

Open Digital Library on Digital Libraries

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Abstract—The information revolution we live nowadays provides the technological power that fuels an unmatched need for preserving, collecting, storing, organizing, propagating, accessing, sharing, constructing, etc. information and knowledge, and digital libraries appropriately support this need. They go beyond the basic functions of searching, browsing, and accessing information, towards being much more adaptive, reflective, contextual, and providing for collaborative environments that allow users to contribute (socially constructed) knowledge to the content, both actively by the means of adding semantic annotations, reviews, and so on, and passively via their use patterns, resulting in a vivid information and knowledge core that benefit of both professional and collective wisdom. In this paper we present our collaborative digital library that we have built to support the learning of the digital libraries subject, as a focused collection of digital objects, along with methods for access and retrieval, for selection and organization, and for maintenance of the collection.

Keywords: *semantic collaborative model of digital library, digital content taxonomy, learning objects, contextual services*

I. INTRODUCTION

The information revolution we live nowadays provides the technological power that fuels an unmatched need for preserving, collecting, storing, organizing, propagating, accessing, sharing, constructing, annotating, reviewing, rating etc. information and knowledge, and digital libraries appropriately support this need. A Digital Library (DL) goes beyond the basic functions of searching, browsing, and accessing information, which are available in any information environment, as it is expected to match and extend significantly the capabilities of traditional libraries. Of course, a classical library means more than well-organized warehouses of books, periodicals, maps etc., being a place where people meet to access, share, and exchange information and knowledge. Moreover, the available resources and the supporting services reflect the needs of the communities they serve.

In this paper we present a digital library - DL² - that we have developed to support the learning of the digital libraries subject. We have been constructing DL² subscribing to the Witten and Bainbridge's definition that states that *a digital library is a focused collection of digital objects, along with methods for access and retrieval, for selection and organization, and for maintenance of the collection* [1]. The digital objects that may be included are: text, 2D- or 3D-graphics, animation, audio, video, simulations, dynamic visualizations etc. This definition accords equal weight to both *user* (access and retrieval) and *librarian* (organization and

selection, and maintenance) and, in our opinion, that balance is what differentiates a real digital library from other digital collections. The librarian is often disregarded by DL proponents who have an ICT background, and approach this work from this perspective rather than from the viewpoint of library or information science, which affirm that selection, organization and maintenance are central to the notion of a library, being it digital or not [1, 2, 3]. For example, the selection of the materials to be included in the library is critical, and it has to be performed according to a set of criteria that ensures that each included material serves the library's mission, while the services provided to the users facilitate the use of the materials by the target community. Moreover, the role of the (digital) librarian is extended to cover the digital services offered by the DL [1, 4, 5].

In addition to the classical library services, by being freed of the limitations of physical space, time constraints, etc. digital libraries can be much more adaptive and reflective about their target communities, and they can provide for collaborative environments that allow users to contribute (socially constructed) knowledge to the DL's content, both actively by the means of adding semantic annotations, reviews, ratings, and so on, and passively, via their use patterns. Moreover, the digital libraries of the moment are expected to be contextual, by being able to express the web-like interrelationships and layers of knowledge that exist among the various DL's resources, resulting in a vivid information and knowledge core that benefit of both professional and collective wisdom [6]. The context of a piece of information may be quite complex, and it reflects the diversity of the audiences of a particular digital library, and the differences in how these use and process that information. Context is multidimensional and it includes various aspects: personal, task, device, social, spatio-temporal, environmental, infrastructure, user interface etc. [7, 8].

Unfortunately, the early digital library model based mainly on a catalog of metadata records has not been able to model this rich multi-dimensional information space. First, the metadata records primarily represented individual item properties, failing to capture the complex contextual relationships that surround DL resources, to distinguish among the multiple entities involved: resources, actors, ontologies etc., and to adapt to the evolving information needs [6, 9]. Second, the static nature of the (created once) metadata cannot capture the dynamic context of DL resources, that can express the changes of preferences, patterns of use, knowledgeability etc., and even a shift in the cultural environment [6, 10]. Third, the metadata centered approach of that model cannot deal with the data or metadata dilemma nor provide for a resource centered

paradigm that provide for managing, manipulating, and processing both content and metadata seamlessly [6, 11]. Moreover, a digital library is ought to be resource-centered (as opposed to metadata-centered in traditional library), and it is expected to provide the proper framework for managing, manipulating, and processing both content and metadata seamlessly [6, 12]. What is more, that model has not aimed to facilitate the creation of collaborative and contextual knowledge environments that are expected to provide for instruction, education, personal growth, and so on [6, 13].

To help our library to accomplish its mission that regards helping learners who are interested in digital libraries to become familiar with this subject, we have developed it according to our socio-semantic model that allows both rich bibliographic description of the DL content, and activities such as semantic annotations, reviewing, rating, knowledge sharing etc. over that content. Despite the fact that our library is focused on supporting learning of a particular subject, i. e. Digital Libraries, the model is generic and it can be used for developing any digital library that cover either broad or specific information.

To build DL² we have been using Greenstone, a suite of open source software for building and distributing digital library collections, which is produced by the New Zealand Digital Library Project at the University of Waikato [14]. The content of the DL² library is organized and categorized according to our taxonomy for teaching and learning of the Digital Libraries subject. The materials are gathered from various open sources: MIT OpenCourseWare [15], OCW Consortium [16], OER (Open Educational Resources) Commons [17], The Saylor Foundation [18], Connexions [19], Universia OCW [20] etc., and may be also contributed by our developers and users. The access to our library is open, so anyone can benefit from the included materials.

The rest of this paper is structured as follows: the next section introduces briefly our semantic collaborative multi-layered model, on which the development of DL² is based. Section III describes our taxonomy of resources about digital libraries or DL-related. The related work on digital libraries' support for education is presented briefly in the fourth section. The last section presents some conclusions and points out the future work directions.

II. THE COLLABORATIVE MODEL OF DL² DIGITAL LIBRARY

Facing the challenges that up-to-date digital libraries have to fulfill, it is obvious that modeling the digital libraries of the moment is a tricky endeavor. These models are expected to capture the multi-layered services that work interdependently to provide individual users with the full suite of collections and services that they need. Moreover, they need to incorporate local and distributed information integrated via web services, and to allow the construction of rich hypermedia documents. Furthermore, they are expected to express the complex relationships that exist among objects (information, content, knowledge, and learning objects) and multi-dimensional spaces, agents, services, communities, scenarios, and meta-information (such as ontologies), and thereby represents information resources in context, rather than as the result of

stand-alone web access. Furthermore, these models are ought to facilitate collaborative activities, closing the circle between users as readers and users as contributors to the content.

The DL² digital library is based on our socio-semantic collaborative model that subscribe to the Web 2.0 paradigm (Fig. 1). The Global Information Space lies at the bottom of this multi-layered environment, and it includes all the *eligible* objects to be added to the DL's content (all the published books, journals, articles etc., all the objects on the Internet, and so on). The object selection is guided by the set of criteria that the digital library that is being built is expected to comply with. Thus, every library collection is ought to have a well-articulated *purpose*, which states the objectives to be achieved, and a set of *guiding principles*, which are the directives that will direct decisions on what should be included and, equally important, what should be excluded from the library's content. Therefore, we emphasize that *librarianship* (selection, organization, and maintenance) is crucial, because finally it is the wisdom librarians put into the library by making decisions about what to include, and how to organize and maintain it [1, 2, 3, 6]. The Collection Management Service empowers the (Digital) Librarian with the needed tools to perform the selection of the objects to be included.

Once selected, the digital objects included in the digital library find themselves on the Raw Objects Layer, where they undergo, under the umbrella of the Repository and Indexing Services, various manipulations: storing, organizing, deleting, modifying, indexing, faceting etc., by several people: Digital Librarians, Metadata Agents, ICT Engineers and so on. Facets stand for different semantic viewpoints over the same digital object, and they are tailored by extracting and using the relevant metadata (for example, satellite images have several facets that correspond to meteorologist, volcanologist, agronomist, seismologist etc.). The raw digital objects can be reused, or re-purposed for various contexts on the upper layers.

Going up through the model, the digital objects in the library are processed in a variety of sorts: information objects, content objects, knowledge objects, and learning objects, and lay on two levels: Content Layer and Learning Layer. Both domain and education experts are needed to perform this processing. An information object may be constructed from one or more raw digital objects, and it is not related to any specific objective, instructional or otherwise. It may be used as such in different delivery systems: web pages, knowledge management systems, reference, news, help, E-Learning, wizards [21]. A content object is based on an information object, and it is purposed to serve to an (instructional) objective, to which is linked to. Normally, a content object is short of the instructional value achieved by a knowledge object (*a knowledge object is a precise way to describe the subject matter content or knowledge to be taught* [22]), and of the extra components offered by a learning object: task, topic, prerequisites, guidance, sequencing, feedback, assessment, technical requirements etc. A learning object is built on top of a knowledge object and supports specific learning experiences that address particular objectives, and specific curricular outcomes, and target identified audiences. It can be identified, tracked, referenced, used and reused for a variety of learning experiences [21].

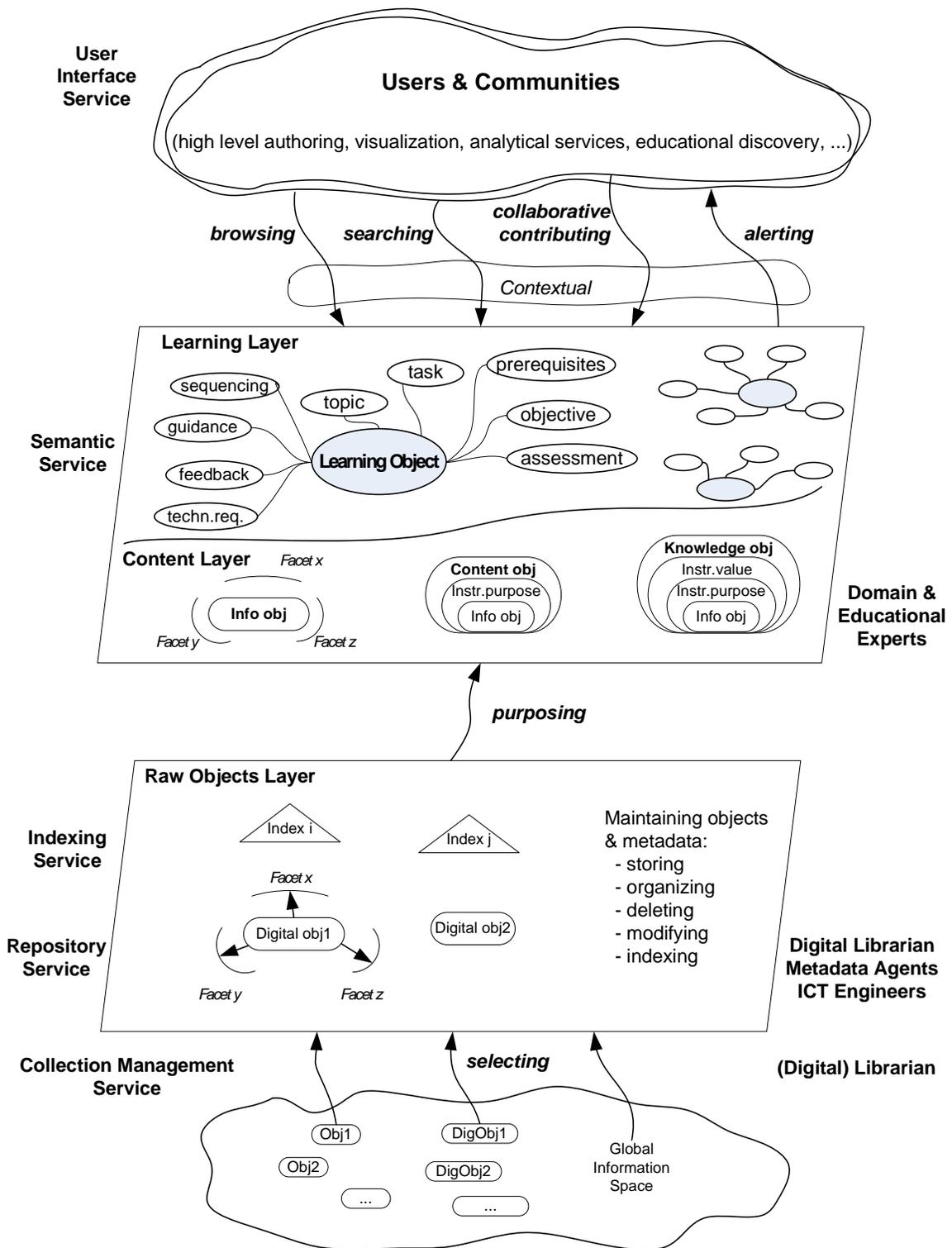


Figure 1. Semantic Collaborative Model of Digital Libraries

Users and communities may access, via the User Interface service, the digital library's content via typical library services, as searching and browsing, and, moreover, they can contribute to it collaboratively by annotating, reviewing, rating etc. the DL resources. Alerting services, high level authoring, visualization tools, analytical services, educational discovery etc. are valuable capabilities to be included as well. Contextual information may be used to supply better services to the user, in a flexible, proactive, and manageable way [23]. The context could include: the provenance of the resource, the ways the resource has been used before, the user comments about it, etc. and it may be used to define the (re-)usability of resources in different experiences, and their quality. Therefore, contextualization is more and more important as a means of adding value to the DL's content.

III. THE TAXONOMY OF DL²'S CONTENT

DL² includes various resources about digital libraries subject that are classified according to our current taxonomy (Fig. 2 include a screenshot with the taxonomy shown via the user interface). First, there are the books! Books' topics range from digital libraries in the broader picture [24, 25], and how-to-build a digital library [1, 3, 26], to issues related to development, access and use of DLs [27, 28, 29, 30], and furthermore, to the future of the digital libraries [31, 32, 33].

Secondly, the course materials on digital libraries, which are openly available in repositories of open educational resources, or developed locally, may be reached via DL². For example, the instructional materials related to MIT's course *From Print to Digital: Technologies of the Word* (available via MIT OCW), or the ones offered by Open.Michigan [34]: *Digital Libraries and Archives* and *Seminar on Digital Libraries* can be both accessed by using DL² digital library. Thirdly, DL² contains also scientific articles from journals or conferences, instructional units or modules about various subjects: what is a digital library, the digital libraries in the global infrastructure, using DLs in humanities, issues and problems in digital libraries etc.

Finally, as an important part of DL²'s mission is to help the interested learners to understand and develop digital libraries on their own, DL projects and examples are included in the content as well. Broad and specific information available digital libraries lie under the projects umbrella, and they may be used by "readers" for searching and browsing only, while the DL examples may be used for learning purposes, from the developer and digital librarian's point of view.

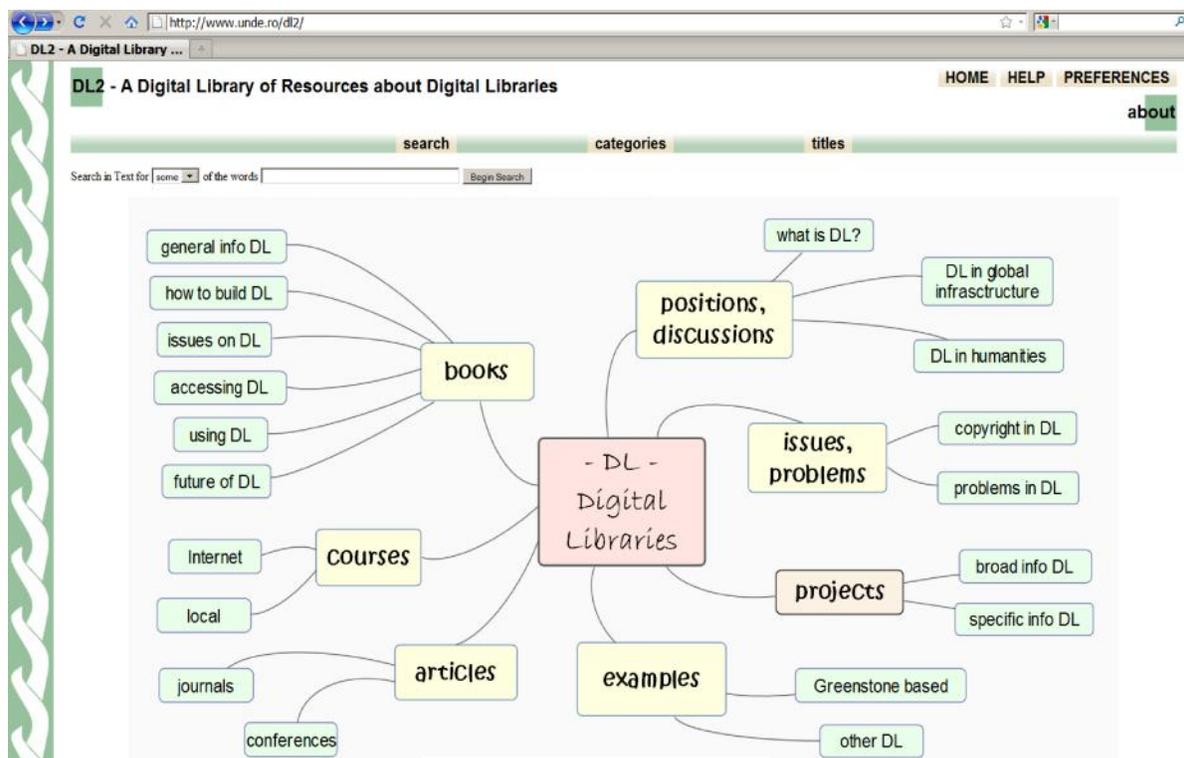


Figure 2. Taxonomy of DL² content

IV. RELATED WORK

The literature includes various works on using digital libraries to support education. The symbiotic relationship between libraries and scholars, within the matrix of digital culture is emphasized in [5], where authors propose models and opportunities for faculty to integrate digital libraries into their professional lives, to collaborate for developing them, to use DL resources to enhance the students' learning experiences, and to participate in online scholarly communities. By integrating DLs into the course development and teaching, the students will be provided with contextual, seamless access to online DL resources and services, and faculty play a crucial role in promoting DL use to their students.

The need for education on the digital libraries has increased significantly over the last two decades, under the pressure of the huge amount of materials being digitized or created digital. In this context, there is a stringent need to approach scientifically the education of staff to develop and manage digital libraries. The main factors that influence the development of professionals in DL education are presented in [35]: educational institutions, professionals, and students involved in library and information management, the library community, the social environment, technical innovation, the balance between the organization and the individual, and the digital librarian profession. Digital librarians are expected to have the needed knowledge and skills in ICT, searching, assessing, selecting, cataloguing, classifying, and preserving the digital resources, and, even more important, to understand the human factors involved in the DL world.

Digital libraries can support effectively also the curriculum development and its areas of presentation, exploration of material, and assessment. Therefore, the students will be provided with *clearer presentations, more focused exploration of the material, and integrated assessments* [36]. The importance of building valuable instructional digital libraries and of involving the conscious user in the process of providing non-authoritative metadata for learning resources, aiming at having fast access to the most appropriate (instructional) resource that is needed for a particular (educational) aim is pointed out in [37]. While notable progress has been made in the development of valuable digital libraries, there is still much to be done both for improving how learning objects are accessed and (re-)used by educators and learners, and for better support for instruction design and for implementation of sound instructional systems [38].

The interactive nature of both mobile devices and DL content create a valuable potential to increase the user engagement level with higher levels of interaction, which has revealed increasing of knowledge gain and reflective thinking. Interactive learning objects, delivered on demand, provide for *support of conceptual learning, inquiry skill building, analytic experiences, or activities anytime, anywhere* [39].

The Importance of Digital Libraries in joint educational programmes is highlighted on [40], where it is shown that the ultimate goal of building joint education partnerships between organizations in developed and developing countries should be *that the quality of education and research will be*

moved forward and digital libraries facilitate reaching that goal. Moreover, digital partnerships between libraries involved in joint educational programmes may remove barriers to information resource sharing and guarantee easier access to the world's knowledge resources for staff and students involved in these programmes.

V. CONCLUSIONS AND FUTURE WORK

The tremendous progress of ICT has already changed substantially the landscape of our everyday life, and nowadays almost every facet of this life is plugged into digital technology. In particular, digital technology has changed the way humans gather, access, use, create, distribute, store, retrieve, and modify information. Digital libraries have a distinct (cultural) role within this digital world, and are characterized by diversity and continuous change. Searchers in general and learners in particular, face a variety of systems, interfaces, infrastructures, protocols, hyperlinked paths, and so on, in a veritable electronic labyrinth.

A wide spectrum of competencies is needed for digital scholars who are expected to use digital libraries effectively and to contribute to their content and to the scholarly online environment. In this paper we have presented our digital library that supports the learning of the Digital Libraries subject. The development of this digital library conforms to our semantic collaborative multi-layered model, which is generic and it can be used for developing any particular digital library with respect to its mission or to its subject. The materials included in our library are classified according to our taxonomy of resources about digital libraries or DL-related. We need to investigate further how to extend the model to adapt to our ever changing world and, moreover, how to include in the future versions of DL² all the key elements of the conceptual model.

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