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The development of an institutional repository service for a large distance education university

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Abstract

This paper presents the process of developing an institutional repository online service in the context of open and distance tertiary education. It describes lessons learned and experience gained from this process, which involved not only technological but also social and organizational parameters, as well as cognitive factors. Other higher education institutes, especially those that may have similar organizational schemes and structures (like open universities), may find this approach suitable and feasible. Through this case study, some useful insights are highlighted regarding different aspects, varying from: the roles of the team members to the various workflows, which might be closely interwoven.

Keywords: institutional repository, organizational engineering, Dspace

Introduction

Hellenic Open University (HOU) is an open and distance learning university that currently has about 28,000 enrolled students, across about 30 undergraduate and post-graduate programs (Hadzilacos et al., 2008). Being an open and distance learning university, the quality of the online services that HOU has to offer to its student is vital. Thus, the need for the adoption of a methodological approach which would tackle effectively complex, interwoven and sometimes contradicting factors (described in the following

sections of the paper) in the design and the development of the online institutional repository service, was imperative.

In the following section, an overview of the services offered through the use of technology to the students of HOU and the impact of the organizational structures on these services are discussed. Also, the methodology and the techniques used in the use case of HOU are briefly presented.

Overview and background

HOU services in conjunction with its organizational structures

Hellenic Open University (HOU) provides distance education to its students and this is reflected to the structure and the design of the courses, as presented herein after:

- universal access to educational resources (in both printed and digital/electronic form) is vital,
- students are encouraged to personal communication with their tutors,
- a small number of consulting sessions between the students and their tutor is organized (about 5 per year).

With respect to the use of Learning Management Systems (LMSs), HOU supports the integrated use of: Moodle[1] LMS and Learning Activity Management System (LAMS)[2]. Except LMSs, various other systems (like: the HOU portal, a webconference system etc) are also used. All the technological tools and services that are being used in HOU are considered as alternative means to communicate and to streamline several aspects of the educational process (Hadzilacos et al., 2008).

Concerning the studies in HOU, the only entry requirement is the successful completion of high school studies. Consequently, students reflect the mean level of experience and competence in the use of electronic services in Greece, which is not high. Thus, "planning for the development of electronic services should address the need for universal access in services of stratified complexity (suitable for each team level in order for all to accept their use) and the organizational aspects of scaling up in numbers and in complexity" (Hadzilacos et al., 2008).

The need of an institutional repository

Many academic institutions worldwide are sharing a common problematic situation: they maintain a large volume of material in various formats (printed, audiovisual and other types), and they face the problem of long-term digital storage and preservation of their data. HOU, which provides open and distance education through a great variety of support services combined with the use of a set of particularly extensive and heterogeneous collections of digital educational material, was also faced with this challenge.

Institutional repositories aim at the enhancement of the organization process of the rapidly developing volume of digital information that circulates in the ecosystem of an academic institution. An institutional repository has the possibility of storing, providing access to, preserving and indexing a wide spectrum of

[1] Moodle, http://www.moodle.org
[2] LAMS, http://www.lamsinternational.com/CD/index.html

digital material, which can be reused in various ways, and be embedded in educational and socio-technical activities of university.

Particularly useful in the description of informational objects or learning objects are metadata which are an inherit part of institutional repositories and (physical or digital) libraries. The library of HOU has tens of thousands of books. For its proper and easy organization and retrieval, several metadata are attached to each book. The role and the importance of metadata, their semantics and the metadata application profile used in the case of the HOU repository are being further explained in this paper.

Design of an information system in its social and organizational context

Software development practice has increasingly revealed the need for Information Technology (IT) professionals to seriously consider human and organizational issues, but it seems that they have failed to incorporate these issues into the systems' development lifecycle in a way that these issues would have a significant bearing upon the specification and development of the technical solutions (Blackler & Brown, 1986; Hemingway,1999;Hemingay & Gough, 1998).

In the design of the UI, end-users may be more or less actively involved. In classical user-centered design methodologies, the opinion of the user may inform (i.e. elicit needs) and evaluate (i.e. evaluate a prototype) the design. In participatory design methodologies, the user actually becomes a co-designer though their participation in the process of solution elaboration and even, in the process of design decisions (Détienne, 2006).

In collaborative design, several socio-technical solutions are possible. The paper will focus in particular on these (Détienne, 2006):

- At the task and organizational level: matching organization structure with task decomposition.
- At the team level: coordination mechanisms through awareness and informal or semi-formal communication.

The design method of a knowledge management system should be able to integrate in the design changes about the system requirements that may occur as the project development cycle evolves. In addition the method should address changes concerning the hosted organization (Plass & Salisbury, 2002). Consequently, the team work had to incline with both the aforementioned solutions, while making available a rapid prototype of the system to a small proportion of users (who are called ‘early adopters’ in the remainder of the paper). Additionally, discussions with the administrators of other instances of Dspace in Greece (such as the instance of the University of Patras and the instance of the University of Athens) were held related to their experience and anticipated problems or weaknesses concerning the use of an institutional repository. From these synergies, the team concluded that cooperation at informal or semi-formal level can grow awareness in a small country and encourage the formation of a community.

Methodology & Techniques

The institutional repository platform was selected with respect to organizational needs and possible future integration possibilities with the rest of the technological artifacts already in use (tools, platforms etc), while also taking into account future thoughts, plans and needs. That was a highly complex,

collaborative procedure, which involved: technological, organizational and economic factors, described below.

Requirement analysis

The requirement analysis involved the following factors:

– Interoperability. According to IEEE, interoperability is defined as "the ability of two or more systems or components to exchange information and to use the in-formation that has been exchanged"(IEEE,1990). It was obvious to the team that the usage of arbitrary metadata accompanying the resources would be a problem concerning the cooperation of the e-services. The attachment of semantically proper metadata is needed in order to foster interoperability between heterogeneous resources. Interoperability with the e-services already in use was an important factor.

– Metadata standards. The aim of the use of a metadata standard (for the scope of their use in this use case) was to enable a selection of a predefined set of metadata that would be appropriate for the description of the resources and the integration of the repository with pre-existing, proprietary library services. Consequently, the use of metadata standards in order to describe the digital resources is one of the critical factors concerning the functionality of an institutional repository. The study of the metadata standards conducted by the team was focused on Dublin Core and LOM, the two most prominent metadata standards in the educational technology field.

– Standards related to the usage of metadata and the exploitation of the existing services. The functionality of the following standards was examined:

(a) SCORM (Shareable Content Object Reference Model) is a set of standard web-based technologies and protocols that allow sharing content and data between different learning management systems (ADL, 2002). Practically, SCORM is mainly used in order to track the progress of the learners while they interact with the SCORM-compliant e-courses, inform the tutor about their performance in a test/quiz etc.

(b) OAI-PMH (Open Archives Initiative- Protocol for Metadata Harvesting) is a significant part of the architecture of distributed services and networking information databases. It is a mechanism through which the data providers (i.e. a digital library) can publish their metadata in other systems. Several external services that also support this protocol can interact with the repository and harvest metadata (OAI TC,2008). So, if a service at the HOU (for example, the cataloging system of the digital library of the HOU) supports OAI-PMH, then it can search and retrieve documents publicly available without any further customization. In the case of HOU, the support of the OAI-PMH was considered a desirable parameter, especially since future plans about storage and harvesting of the metadata of the students' theses (which would be freely accessible by the students and the faculty of the HOU) existed.

(c) Z39.50 (ANSI/NISO Z39.50-1995) is a standard for information retrieval. It enables access to digital resources regardless of their location in the WWW and the way they are stored in the databases, by allowing a 'client' to perform searches in these databases and retrieve the results of a search query. This standard is popular amongst digital library systems, since it allows their integration (NISO,2003). The support of Z39.50 was considered desirable for the same reasons as OAI-PMH: it can foster the

integration with other sophisticated systems, like the OPAC (Online Public Access Catalog) system used by the HOU digital library.

– Long-term preservation of information. One of the main aims of a digital repository is the long-term preservation of the digital resources. Except the kilobits that comprise the informational material per se (for example, a text document), attention should also be placed to the fact that it should be accessible in various formats or stored with its source code etc., since a format may become obsolete or extinct in the future.

– Types and formats of the existing educational and informational digital content. A great volume of heterogeneous educational material was created by the HOU tutors in collaboration with the Educational Content, Methodology and Technology laboratory (E-CoMeT)[3], which was used supplementary to the printed educational material (i.e. printed books). Qualitative analysis conducted by the team revealed a high heterogeneity level, especially in terms of the available formats (mainly: Webcasts, DVDs, software, multiple choice questions and hypertext) and types (bachelor, master and doctoral theses of students, research publications, material already existing in the HOU digital library, proceeding, reports etc.)

– Discussions with the technical staff working at the HOU digital library and other staff from the E-CoMeT laboratory (that have organized, supervised and supported the production of the existing digital educational material), revealed additional requirements, which led to the following conclusion: the storage of the existing digital material in the repository has become a complex matter. For example, a video lecture could be separated to many parts, contain subtitles, presentations etc. Thus, the granularity of the learning objects that may be stored in different locations of the repository as self-contained, re-usable material was a decisive choice. Additional requirements that the repository should satisfy, were the followings:

(a) Support batch import of a large variety of data types, like compressed files, video, images etc.

(b) Support the efficient organization of the material into collections. Without col-lections and sub-collections, the retrieval of the useful material will be of limited efficiency.

(c) Support large files (some of the existing lectures were near the size of a GB) in a single record.

– Existing technological artifacts. One of the main goals of the requirements analysis was to provide insights concerning the integration of the repository with the rest of the technological tools, services and platforms already in use by the university, in order to achieve interoperability between them. These are:

(a) Portal. A related requirement was to host the educational material and inform the HOU portal by providing back to it a unique identifier (URI) for each item.

(b) Moodle. The requirement concerning the integration of Moodle with the online repository service was also the use of unique identifiers that would be referenced by the Moodle environment. Single-Sign-On (SSO) was another additional requirement.

[3] E-CoMeT laboratory, http://eeyem.eap.gr/en/about

(c) Other services: LDAP (directory service) and OPAC. A great proportion of the available educational material is not available to the public. That poses the requirement of having private collections, accessible only from certain group of users (i.e. having specific authorization rules). The adopted solution would also support LDAP authentication.

(d) OPAC is the system used by the librarians for indexing and search purposes. Through an online form the user can perform search queries using various criteria and check the status (available or not, in a physical or digital form) of the resource(s). The system uses MARC records. The integration with the repository can be summarized as follows: once a resource is stored in the repository, it obtains a unique URL. This link could be added to the MARC record so that the users will use the OPAC user interface - with which they are already familiarized - to search within the repository. After discussions with the librarians (especially with the library technician that liaise between the software engineer and the librarian) this solution was considered as satisfactory.

Finally, the integration with other platforms used (for example, the web conferencing system) was considered as unimportant and for that reason is not mentioned in this paper. Many discussions with all the stakeholders were held, so as to get a clear understanding of their needs concerning the online repository service, at least in the near future. Other important factors that affected the procedure reaching conclusions were: informal communication and awareness (Détienne, 2006).

Informal communication was used in order to ensure coordination and reduce the amount of information lost or mis-directed. Informal communication and awareness i.e. common understanding of shared plans, assignments, roles and their modifications and other similar issues were important, since discussions between people with background from different disciplines had to reach a mutual understanding so as not to jump into vague conclusions. One example: reaching a common consensus of the university's current and future needs.

Comparative analysis

The comparative analysis involved the study of the functionality of the following institutional repositories:

1. Dspace[4] is an open source institutional repository software, highly customizable to fit the needs of the hosting organization as follows:

- customization of the UI
- customization of metadata
- configure the "browse and search" functionality
- configurable database
- ability to choose the default language

It preserves all types of digital content including text, still images, moving images, and data sets. It is being developed by the MIT University in collaboration with the Hewlett-Packard labs, and it is fully OAI-PMH compatible. The recent versions of the platform are launched along with two types of UI: one written in Java and the other one in XML code (called Manakin), for easier customization and

[4] Dspace institutional repository software, http://www.Dspace.org/

integration. In terms of metadata, a metadata application profile of the DC (Dublin Core) metadata schema is launched along with the Dspace source distribution, but other arbitrary/local schemas can also be used. On the other hand, the usage of arbitrary metadata schemas and/or metadata application profiles is not advisable, because it doesn't promote interoperability and other desired qualities that each digital item should ideally possess (reusability, modularity etc).

One of the key features of the Dspace institutional repository software is the CNRI Handle System, a system used to provide a unique and persistent identifier (i.e. a URI- Uniform Resource Identifier) for each item stored in the repository. Finally, the Information model of Dspace is comprised of: Communities, Sub-Communities, Collections, Items, Bundles and Bitstreams. Different policies may apply in each of these levels.

2. Greenstone[5] is a software suite for building and distributing digital library col-lections, produced by the New Zealand Digital Library Project at the University of Waikato in cooperation with UNESCO and the Human Info NGO, and distributed as an open source, multilingual software. It supports the latest version of OAI-PMH protocol and the METS (Metadata and Encoding Transmission Standard). The key points of its core business functionality include:

- Distribution on the web as well as on CD-ROM
- Highly customizable metadata and UI
- Multilingual UI
- Platform independence

Greenstone is designed to allow non-specialist users to produce single, individualized, digital library collections (Wittten, 2005).

3. Eprints[6] is a popular open source platform for repositories mostly populated with: research outputs of literature, scientific data, theses and reports or multi-media artifacts from collections, exhibitions and performances. A key point of its functionality is that it supports OAI-PMH for the exchange of metadata between several Eprints services. To ensure the long-term preservation of the digital items, Eprints is using the LOCKSS (Lots of Copies Keep Stuff Safe) system which is actually a combination of technical elements and business-aware elements that can be deployed to ensure the long-term accessibility to electronic journals even if the publisher ceases to exist, or a subscription is terminated, or the acquired content is damaged (Rusbridge & Ross, 2008). The functionality of the LOCKSS system attributes to the fact that it creates copies of the digital material in various locations, in order to prevent unwanted deletions.

4. Fedora[7] is (an acronym of Flexible Extensible Digital Object and Repository Architecture) is a general-purpose, open-source repository. It provides:

- a core repository service, exposed as a set of web-based services with well-defined APIs (REST/SOAP)

[5] Greenstone digital library software, http://www.greenstone.org/
[6] Open Access and Institutional Repositories with EPrints, http://www.eprints.org/
[7] Fedora Commons Repository Software, http://www.fedora.info/

- an array of supporting services and applications including full text search service, OAI-PMH Provider Service, JMS messaging, administrative clients, and more
- RDF support, for example RDF search (SPARQL)
- sophisticated features that support digital preservation.

In conjunction to HOU needs, the advantages of Fedora compared to the other three repositories were: the wide usage of web services internally in the system and its rich information model, through which many different types of digital items can be supported (documents, images, e-books, multimedia, datasets, metadata etc). The content can be of any format and can be stored locally or it can be distributed and be referenced by the repository. Moreover, Fedora can be highly scalable (it can handle more than 1million objects). Batch import of objects is also supported. On the other hand, Fedora has high maintenance cost and its community is less active than those repositories already mentioned (4 times less active that the one of Dspace).

A comparison of Dspace with the other systems already mentioned, such as Eprints and Fedora is available at JISC website (2009). The comparative analysis conducted by the HOU re-search team revealed that all the aforementioned repositories are -at a great extend - capable to support the needs of the university. This analysis compared the repositories based on various parameters and characteristics, such as: support of various formats, degree and type of customization, workflow processes, Greek UI etc. Dspace was finally selected, taking into account not only the functionality parameters already mentioned above, but also other two important criteria, related to the organization's 'ecosystem': existing know-how and interoperability with the existing technological infrastructure used in the university (tools, platforms etc).

The next section presents the work conducted by the team focusing on the significance (in the process of setting up the repository service) of parameters such as: the complexity of the interdependencies between various categories of the stakeholders and their diverse needs, the policies related with different groups of users and the existing technological and organizational infrastructure.

The customization of the open source institutional repository (Dspace)

First phase

The first phase included the integration of the repository with the LDAP-based authentication scheme. For this purpose, additional code was written in Java which resulted to the customisation of the DSPACE LDAP authentication manager and the LDAP servlet module in order to enable mappings with the specific design of the HOU LDAP directory. In this way, the user authentication policy was inclined with the one described in paragraph 2.1.

Following, the design and development of Communities, Sub-Communities and Collections was a two-step process:

1. the configuration of the GUI
2. the development of authorisation policies and the attribution of access rights.

In the process of creating the hierarchical structure which consisted of Communities, Sub-communities and Collections etc, the educational, technological and organizational status described in paragraph 2.1 was a determinant factor. As a result:

– the first level of organization of the digital content (i.e. the Communities) corresponded to the undergraduate and postgraduate programs

– the second level (i.e. the Sub-Communities) corresponded to the thematic units and

– the third level of organization of the digital content (i.e. the Collections) corresponded to specific categories of the digital content. For example: complementary educational material or backup files of the teleconferencing meetings or article re-views etc. For usability reasons, having four levels of hierarchy was considered a bad design choice.

As written in Hemmingway & Gough (1998), "the functionality of a system cannot be considered distinct from the representation of information to its users". Processed data only take on their full meanings when communicated to users as messages in their own language (Witten et al., 2005) and program and interface are fundamentally connected. In alignment with this opinion, the configuration of the UI included processes varying from the localisation of the UI and the introductory texts in the homepages, to logo icons and the selection of colours in the webpages. Most of the design decisions were driven by the aim to achieve consistency with the other existing platforms of the HOU. An additional challenge concerning the representation of the information was related to the semantics of the metadata. The problem was that the available digital content already had metadata attached to it. Their semantics were often contradictory and their translation to the Greek language (as a part of the localisation process of the system) added complexity to the matter.

In the process of the design of the UI, a liaison person (helpdesk) between the students and the team provided useful insights about users interactions with the existing KBS (Knowledge Based Systems) and CMS (Content Management Systems) and how the informational needs, the functionality of the existing services and the students' expectations would affect the social acceptance of the online repository service.

Second phase

The second phase involved the preparation needed in order to store and index the digital items. The heterogeneity of the existing digital (mostly, educational) material was a challenge due to the following reasons:

– the granularity of the learning objects and the digital items, in general

– the authorization policies. This was a complex issue, since it involved the levels of the organizational hierarchy (Communities, Sub-Communities, and Collections) and the groups of users, in conjunction with the various access rights. For example, one user (that belongs to group A) may see the title of the item stored in a specific collection but cannot access the items' webpage; another user (that belongs to group B) has access to the items' webpage and she can see the metadata, but still cannot download the informational material; finally another user (that belongs to group C) can download the

informational material. This flexibility concerning authorization policies is one of the key features in the functionality of the Dspace software

– the accompanying metadata, used so as to cover as sufficiently as possible the informational needs of the stakeholders. As already mentioned, Dspace is using the Dublin Core metadata schema. DC metadata schema is comprised of 22 main elements (simple DC schema) and 65 qualifiers (Qualified DC Metadata Schema). Dspace is launched along with a Metadata Application Profile (MAP) which wasn't suitable for the HOU case. In order to develop a new MAP, the metadata semantics and the indented usage of each of the DC metadata elements needed to be clarified. A technique used to support this purpose was the creation of a 75 to 7 matrix, with the DC metadata elements (including: the Dspace MAP, the simple DC schema and all the qualifiers) in its rows and in its columns check lists (for "yes/no" answers) and text boxes (for open-ended answers) that corresponded to answers regarding the indented and proper usage of the metadata elements. In order to fill in this table interviews were conducted with policymakers and developers of the HOU. The production process of the educational digital material and its evaluation process were also discussed, in order to clarify the usefulness of the elements dc.contributor.*, dc.creator, dc.publisher etc. As a result, a HOU Dspace MAP was built, containing only 15 mandatory metadata elements. A meeting with all the stakeholders was held in order to confirm their acceptance regarding: the basic functionality of the institutional repository, the selection of the Dspace open source software, the semantics and the best practices of the metadata elements comprising the HOU Dspace MAP.

Third phase

The third phase involved the collaborative work on the pilot/test server. During this stage (which lasted several months), the functionality of the Dspace pilot instance of HOU was tested and further optimised by taking valuable feedback (suggestions, but mostly complaints) by the 'early adopters'. Finally, in the production server a private company replicated the previous work done in an upgraded version of the Dspace software. This version was launched with two types of GUIs: the "Manakin" UI (written in XML) and the "traditional" UI of the previous version (written in Java). Since Dspace is open source software, it is being continuously evolving and supported by a worldwide community of developers. For example, the localisation file (in Greek) of the Manakin UI was contributed to the Dspace open source community from one of the team member in collaboration with the Technological University of Cyprus. This collaborative translation was based on the localisation file of the previous version, in order to achieve consistency with the existed terminology, as the types and versions of the UI are involving.

Future plans include working with the Manakin/XML UI, instead of the UI launched via JSPs as well as, the creation of additional Communities and Collections in order to cover all the administrative and informational needs in the HOU.

Conclusions

The paper presented the description of work (focusing on the difficulties) concerning the customization of an institutional repository, viewed as an example of the usage of technology in its social and

organizational context. In a university that offers distance education, the technological artifacts should be designed in relation to many interwoven (and sometimes contradicting) parameters that can be largely anticipated within the context of a socio-cognitive engineering approach. For example, concerning the universal adoption of the specific MAP in HOU, it has opened a passage from a chaotic flexibility in describing and annotating the digital educational resources to a benevolent inflexibility that was finally respected from all. Since this constitutes partly a change of attitude (discipline, respect other people needs, compromising, reaching consensus etc), it was not an easy process.

On behalf of the students, they frequently discuss about this institutional repository service in an online forum. Since this forum was created by the (geographically dispersed) HOU students themselves, they communicate in a spontaneous and informal way through it. Thus, their comments may provide valuable insights on the way they actually perceive the notion of the institutional repository in the context of HOU. Their complaints involve mostly: the volume of the informational items, problems with the authorization process and the process of indexing, which should be more straightforward. Another example on learning preferences: one student wrote in the forum that although this service might be helpful in downloading the available digital educational material, he prefers the printed form. Also, he has written that he would read from his books solely and wait until the books arrive in his house via ordinary mail. It is also worth noted that the students prefer to solve their problems through the forum than to give a notice to the helpdesk. This is being partially explained by the fact that through this forum (which was created years ago) the students have built an online community of interest and have established a sense of trust, a sense of belonging and also a sense of 24/7 'presence'. The ultimate goal of the technical support service would be to establish this kind of relationship with the end users through continuous and reliable communication. With regards to quantitative feedback, the 'Statistics service' has been activated. It provides monthly reports as well as daily reports on user logins, words searched, number of views (Communities views, Collections views, Item views) etc. Finally, after the use of dspace was streamlined, a unit of the HOU called "Unit of Internal Evaluation and Training" incorporated the use of the institutional repository service in the informational/training material disseminated to HOU staff and students.

The added value of the papers is that it may help similar universities and institutions to foresee challenges related to: current and future organizational policies, diverse needs of various groups of users, and technological infrastructure and transform all that into useful input that informs the process of building an institutional repository service, which can some-times be an ill-structured problem, due to its implicit complexity.

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