

The Role of Digital Libraries in Higher Education

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Abstract - Digital libraries are quite new – about 20 years of age. At the same time, they have been growing at a fast pace. Digital libraries have the following characteristics – they store, preserve, distribute and protect contents in different formats and, at the same time, they allow interaction between the user and the contents; they are always present, both geographically and over time; they can make works internationally known, enhancing referencing and citations; they can make public the products of the educational process and let them be used as inputs for further learning. This work addresses some aspects of digital libraries that make them suitable tools to support higher education. Examples are presented.

Index Terms – Citations, digital libraries, electronic theses and dissertations, higher education, open access.

INTRODUCTION – A LITTLE ABOUT DIGITAL LIBRARIES

Digital library projects started in the early 1990s.

One of the first projects was Vatican Library Accessible Worldwide – a partnership of the Biblioteca Apostolica Vaticana, the Pontifícia Universidade Católica do Rio de Janeiro and IBM (Brazil, Italy and USA). The items to be digitized were selected from the manuscript and rare book collections. The prototype server was first tested in July 1995. Mintzer et al [1] presented some results of the project in 1996.

Another, at about the same time, was Alexandria Digital Library (ADL) – a project of the University of California, Santa Barbara. It began in 1995 and the digital items are geographically referenced materials. Unlike the Vatican Project, ADL is still operative and information about it can be obtained from the *What is ADL?* item of the project website [2].

Both projects involved universities but none focused on materials created either by faculty or by students. They aimed at making available collections of very specific items that were produced outside the higher education process.

Almost at the same time, in 1993, at Virginia Tech – Virginia Polytechnic Institute and State University [3], the first electronic theses and dissertations were ready to be published [4] following an initiative of the graduate programs.

After these early activities, a lot has happened in the areas of digital libraries, digital publishing and networking of electronic educational and cultural resources. Side by side with the advancements came a set of challenges, two of them are intellectual property rights in the digital and networked

arena, and digital preservation, an ever growing concern as collections migrate to digital formats and traditional versions are discarded.

In this world of fast change, digital libraries offer many facilities to education in general and to higher education in particular.

This work addresses some of the roles of digital libraries in higher education; comparisons to traditional libraries are also presented. The following section is devoted to each of them. The third section addresses the two challenges – intellectual property rights and digital preservation – for the use of digital libraries in this context. The last section comments on the importance of digital libraries and its networks for higher education.

DIGITAL LIBRARIES AND HIGHER EDUCATION

Over the centuries, libraries have been the keepers and distributors of books, journals, maps and other materials that are used by students in the learning process. They have also been the legal deposit of part of the products of scholarly publications – theses & dissertations, articles, technical reports, etc.

In general, students have been patrons of the libraries of their institutions. In order to make more contents available and thus benefit students and faculty, pools of institutions have engaged in commuting items and/or their copies.

There is no reason for digital libraries not to have the same functions of traditional libraries, except that they can add functions and value due to their digital and networked nature.

Let the different functions of a digital library in the higher education context be examined.

Digital Libraries and Courseware

Books and traditional items have been kept and distributed by the university libraries. On the other hand, class notes, simulators, spread sheets and other materials created by faculty have traditionally been made available by their authors through copies in an informal distribution situation.

The use of ICT – Information and Communication tools has changed the informal distribution to computer and networked based solutions. As consequence, a great amount of contents became available from computers lacking the necessary identification and access control. Identification (description of the digital contents) is important for the search and retrieve actions by users.

The LTSC – Learning Technology Standards Committee [5] is a committee of IEEE – Institute of Electrical and Electronics Engineers [6] whose mission is ‘to develop technical Standards, Recommended Practices and Guides for software components, tools, technologies and design methods that facilitate the development, deployment, maintenance and interoperation of computer implementations of education and training components and systems’, as stated on the LTSC web page. The use of digital contents in education has become so important that LTSC has one of its working groups with the specific mission of addressing metadata for LOs. The work of the LTSC is heavily based and interrelated to the developments of the Ariadne Project [7], the IMS Global Learning Consortium [8] and the actions of NIST – National Institute for Standards and Technology [9].

Two of LTSC’s areas of work are closely related to digital libraries which must comply with the specifications for metadata for LO – Learning Object identification and their management functions.

Digital libraries are suitable tools to manage courseware and additional reference items used in class. Some reasons for this use are:

- Management of documents in all formats in a unified way – texts, animations, interactive exercises, audio files, video streams, e-books, e-journals and online tests can be stored, described and distributed through computers and networks. The management is independent of the type of information, as long as it can be stored in digital files. It also can be shared without human intervention making the whole process faster and cheaper.
- Access control – contents can be assigned different types of access according to the classes of users that are entitled to them. Authors can decide if their works are to be used by their students only, by any student of a given institution or the public in general.
- Content sharing – authors can make their contents available for other faculty to aggregate into their courseware. This can be done without duplication, simply by ‘pointing’ to the contents with the suitable set of metadata elements.
- Interactivity – contents that are managed by digital libraries can be interactive and based on multimedia. Students can listen to soundtracks, view animated images, solve exercises and have them checked online, write and send comments to authors and/or tutors.
- Customization – some users may require special characteristics of the contents and the system. This is true when people with special needs are involved, for example, persons who are blind or visually impaired. System interfaces and contents in digital formats can be customized to fulfill these necessities.
- Reuse – courseware can be developed with a granularity that makes it flexible to combine and support multiple syllabus. Reuse is important because developing courseware is expensive and takes time, so increasing reuse improves efficiency. An example of the importance of this topic can be seen from a note on the Clips & Pinters section of the D-Lib Magazine [10]

presenting the results of the study “Long Term Retention and Reuse of E-Learning Objects and Materials” [11] that was funded by JISC – Joint Information Systems Committee [12] in the United Kingdom.

- Cross-institution cooperation – digital libraries in general are connected to the Internet, this allows that contents be used from different cooperating institutions, as long as the LOs are described (metadata) and managed in a suitable way. An example of the importance of cooperation is MERLOT – Multimedia Educational Resource for Learning and Online Teaching [13], an organization whose mission, as stated on the website, is “MERLOT is a leading edge, user-centered, searchable collection of peer-reviewed, higher education, online learning materials created by registered members, and a set of faculty development support services. MERLOT's vision is to be a premiere online community where faculty, staff, and students from around the world share their learning materials and pedagogy. MERLOT's strategic goal is to improve the effectiveness of teaching and learning by increasing the quantity and quality of peer reviewed online learning materials that can be easily incorporated into faculty designed courses.” Digital libraries are useful tools to manage large quantities of LOs.
- Any place and at any time – students study in different hours of the day any day of the week, this is more significant when distance learning is considered. Students can be in any country and accessing courseware anytime. Since digital libraries are available 24/7 (24 hours per day, 7 days per the week) and the Internet connects the whole world, courseware is always available from any geography.

At PUC-Rio, there has been some experience in the use of digital libraries to manage courseware. The results have been satisfactory in terms of access and sharing levels [14]. The Maxwell System [15] allows 5 access levels and 4 sharing levels, and this has given faculty a reasonable flexibility in the use of contents, yielding a fair amount of reuse of basic contents [16].

Digital Libraries and References

Students go to libraries to look for materials that go beyond course contents. They seek additional books, journals, theses & dissertations, technical reports and other items that enhance the learning process.

This is extremely important in the high undergraduate years and in the graduate level. Research is based on a lot of searching, retrieving and reading. So, libraries must carry and make available collections to fulfill this need. Some examples in the traditional world are the subscriptions of scientific journals and conference proceedings.

Digital libraries, like their traditional counterparts, can hold reference materials. In addition they have all the advantages mentioned in the context of courseware. At the same time, the characteristics of being available all the time

from anywhere and of cross-institutional cooperation are the strongest points.

Digital libraries in their role of courseware and reference holders and distributors are of paramount importance in distance learning and training. A very special situation occurs in continued education when focusing on training professional staff who works in remote locations, as for example engineers in road and dam constructions, and offshore oil drilling. Current trends in continued education make digital libraries very useful, specially due to the possibility of customization of contents to meet individual needs [17].

Digital Libraries and the Products of Higher Education

In general, when someone thinks about educational contents, courseware comes to mind. But there are contents that are produced by higher education processes. They are results (outputs) of all levels – undergraduate students write projects in order to get their degrees, while master and doctoral students research, write and publish theses/dissertations.

Besides being results of higher education, these works are reference materials used by other students. They are also contents that researchers seek.

Theses & dissertations are specially important items because they contain state-of-the-art results and up-to-date bibliographic reviews. They have received the most attention in terms of dissemination among the results.

The use of digital libraries makes theses & dissertations much more available and, for this reason, much more visible. Besides this, ETDs – Electronic Theses and Dissertations allow multimedia to be used making the works richer and more attractive.

In 2000, Hagen and McMillan [18] presented some interesting points related to ETDs; two are worth being mentioned. The first is that much of the research developed during graduate work ends up by not being published in journals and for this reason is not known. Digital libraries make this knowledge easily and widely accessible; the whole process is much faster than traditional publication. Virginia Tech started requiring ETDs in 1997; the total requests for theses and dissertations rose from 31,171 in 1996 to 1,090,113 in 1999. The second important point is the decrease in administrative costs: paper, binding, handling and shelf space.

Universities all over the world have engaged in ETD projects. A lot of work has been done in the various countries and in the international scenario. Some countries established national consortia of ETD digital libraries and a national union catalog, as for example Brazil and Lithuania; others have national regional consortia, as for example the United States; a third group is composed by countries that have formed regional multi-country consortia like the Australasian Digital Theses Program; another group of countries has consortia and individual university contributions, like the United States; and some countries have only individual contribution from the universities.

No matter the type of organization, these institutions have decided to establish standards of operation, to allow

interoperability, and have joined NDLTD – Networked Digital Library of Theses and Dissertations [19]. NDLTD is an initiative that began in 1996 at Virginia Tech and “is a collaborative effort of universities around the world to promote creating, archiving, distributing and accessing Electronic Theses and Dissertations” [20]–[21]. Their objective is to make ETDs available worldwide and as easy to find as possible. Currently, the NDLTD union catalog has over 300,000 records of online full-text theses & dissertations from all over the world.

All universities that have ETD digital libraries have experienced the increase of accesses to theses and dissertations and also an international interest for the works. At PUC-Rio, the access statistics of the Maxwell System show that five ETDs had more than 5,000 accesses in 2006.

Following subsections will address the organization of these union catalogs and the open access movement.

Digital Libraries and Scholarly Publications

Universities have contributed to a class of publications referred to as “scholarly publications”. The availability of personal computers connected to the Internet has allowed researchers to report results through these systems in addition to the traditional printed journals.

Van de Sompel and Lagoze [22]–[23] mentioned that the fast pace of research results in the sciences has required alternative forms of publication to overcome the latency times of traditional peer-reviewed journals. At the same time, the rising costs of journal subscription have also yielded the need for alternative ways of publishing.

According to the authors, these two factors and the availability of computers and networks paved the way for scholars to publish research results on the Internet. Many repositories have been created to communicate scholarly results in the form of E-Prints (pre-prints). The possibility of making the repositories interoperable in order to bridge them, so results could be found, led to a set of meetings, the first one in Santa Fe, NM, in 1999. The result of this activity was the broadening of the scope to go beyond E-Prints and the creation of the Open Archives Initiative [24].

The Open Archives Initiative implemented the OAI-PMH – Open Archives Initiative Protocol for Metadata Harvesting that is used to automatically collect metadata from repositories and deposit them on union catalogs for integrated search. OAI-PMH is used for any type of digital contents and ETDs use it to build the many union catalogs all over the world.

Digital Libraries and Open Access

All over the world, intellectual property rights (IPR) are protected by law. This is important because IPR are basic rights of democracy and stimulus for intellectual creation.

At the same time, authors may want to share their works, specially in the academia. This is the idea behind the Creative Commons [25], a non-governmental organization created in 2002. The goal of this organization is to help authors share their works under the idea of “some rights reserved” instead of “all rights reserved”. They neither

suggest that authors' rights be violated nor that copyrights be abandoned; only that works be shared in the extent authors find suitable. The motto on their website is "Share, reuse and remix – legally". This motto contains ideas that can easily be implemented if digital libraries are used to manage digital contents.

Creative Commons defined a set of six types of licenses for contents to be shared. When an author decides to use the CC idea of content sharing, one of the types must be chosen. The use of CC licenses has become quite popular. At PUC-Rio, a book on Engineering Education [26] was published on the Internet under CC Attribution-Noncommercial 2.0. From the day it was made available (November 11, 2005) until April 30, 2007, it was accessed 5,269 from 40 different countries. It is important to remark that it is written in Portuguese.

Currently, there is a worldwide effort towards Open Access (OA) to information. Some remarkable events towards this goal can be cited.

The first is the event that was held in Budapest, Hungary, in 2002 – representatives from various types of institutions signed a document of support of Open Access to information; later on, over 4,000 individuals and 300 institutions subscribed it. This meeting is known as Budapest Open Access Initiative [27]. The second is the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities [28]; it was signed during the Conference on Open Access to Knowledge in the Sciences and Humanities in 2003. The third is an action of the Humboldt University [29] in Berlin; in May 2006, the Senate of the university approved the Open Access Declaration of the Humboldt University Berlin [30] encouraging its scientists to publish in open access journals and making available technological infrastructure for this to happen.

Digital libraries are suitable to hold and distribute open access materials – they can manage contents and, with OAI-PMH data providers, make metadata available for harvesting for union catalogs. They can multiply accesses because of interoperability and the existence of an active worldwide digital library community.

It is important to assess the importance of Open Access to higher education. It can be viewed from two different points of view.

Initially, the student or researcher looking for references must be considered – the more contents are made available the better. Knowing previous results avoids duplications and waste of time and funds. At the same time, the search must be efficient and this is accomplished with digital libraries that are compliant to standards and best practices.

The second role is that of the author of the works – in the academia citations are a measure of quality of the works. This second vision is directly related to the impact factor introduced by Garfield in 1955 [31]. A lot of discussions have been devoted to impact factors and how they can be biased, perfect, etc. An interesting item of this discussion was introduced by Garfield [32] almost 40 years after his first work, where he states that review articles are more cited because they contain extensive bibliographies; this is a characteristic of ETDs and students always mention this is an important motivation to access them.

Stevan Harnad et al [33] presented interesting results comparing the impact of articles published in OA journals when compared to traditional ones. They suggest there are two roads for articles to be accessed – the golden road of OA journals and the green, where both traditional and OA versions exist (green because the authors granted "green light" for OA publishing). After examining the numbers, there is no doubt that OA articles are more cited and even cited much earlier due to the latency time of traditional journals; this generates a positive feedback in terms of citations. Another work [34] shows the shift in the behavior of editor that allows OA versions in parallel to the traditional printed article (pre-prints, pos-prints, both).

Therefore, OA is beneficial to higher education from both points of view. Digital libraries are useful tools to OA.

CHALLENGES FOR DIGITAL LIBRARIES

Digital libraries face many challenges – interoperability; 24/7 operation; multi-language, multi-culture and multi-legislation situations; multiple types of information and ever changing digital formats; information asset security; digital preservation; and IPR – Intellectual Property Rights.

The last two seem to be the most crucial. Worldwide many efforts have been devoted to the study of these two topics and to finding solutions for the problems they represent in the use of digital contents.

Digital preservation can be seen from three different points: (1) the physical preservation of the supporting medias (HDs, CDs, DVDs, tapes); (2) the technological preservation to avoid technological obsolescence; and (3) preservation of access. Some important actions can be mentioned dating as far as the 1990s.

In 1994, the Commission on Preservation and Access and the Research Libraries Group [35] created the Task Force on Digital Archiving. In 1997, the Commission on Preservation and Access merged with CLIR – Council on Library and Information Resources [36].

The objective of the Task Force was to investigate the means of ensuring "continued access indefinitely into the future of records stored in digital electronic form". The group had members from different organizations interested in the preservation of digital collections – archives, libraries, museums, universities, scholarly societies, publishers and industry. In 1996, the Task Force presented the final report of its activities [37], where problems were identified related to both media deterioration and to technological obsolescence. Analysis was performed on solutions for obsolescence; different types of migration of technology were analyzed along with the issues of integrity of documents and of the information. This document also addresses costs associated with preservation efforts.

In 2003, UNESCO published the UNESCO Charter on the Preservation of the Digital Heritage [38] whose objective is to make governments and all institutions that create digital contents aware of the necessity of the preservation of both contents and access.

A special case of preservation challenge is related to born-digital contents, i.e., contents that have no existed on other media except some type of digital media. This is the

case of computer based simulators, on-line interactive exercises and animations which are important learning objects. Another set of born-digital contents is present in all on-line interaction in companies or between companies and business partners or clients (e-business and e-commerce) and in government actions (e-government). This is an area where archives and archivists are very active due to the mission of preserving institutional and government archival documents.

As higher education migrates from traditional medias to the digital formats, these problems will have to be faced. For example, when theses and dissertations written on paper are no longer used and ETDs become the only format, archival problems will be present concerning the long term preservation of these works. The preservation of born-digital LOs is a current concern specially due to products that are discontinued.

Preservation of access is another big challenge. A news release published by Ascribe [39], on an article written by Dellavalle et al [40], shows the results the authors obtained after searching Internet based reference on medical publications. The numbers are quite surprising: (1) Internet references accounted for 2.6% of all references on more than 1,000 articles published on three medical journals between 2000 and 2003 – New Journal of Medicine, The Journal of the American Medical Association and Science; (2) 13% of the Internet references were lost for articles that were 27 or less months old.

One of the possible solutions to overcome this problem is the DOI – Digital Object Identifier [41]; it is a controlled name assigned to a digital object that does not change, even if its location changes.

The second challenge is intellectual property in the digital world – another point of great attention. The digital world has changed the way information is recorded and distributed, as well as the roles of the actors in the process. Anyone can publish a book on a website, or make a film and distribute it through YouTube, or take pictures and distribute them via e-mail. At the same time, intellectual property laws, in general, were created before the information revolution took place.

In 2006, the British Library [42] launched its Intellectual Property Manifesto [43]. The manifesto deals with the balance between access and authors' rights. It suggests six areas to be addressed.

Another important document is the report written by the Committee on Intellectual Property Rights and the Emerging Information Infrastructure [44]. The motivation of the committee was 'to assess issues and derive research topics and policy recommendations related to the nature, evolution, and use of the Internet and other networks, and to the generation, distribution, and protection of content accessed through networks'. As in the case of the Task Force on digital preservation, this committee had representatives from all interested parties.

Intellectual property is of paramount importance in higher education. One of the reasons is the students must be taught about IPR and how authors' rights must be respected, while research and use of previous works is necessary and must be encouraged. A second reason is that's results of the

higher education process – technical reports, articles, theses & dissertations, books and patents are to be protected.

Intellectual property rights come to discussion when OA is considered and/or when an author must choose a Creative Commons Attribution (license level). So, students as well as faculty will be involved in the world of IPR. Universities will have to adjust their rules and the way they deal with IPR in this new environment.

IPR in the digital age will impact higher education.

COMMENTS

Libraries have been the companions of higher education for many centuries. They have preserved and given access to all sorts of materials – books, manuscripts, rare documents, journals, maps, etc. – that have supported the process of learning. They have also been the keepers of materials produced by students, faculty and researchers – graduate projects, theses & dissertations, technical reports, etc. – in this sense they have functioned as the institutional archive.

It is important to remark that, for institutionally created materials, the library has to grant access while preserving the documents as an archive. Theses and dissertations are scientific works but, at the same time, are parts of the history of the institution.

When a digital library is created, all the functions that have been performed by the traditional library will have parallel in the digital and networked environment.

In terms of preservation, the problem is more complex since two types are to be considered – the physical preservation (as traditional libraries) and the technological preservation, in a world of fast-changing technology.

At the same time, a digital library can perform functions that are impossible with traditional situation and that aggregate value to higher education. These were presented in the second section of this work. Accessibility, availability, interaction, customization and reuse are strong reasons to use digital libraries for higher education even when there are challenges in the digital and networked environment.

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