the researcher could not resist to take this work in his hands.

No doubt, the scope of research in Digital libraries is very wide. New areas are emerging day by day. Mostly the people from Engineering and Technology are contributing a lot in this field of knowledge; nevertheless researchers in Educational technology and distance learning have also shown tremendous exploration.

Learner's satisfaction is a very important factor in enhancing the knowledge through Digital Libraries. Being inspired by such studies the researcher wanted to explore and assess various types of techniques of digital libraries with special reference to their
usability & effectiveness and to find out their relationship with learners' efficiency, satisfaction & learnability.

1.7) STATEMENT OF THE PROBLEM

The problem is formally stated as below:

"Learning assessment of digital library techniques: usability, effectiveness, efficiency, satisfaction, and learnability”.

1.8) OBJECTIVES OF THE STUDY

The main objective of this research is to assess the major techniques of digital libraries with special reference to their usability, and effectiveness in relation to the learners' efficiency, satisfaction & learnability.

The main variables in this study are usability and effectiveness with reference to digital library and efficiency, satisfaction and learnability with reference to learner.

The specific objectives include:

1. To explore various techniques of learning via digital library;
2. To evaluate these techniques of digital library;
3. To discuss the impact of these techniques on learner’s efficiency, satisfaction & learnability; and
4. To highlight the need for education by using digital library techniques as virtual means

1.9) DELIMITATIONS

As Yemen is a large country, it is difficult to cover the entire geographical area in a single study like the proposed one; therefore, the researcher selected the sample from
the higher education institutions only, (English Language Teaching, Undergraduate final year students of Taiz University) who use Berkeley digital library materials for their learning and teaching process.

1.10) DEFINITION OF IMPORTANT TERMS

Several authors have pointed out that little work is being done to understand usability of digital libraries in any context (Blandford, Buchanan, 200212-200313, 69; Byrne-Kinns, Blandford, and Thimbleby 200019, 181; Borgman et al. 200016, 229; Theng, Mohd-Nasir, and Thimbleby 2001138, 238; Thomas 1998141, Stelmaszewska & Blandford, 2004133; and Judy Jeng, 2005a66, 2005b67). There are a number of methods to evaluate usability of digital libraries according to Askin, 19987; Blandford et al. 200414; Nicole Compell 200110; Kantner and Rosenbaum 199712; Keith et al. 200317; Nielson and Mack 1994104; Pearrow 2000109; Popp 2001113; Rosson and Carroll 2002122; Snyder 2003132. However, for the purpose of this study the following definitions are provided.

1.10.1 USABILITY

Furtado et al. (2003)44 considered “usability” from case of use point of view and added that usability should include ease of learning. International Standards Organization (ISO) defined usability as:

"The context to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use”.

According to Nilson (2003); Kim, Kyunghye (2002)79; and Judy Jeng (2005a66, 2005b67) the usability of a system can have four quality components as follows:

1. Learnability: how easy is it for the assimilation of distinct ways of using DL?
2. Efficiency: how quickly users (learners) can perform tasks?

3. Satisfaction: how pleasant it is to use the design?

4. Effectiveness: how many answers are correct?

1.10.2 ACTIVE LEARNING

In active learning, learners take responsibility for their own education and study strategies to accomplish their goals (Lee & Kim, 1999). Active learning consists of Active Consuming (active reading, active watching, and active listening), Information Gathering (constructing the user's reference collection with ease), and Information Seeking (facilities are needed to locate suitable materials) which are hereby measured by browsing and searching attributes.

1.10.3 DIGITAL LIBRARIES

From the previous section in the definition part of the digital library, this research can pay attention to the following definitions of the digital libraries: IBM (1994) definitions are more of a hybrid digital library, one that includes the features of traditional libraries.

The researcher can define digital library as a means that include a collection of information, which includes video, audio, documents, articles, journals, periodicals, etc. that use to enhance learners' skills, and cognitive and increase learning (formal and informal) outcomes using some activities.
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50


