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A Study to Determine what Kindof Learning Objects are Used in Higher Education Institutions

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Abstract The proliferation of Web-based technologies during the last decade may have given the impression of wide-spread changes in educational practices. In fact the use of Web-based technologies in the teaching and learning process has obtained excellent results. On the other hand, there is also a constant use of educational content /Learning Objects (LO) in different formats and different types of platforms, enhanced by Web 2.0. The current study presents a comprehensive analysis of the use and effect of learning objects in a study about the development, availability and use of LO in Higher Education Institutions. It is reasonable to conclude that the Higher Education Institutions surveyed do not develop and do not reuse LO, which use SCORM and IMS content package specification. Finally, it also presents advantages and disadvantages of the educational use of these LO.

Keywords Learning Objects, Learning Objects Repositories, Standards, WEB 2.0, Higher Education Institutions

1. Introduction

Technologies, in particular the internet, provide teachers with many interesting tools that can be used to improve teaching. The usefulness of these tools makes it important for teachers to have more information about the advantages and possibilities of using technology in the classroom[1], as well as the results derived from their application.

Development, storage and reuse of educational content, commonly called Learning Object (LO), is an issue of major importance that has been studied by the scientific community since the 90s. The Institute of Electrical and Electronics Engineers (IEEE) defines a learning object as "any entity, digital or non-digital, thatmaybe used for learning, education or training"[2].

The LO can be deposited or made available in an e-Learning platform or/and learning objects repository (LOR), for collaborative purposes.

The E-learning platform, also known as a Virtual Learning Environment (VLE), is a computer program that simplifies the so-called e-learning (electronic learning). These VLE are the most popular products and are currently present in almost all higher education institutions, as a backup to distance learning and face-to-face teaching. The ease of interaction content available through synchronous and asynchronous communication tools, make these platforms for educational agents spaces desirable[3].

On the other hand, solutions for e-learning repositories are advancing, offering federated sophisticated searches of learning objects through a network of repositories (Duval E. et al. cited by[4]).

Another important phenomenon is the use of WEB 2.0 tools in the field of eLearning. The current generation of Internet (O'Reilly Web 2.0, 2004) has brought changes in the way the technology relates to society, especially education. With Web 2.0, knowledge has become global and dynamic at the same time. The Internet is a global platform, where sharing information, emotions and experiences, achieveing fairly high level of interactivity. It also provides a set of tools that can store and share content in different formats, allowing one to create collaborative knowledge bases or learning communities.

Downes, in 2006 and Bartolomé and Hambug and Hall in 2008 ranked this phenomenon as eLearning 2.0[5, 6, 7], since the one who directs the operations is the user himself and it easily creates the content and makes it available on the Internet.

However, like the traditional Web, the Web 2.0 lacks data and languages to structure and represent the information (and their meanings) which hinders interoperability and reusability of LO[8].

To work around this problem, the communities of the Semantic Web and Web 2.0 have joined forces to create the so-called Semantic Web Social (Social Semantic Web) or Web 3.0. One can thus create Collective Knowledge Systems in which communities can share information (such as in Web 2.0) and organize and structure meaning (as in

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Semantic Web)[9].

Currently, the community of Artificial Intelligence applied to education is of the opinion that the use of Web 3.0 in education can provide results which are markedly positive when compared with the Web-based learning environments and traditional Web 2.0. Many of these results are available for free on the O4E-Ontologies for Education (http://O4E.iiscs.wssu.edu/drupal/).

However, this reality is still far from fitting in the institutions of higher education as we can see in the study presented.

In this work we start by defining the concepts of Learning Object (LO) and LOR (Learning Object Repository). Then, we present a study that aims to measure the rate of development and use of LO in teaching and learning in higher education institutions. Finally, we present the study's findings and observations about the advantages and disadvantages of the use of IT.

2. Overview

2.1. Learning Objects (LO)

The concept of LO appears related to the evolution of e-Learning, the presence of LMS and the growing number of online courses based on these platforms. These are grounded on an object-oriented programming IT philosophy, the purpose of which is to build small parts to reuse in different learning contexts, just like Lego pieces.

A LO is “a digital resource that can be reused as an educational support "[10].

L'Allier says that a LO "is defined as the smallest experimental structure that contains a goal, a learning activity and a form of evaluation"[11], assuming that goal represents a statement of expected results and criteria of learning activity, the learning activity is the part that teaches the pursuit of the goal, and also assuming that evaluating an element that determines whether the goal was achieved with the expected results.

Merrill defines it as "a way of organizing a knowledge base of resources (text, audio, video or graphics) so that a particular algorithm-reflecting teaching strategy can be used to teach a variety of different contents"[12].

Quinn and HOBBS describe a LO by using four components: content, learning objectives, functions and characteristics of LO[13].

Cisco Systems, says "a LO is defined as having content, interactivity, and metadata. Still, each LO has a goal of learning and, therefore, is also associated with a learning activity, exercises and evaluation to ensure that the new skills and knowledge were purchased "[14].

In the context of this work we have adopted the following definition: a LO is a digital resource with educational purposes that has technical characteristics and which includes pedagogical aspects.

In conclusion, we can say that the concept of LO is subject to multiple definitions, some of which are more restricted than others. They differ in terms of size, scope, content, design, and technical implementation. Polsani observes that "there are as many definitions of LO as there is of a number of users"[15]. However, some requirements seem to gather consensus: Re-use, interoperability, durability and affordability.

Reusing refers to the ability of using in multiple applications and contexts (easy to use and modify). Interoperability is the ability to exchange between different platforms (adapts easily to different systems of e-Learning). The durability is equivalent to the ability of the contents to prevail with changing of technology and knowledge is the ability to remotely access content and distribute it to different locations.

The concept of LO is not only limited to e-Learning systems. Over time, museums, libraries, and other entities have adopted this concept and implemented LOR, developed VLE or online educational multimedia applications.

The LO are typically described by metadata. Metadata is a set of structured data that describe, explain and locate the information[16].

Cataloging LO by using metadata allows these to be distributed individually or combined with others, to form larger learning contents, as well as facilitating their recovery. However, the recovery and reuse of LO is influenced by the degree of detail of the contents (granularity). The granularity corresponds to the level of detail of a component or part of the learning contents existing in learning materials.

The granularity of a LO can vary from a simple image or graph to a complete curriculum or lesson course[2]. However, the higher the granularity of the LO, the greater is your chance of re-use[15].

The main consortia involved in the development of specifications and tools for the generalization of LO are World WideWeb Consortium (W3C), the International Standards Organization (ISO), American National Standards Institute (ANSI), Institute of Electrical and Electronics Engineers (IEEE), Dublin Core Metadata Initiative (DCMI), Instructional Management Systems Global Learning Consortium (IMS/GLC), among others. They created working groups with the aim of defining protocols and standards for specifying and managing metadata.

The efforts of these working groups, among others, resulted in standards or specifications and schemas for metadata (metadata element sets), including: Dublin Core Metadata (DCM), IEEE Standard for Learning Object Metadata (IEEE-LOM), IMS Learning Resource Metadata (IMS-LRM), Model for Metadata for Multimedia Information (MMMI), Meta Data Interchange Specification (MDIS), Multimedia Content Description Interface(MPEG-7), among others. Currently, there is a meta-language to describe features or language for expressing metadata Resource Description Framework (RDF). The use of this meta-language (or metadata that it expresses) adds layers of knowledge content, favoring a true understanding of the

information published not only from the perspective of humans, as well as the machines.

The most popular metadata schema is DCM, while LOM is the most widely used in the field of education. However, RDF is the proposal that most stands out t in the context of WS, since it is a W3C recommendation and enables one to express the metadata elements of DCM schemas and LOM.

The SCORM is a reference model for E-learning content. Currently, this model is composed of 3 sections Content Aggregation Model (CAM), Sequencing and Navigation and Run Time Environment (RTE). The main objective is to standardize the way that the contents relate to the systems that support them (LMS, LCMS). Its main features are: Organization of content migration/portability, reusability and standardization, and versatility.

However, the current learning systems based on the Web have little, or no, inter-operability between themselves, i.e. virtually all available information on a given system cannot be shared with other systems. For example, the interactions and learning styles of a student cannot be shared, because the way to represent the student model varies from system to system[8].

2.2. Learning Objects Repository (LOR)

An institutional repository is a set of services that a university/institution offers to the members of its community for the management and dissemination of digital materials created by the institution and its community members[17].

In recent years, a range of tools have been developed to assist in everything from drawing up preservation plans and policies to extracting preservation metadata from files, alongside modular architectures for linking all the tools together.

In 2010, DCC produced a report that provides a snapshot of the state of the art of preservation and curation in an institutional repository context, noting areas of recent and current research and development, namely: The current provision for preservation and curation in EPrints, DSpace and Fedora; models and architectures of repository relevant to preservation and curation; a selection of preservation planning tools of possible use in a repository context; pertinent developments in metadata and tools for working with such metadata; Technologies that assist in performing emulation, reverse engineering and migration; the issue of identifiers for repository materials; guidelines and tools for auditing curatorial aspects of institutional repositories, and, finally, a selection of tools for calculating the costs and benefits of curation[18].

The files found in these repositories are mainly scientific in nature. However there are also academic resources, including teaching materials. Specifically for educational content and, because of their characteristics and intended audience, the concept of institutional repository evolved into learning objects repository.

A learning objects repository is a system that "enables the storage, discovery and retrieval of metadata and/or electronic objects stored at a local or distributed level" (The JORUM Team, 2006 cited in[19]).

More specifically, a learning object repository (LOR) is a system that manages the access to reusable learning content, as it has been defined by several authors Downes, 2004; López 2005; Namuth, Fritz, King, & Boren, 2005 cited in[19]). MERLOT, PALOMA, EDNA and ARIADNE LOR are some of the prominent LORs. However, some of these repositories are using different metadata schemes to describe the content stored in the repository, research in the field of e-learning repositories is mainly focused on interoperability between LORs.

The GLOBE (Global Learning Objects Brokered Exchange) project is an international effort to create federated search engine over distributed LORs for searching e-learning content[20].

However, the repository universe is much vaster, and goes beyond these options. With the growth of the web, and particularly Web 2.0, many academics ' published ' or shared their learning materials online in an open and informal way which contrasted significantly with the growth of institutional VLEs. Learning materials in VLEs were often ' hidden ' behind authentication systems that resulted in content not being shared across departments and were only accessible to tutors and students on each course. Institutional repositories present a way of bringing the two together and can offer different degrees of openness so that academics can choose how widely they want to share their materials.

Following the trend of integration and interactivity of Web 2.0, some institutions have come to integrate LO into VLE with communication tools and sharing. For example, the Ministry of Education of Brazil (MEC) integrated the repository CESTA ("Coletânea de Entidades de Suporteaou so de TecnologianaAprendizagem"), now called the "BancoInternacional de ObjetosEducativos" (International Bank of Educational Objects), in a teachers' portal. This repository is composed of 7,031 educational resources[21].

Therefore, in a dynamic environment of sharing content and educational practices the ELVs and the LOR have to integrate, thus creating dynamic learning environments to allow the interoperable user to retrieve them by searching through federated repositories, with the ability to modify those objects and compose lessons out of them.

3. Study

3.1. Purpose

The purpose of this study was to examine the development and the use of LO in Higher Education Institutions. As mentioned previously, a LO is a digital resource with educational purposes, which has technical

characteristics (reusability, portability, modularity, standardization and metadata defined by IEEE and IMS) and which includes pedagogical aspects (interactivity, autonomy, cooperation and cognition). We want with this study to answer the following research questions:

1). Does the institution use IT (information and communication), including LMS, to teach courses in eLearning or bLearning? Which LMS is used?

2). Has the institution implemented some repository of scientific contents and/or LO? What are the features of the repository in terms of the content level (scientific, educational resources), content management, cataloging and content access control? Is the repository integrated with other national and international stores?

3). Does the institution develop educational content in LO format? How the development teams are are formed? What are the specifications used?

4). Does the institution promote reuse? How?

3.2. Method

Having identified the problem and research questions, the next challenge resided in the establishment of the research strategy to adopt for the selection and analysis of empirical material that would respond to research questions formulated. This process consisted of:

3.2.1. Literature Review

The Internet was the tool used to search for information about: Web 2.0 and the Semantic Web, LO, specifications for metadata definition and courses, and LOR. The sources used were doctoral dissertations and master's degrees, author texts, articles in scientific and technical journals and access to existing documentation in LOR. Throughout the article the citations refer to the different sources used.

3.2.2. Interview

Taking into account the objectives that were achieved with the completion of the interviews in this work the interviews were, in this work, designed and conducted in alignment with the principles and recommendations laid down and proposed by Holstein and Gubrium, agreeing to what the authors mean by active interview[22].

According to the perspective of the active interview, interview schedules should take the form of a set of guidelines and not be predetermined hard scripts. The schedules must be sufficiently flexible to be built and changed in the course of the interview, so as to explore new directions which were not anticipated. Despite its flexibility, the course of the conversation is always accompanied by thematic and general guidelines stipulated by the interviewer.

On the one hand, we intend to respond to research questions and, on the other, have sufficient flexibility to develop or confirm views on the items under consideration, if there need be. Although the script of the interview was already prepared, based on the literature review, a few questions were made as the interview took place.

The order of the items which were brought up for discussion changed from interview to interview.

The sequence in which items were addressed in the course of an interview proved to be fundamental, allowing for reviews and adjustments, based on the experience obtained from previous interviews.

With this interview format, we could also ask various types of "experts", "instructional designers", technical managers of units of E-Learning as well as teachers.

3.3. Sample

To obtain a sufficiently representative sample we have taken into account two factors:

1). The size and nature of the sample – we decided to ask higher education institutions and University and Polytechnic organic units of different scientific areas including Business, Engineering, Health Sciences, etc., from distinct geographic areas.

2). The selection of interviewees – Select "experts" (responsible for research centres accredited by the Foundation for science and technology (FCT) in the area of the study), "Instructional designers", technical managers of units of E-Learning and teachers.

Having applied these criteria the following 8 institutions were selected:

1). ISEP (Instituto Superior de Engenharia do Porto), organicunitofthe Instituto Politécnico do Porto (IPP)

2). ESEIG (Escola Superior de Estudos Industriais e de Gestão), organicunitofthe Instituto Politécnico do Porto (IPP)

3). ISCAP (Instituto de Contabilidade e administração do Porto), organicunitofthe Instituto Politécnico do Porto (IPP).

4). GATIUP (Support Office for new technologies in education of the University of Porto). The University of Porto is made up of the following Units: the Faculty of Architecture, Faculty of Fine Arts, Faculty of Science, Faculty of Nutrition Sciences, Sports College, Faculty of law, Faculty of Economics, Faculty of Engineering, Faculty of Pharmacy, Faculty of Arts, Faculty of Medicine, Faculty of Dentistry, Faculty of Psychology and Educational sciences, Institute of Biomedical Sciences Abel Salazar.

5). FEUP (Faculdade de Engenharia da Universidade do Porto).

6). CESPU (Cooperativa de Ensino Superior, Politécnico e Universitário), organicunits: Instituto Superior de Ciências da Saúde-Norte (Universityeducation) and Escola Superior de Saúde do Vale do Ave (Polytechnic)

7). ESE (School of education), Organic unit of the InstitutoPolitécnico de Bragança.

8). UAb (UniversidadeAberta). This institution is the only institution of public higher education in Portugal of Distance Learning. In 2010, Distance Learning practiced at UAb was awarded with the Prize of EFQUEL-European Foundation for Quality in Elearning and the certification of The Quality Label for the use of ICT in Higher Education (Universities and Institutes). In the same year, UAb was also qualified by

an international panel of independent experts as the reference institution for teaching in elearning system in Portugal. In 2011, UAb was awarded with the 1st Level of Excellency of the European Foundation for Quality Management (EFQM).

3.4. Results Analysis

The tool used to conduct the analysis of interview was Excel. We chose this type of tool because, in the course of the interviews, we found that there were several questions that had only 2 types of answers (Yes or no) and the most frequent response was no. Thus, there was no need to explore the subtopics related to the issue.

It is important to highlight the fact that the last question was the one that proved important for our content analysis. However, as the information was not much and the categories were previously defined-advantages and disadvantages in the use of LO-we decided to point the referenced by the interviewees in the spreadsheet.

Having performed the analysis of the interviews the following conclusions were reached:

1). Does the institution use ICT (information and communication), including LMS, to teach courses in eLearning or bLearning? Which the LMS used?

All the institutions use LMS Moodle, as a complement to classroom teaching, with the exception of the CESPU UNIVERSITY which is currently in the implementation phase of the LMS. We also noticed that 75% of the institutions teach short courses and/or post graduations with b-Learning. It is important to highlight the fact that Uab only teaches courses with eLearning.

2). Has the institution implemented some repository of scientific contents and/or LO? What are the characteristics of the repository at a content level (scientific, educational resources, Learning Objects), content management, cataloging and content access control? Is the repository integrated with other national and international repositories?

The table 1.shows the types of repositories implemented in the higher education institutions surveyed.

75% of the institutions have implemented a repository of scientific and/or educational content. Most of the content is exclusively scientific. However, GATIUP, FEUP and Uab have scientific content and a reduced number of educational content.

At ISEP there is an educational repositories that files contents in multiple formats (Powerpoint, Flash, ...), catalogued with the LOM specification. In this repository part of the metadata is automatically extracted from the educational content. This repository is accessible only to teachers and students of the institution. The type of access assigned to each content is the responsibility of the author. In the framework of research projects, the Medical Learning Objects Repository, GILT (Graphics Interaction and Learning Technologies) was recently developed, in http://gilt.isep.ipp.pt:8080/melor/. However, this repository does not contain contents used in practice teaching of ISEP teaching.

Table 1. Characterization of the Institutional Repositories

Institution / Unit	Repositories		
	Scientific and educational content	Scientific content	Educational content
ISCAP	-	Yes	-
ESEIG	-	-	-
ISEP	-	Yes	Yes
GATIUP	Yes *	-	-
FEUP	Yes *	-	-
CESPU	-	-	-
ESE	-	Yes	-
UAb	Yes *	-	

* Over 90% is scientific production

ESEIG is currently acquiring online content availability practices in LMS, to support classroom study. It turns out that there is at least one teacher who has developed and uses a repository of educational content. However, the institution has not adopted this practice yet.

At ISCAP a digital content repository is being implemented, aiming to store, disseminate and keep LO accessible using the SCORM specification. However this repository is not yet accessible to the public. Several years ago, it implemented a repository of scientific production that is currently being integrated with RCAAP-open access Scientific Repository of Portugal.

The GATIUP aims to encourage and facilitate initiatives in open and distance learning, taking advantage of Internet technologies, in particular the Web. It is important to highlight the fact that this Office is bringing together professionals from various areas for content production in conjunction with the faculty members (s) that recommend its development. It meets the necessary conditions to, in collaboration with the teachers, develop multimedia materials, in various formats, of interest to the education and training activities of UP. However, these materials are not available in the scientific and educational repository of UP. This material is given to the teachers but stored by GATIUP.

Just like in other institutions, this institutional repository contains mainly scientific production. There is also some multimedia content in various formats, including educational content for students with special educational needs.

In addition to interviewing GATIUP, from the University of Porto, we also decided to interview an "expert", and a technical manager of an E-Learning Unit of FEUP (CIMAT) because this unit is a centre of excellence for the development, provision and reuse of LO due to their mission.

FEUP offers an institutional repository that stores scientific and educational content. We also note that the educational content is significantly less than the scientific one.

Within the framework of a project, it developed LO in SCORM format, in partnership with other institutions, to be used in vocational training.

CESPU is currently implementing an LMS to support in-class teaching.

ESE has a scientific repository – A Digital Library of IPB, which aims to disseminate and permit free access to scientific literature produced by the academic community, promoting integration, sharing and visibility of scientific information and ensuring the preservation of the intellectual memory of the Polytechnic Institute of Bragança.

Within the framework of a research project, it implemented a portal, about 10 years ago, which had as its purpose to promote communication between Primary and Pre-primary schools as well as promoting the same communication of these schools with the community, in general, and with the children and their parents or guardians, in particular, notably through collaborative play teaching tools and content dissemination and promotion. This is still available on the school Website.

At UAb there is an institutional repository that offers educational and scientific content in various formats. The user downloads statistics are available and feature queries.

Repository statistics found that 96% of available resources are in PDF format.

The contents of the courses are made available through the Moodle platform and are the responsibility of the teacher.

3). Does the institution develop educational content in LO format? How the development teams are are formed? What are the specifications used?

No institution develops LO using these specifications. Exceptionally and following the initiative of the teachers some SCORMS were developed. However they are not available for (re) use. FEUP, within the framework of a project developed LO in partnership with other institutions, which are to be (re) used in vocational training.

4). Does the institution promote reuse by showing teachers and students and academic community in general the LO which were developed?

None of the institutions has experience in developing, submitting,advertising and above all (re)using LO that use SCORM and IMS Content specifications.

At the end of the interview, the interviewee was asked to indicate the advantages and disadvantages of using LO using SCORM and IMS Content specifications. The replies to this question are the conclusions presented in tables 2 and 3.

From the study carried out we can conclude that the granularity of LO conditions their (re)use, the higher the granularity, the greater reusability[2,15]. We also note that Web 2.0 made new storage toolbars, interaction and sharing available, which promotes the active participation of its users in the construction and organization of content[5,6,7].

We also observed that the development of LO requires financial resources, qualified human resources in various areas of science and material resources (development offices and production tools and/or sharing). So the effort spent in development is offset when the LO reuse rate is great. This happens in hard format courses, which are replicated in various institutions and in various editions, e.g. vocational training courses.

Table 2. Advantages in the use of the LO in the teachers' practice

Advantages
The use of standards or specifications facilitates interoperability between tools; **
Suitable for self-study*.
Suitable for rigid training courses including vocational courses. The contents are static and trainers are not critical; *
Suitable for the teaching/learning process in the current context, appropriate courses according to the Bologna process*

* All mentioned
** only a few reported

Table 3. Disadvantages in the use of the LO in the teachers' practice

Disadvantages
Teachers, in teaching practices, use educational content with lesser degree of granularity, for example, videos, pdf etc. *
They do not exist or do not appear in LO quality searches. If they did, teachers would use them **;
The development of LO takes up a lot of financial, material and human resources*;
Lack of support offices for production of Lo*.
Lack of human resources for provision and cataloguing; * Format is too hard to be updated frequently. **
The academic community does not value the development of educational contents; **
There is only inter-operability learning in different environments. The part of the communication and registration of existing student activities, in the learning environment, is lost; *
The potential offered by Web 2.0 came make use of educational contents in packaged format (it is not possible to package Blogs and wikis)*
The existence of multiple standards makes interoperability between tools difficult. For example, different versions of SCORM model are incompatible; * The creation of LO in an autonomous way accounts for the lack of consistency in the different CU (Course Unit) *

* All mentioned
** Only a few reported

4. Conclusions and Future Work

The scientific community is faced with the lack of a clear and widely accepted definition of what is a LO[10,11,12,13,14]; although this concept have been studied since the 90s. Thus, it becomes necessary to redefine the concept of LO, taking into account the development of technology in the WEB.

In this article we define LO as a digital resource with educational purposes, which has technical characteristics (reusability, portability, modularity, standardization and metadata defined by IEEE and IMS) and which includes pedagogical aspects (interactivity, autonomy, cooperation and cognition).

The use of specifications in the description of LO enables a good platform of understanding, and in this sense can facilitate reuse.

The study concluded that higher the education institutions surveyed do not develop, do not reuse nor promote the reuse of LO using SCORM or IMS Content specifications. They use educational content with lesser

degree of granularity, for example, videos, Pdf,etc.

The advantages given by the analyzed institutions for the reuse of LO were: suitability for self-study and for rigid training courses including vocational courses.

After this review, it is important to know what kind of educational content/LO teachers use and reuse in their teaching practices. Are the educational contents fully produced by the teachers?Where does the teacher store the contents developed? Does content reuse exist or not? Will Web 2.0 tools answer these questions?

After this review it is important to know what kind of educational contents/LO teachers use and reuse in their teaching practices. Are the educational contents fully produced by the teachers? Where do the teachers store the contents developed? Does content reuse exist or not?

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