

# The Learning Object Pool and the BOA-GPI Case Study

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*Abstract* —The LOP system (Learning Object Pool) is a Learning Object Repository with innovative features with the aim to maximize authors and end-users or learners participation. LOP is intrinsically based on a credits mechanism and uses the “stock exchange market” metaphor for dynamically varying the LOs value according to their popularity. This paper describes the BOA-GPI case study, which is the first real experience in using the LOP system during the fall semester of 2008 in the context of a university course. The results of this case study conduct us to design and develop the LOP 2.0 version, with new and relevant features.

*Keywords* – learning object; learning object repository; e-learning.

## I. INTRODUCTION

The advancement of computer and network technologies are providing a diverse means to support learning in a more personalized, flexible, portable, and on-demand manner. These radical changes in learning needs and technology are fueling a transition in a modern learning in the era of the Internet, commonly referred to e-Learning [1]. There are several definitions for e-Learning; however, a simple one refers to e-learning as “the use of information and computer technologies for creating learning experiences” [2]. E-learning is becoming an ever-increasing way of facilitating education, among others, to students who are unable to attend a traditional on-campus university as well as supporting on-campus teaching [19].

E-learning uses resources like Learning Objects (LOs) to build blocks of learning units [3]. The IMS Content Packaging Specification [4] describes how digital resources can be organized into logical learning units called content packages. LOs are educational resources that can be employed in technology supported learning. LOs enable and facilitate the use of educational content online. Internationally accepted specifications and standards make them interoperable and reusable by different applications and in diverse learning environments [5].

As a consequence, the dominant learning technology employed today is a type of system that organizes and delivers LOs – the Learning Content Management System (LCMS) [6]. A LCMS includes, in addition to other components, LO

Repositories (LORs). Repositories may be viewed simply as a place to put digital objects [3].

In order to take full advantage of LOs, instructors, developers and learners need to know about LORs and have some training in how to make optimal use of them. Repositories may store the metadata describing the LO with associated links and may as well store their content physically [7]. The use of LOs should employ meta-tags for ease of search, retrieval, and use. Metadata is “data about data” and needs to be thoughtfully determined and applied to the LOs. Metadata describes the content, their origin, form, applicability, and other significant characteristics [8]. There are standards defined for LO metadata. It is common to use reference models such as SCORM [9], or metadata standards like IEEE LOM [10] and the Dublin Core [11].

A few of the larger number of LORs that encourage downloading and sharing of resources include the following [12]: Campus Alberta Repository of Educational Objects (CAREO) [13]; Federal Government Resources for Educational Excellence (FREE) [14]; Multimedia Educational Resource for Learning and Online Teaching (MERLOT) [15]; Wisconsin Online Resource Center [16]; SMETE [17]; ARIADNE [18]. Based on McGreal analysis there are three main types of LORs [7]: Content repositories; Linking or metadata repositories; and hybrid repositories that host content and link to external LOs. He analyses also the LORs according to their main functionalities which a LOR should have, namely: Search and Find; Quality Control; Requesting; Maintaining; Retrieving; Submitting; Storing; Gathering; or Publishing.

This paper focuses on how the LOP system can be implemented to support a concrete application scenario based on a university course with about 200 users. It was developed a group of several functionalities under an existing system to response this application scenario requirements. Section 2 overviews the Learning Object Pool (LOP) system and its generic functions. Section 3 describes the adjustments developed on the context of this current work conducted to the LOP, version 2.0 (or LOP2.0 for short). Section 4 presents the BOA-GPI case study, describing and discussing the LOP application at a university course context. Finally, section 5 presents the main conclusions of this research.

## II. THE LOP SYSTEM (VERSION 1.0)

LOP system is a flexible and innovative LOR platform with several features aiming to maximize authors and end-users or learners participation. It is a web application where users submit and retrieve LOs [20]. This repository is different from others because it is based on a credits mechanism and uses the stock exchange market metaphor for dynamically varying the value of LOs.

The LOP system is an application that runs on top of the WebComfort platform [21]. WebComfort is a Web Content and Application management framework, promoted by SIQuant and implemented using Microsoft's ASP.NET 2.0 technology that allows, in a dynamic and integrated fashion, the management and operation of web applications. WebComfort provides mechanisms for content management (structured or not) through generic Web clients (e.g., Internet Explorer, Mozilla Firefox). It also allows access from mobile devices (e.g., mobile phone or PDA), albeit in a more limited fashion [22, 27].

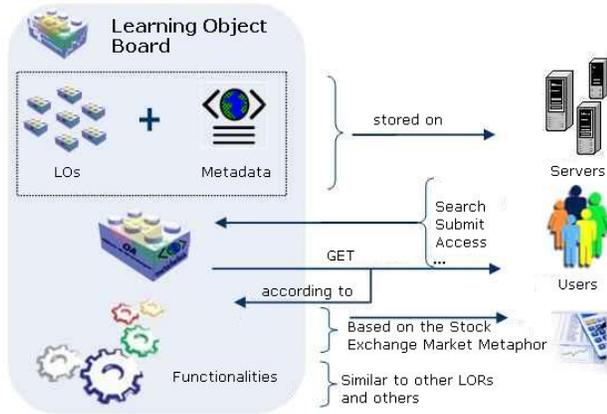


Figure 1. LOP Overview

Figure 1 overviews the main concept and features proposed by the LOP system. Below we introduce its key issues. However, for more information the interested reader should consult [20, 23, 24].

### A. Credits Mechanism

All registered users can buy and submit LOs. Each LO has a value which ups and downs as LO is purchased or not. When a user submits a LO, he establishes the initial value of LO and a minimum value (LO can never get lower than this value). The current value of LO is updated at the end of each day. If there are no purchases, its value decreases. Otherwise, its value increases according to the number of purchases.

Users can buy objects with credits and they receive credits for submitting LOs. They also receive credits when their objects are purchased by other users. This way, users get motivated to submit LOs with quality.

### B. System Configuration

The system is configurable so it can be adjusted for several application scenarios [23]. It is possible to configure values by percentage or absolute value, for example regarding:

- Credits that authors get when they submit or when they “sell” objects;
- Credits that users spend when they buy an object; or
- The increase and decrease rate of LO value update at the end of the day.

Of course, only a user with special privileges (Administrator) can change and configure these values.

### C. Metadata

LOP adopted Dublin Core metadata standard [11] in order to simplify the submitting process. Some metadata definitions were extended to complement the information of LOs. The organization of LOs into topics is one of the modifications which permit better results on searching and categorizing LOs.

### D. Evolution to a new LOP system

Although the LOP version 1.0 (from 2007) presented very innovative functionalities, its application to real application scenarios conducted in 2008 leads to additional functionalities. These functionalities allow the application of LOP system in diverse environments and new situations.

The system will have to provide management functionalities (user and content management), workflows definitions (for quality control and LOs approving) and more configurable values to suit different business rules. Values of LOs are always changing and taking the concept of credits to real life is a challenge.

Still, the following questions conduct our research:

- How much is a reasonable value for an object in terms of “LOP credits”?
- How can we impose certain rules so users cannot submit whatever and whenever they want?
- In a university course scenario, how can we define the process of evaluating the LOs submitted by students?

In the next section, we described how this system was adapted to answer to these questions and the functionalities developed to response to these scenarios needs.

## III. THE NEW LOP SYSTEM (VERSION 2.0)

When the LOP system was preliminary tested by the open community and primarily by university students, they emerged several problems that should be solved to adequate LOP to real scenarios. This section introduces and discusses the new features that conducts LOP to the 2.0 version.

## A. Users

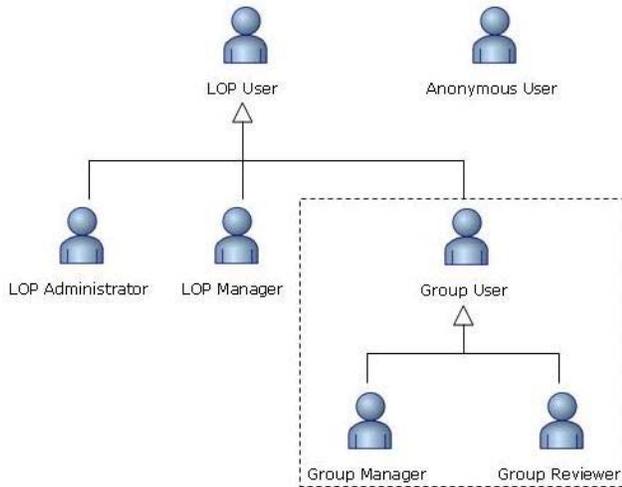


Figure 2. User Roles

Anonymous users can only view and search objects. They are not allowed to buy or to submit objects. The LOP User is a registered user. It is the most common user of system. He is allowed to submit and buy objects. LOP Administrator is responsible to configure some general configuration values and LOP Manager is responsible to manage the LOR. He can create and manage groups, publish objects making them available for other users, and manage users. Group Users are LOP Users who have certain permissions in a Group. These permissions are managed by the Group Manager. Group Reviewers are assigned to a Group and they are responsible by reviewing and evaluating LOs. Groups' features are described in section D.

## B. Repository Management

As it was referred earlier in the paper, LOP provided configurable options. But these options become insufficient to solve some questions that appeared in the real scenarios.

### 1) The time window for LOs submission

Traditionally, in a course, students have time limits to submit their works. So, it was created a feature that enables submission over time. It is possible now to define if the system accepts LOs based on time restrictions or not. This feature was implemented introducing the concept of time-window related to a specific set of topics. This feature is also discussed below on section C.

### 2) How much values a credit

The concept of "credit" might be confused for users. Although LOP provides the configuration of initial credits available for a user at registration time, a user might have some doubts about the value of his object in the system. So, defining a constant initial value solves user's problems. When submitting an object he doesn't have to think if the value is too high or too low. Another advantage of this feature is that all the objects start always with the same value. So, over time, the object will always tend to the most correct value (according to its purchases).

## C. Topics Hierarchy

As it is referred earlier in this paper, LOP provides a categorization mechanism based on a hierarchy of topics. This mechanism was changed to support the time window submission. In a moment of time, users may submit objects only for specific set of topics. Each topic will have in its own definition the start date and the end date for which users may submit objects. This way, it is possible to define milestones for submitting objects of a certain topic.

## D. Groups

Not all users should have the same permissions inside the LOP system. It makes sense that some objects are just available to some set of users. Developing the "Group" concept into LOP, makes possible to share the same LOP instance among different courses on the same university, or among different universities, or even with groups promoted directly by open and online communities.

A Group is defined and created initially by the LOP manager which also associates the group to a specific user with the "Group Manager" role. On the other hand, the group manager is responsible to manage the group through several definitions:

### 1) Users Permissions

Users' permissions are defined into three groups: Viewers, Creators and Reviewers. Users that belong to Viewers can view all objects of that group and buy them. Users that belong to Creators can view and submit objects into that group. Reviewers are responsible to evaluate the objects of that group. This feature is discussed on section D.

### 2) Topics

As different groups can correspond to different communities, the topics may be different according to each group. So, the definition of topics was included in the group definition. When user submits an object, he must first select in which group he will create the object. Then he is able to select which the topics.

### 3) Group Characteristics

Beyond the generic characteristics, like group name and description, the group manager is able to modify other characteristics:

#### a) Group state

Group state can be enabled, enabled only for viewing and disabled. The normal state is enabled – users can view and submit objects for this group. When state is enabled for viewing, users can only view and buy objects. Even creators won't be able to submit objects for this group. Disabling a group makes the group inaccessible to all users. The value of objects of this group won't be updated while the group is disabled.

#### b) Default Group

A group can be checked as the default group, i. e., this group will be available for viewing and submitting objects for all users.

### c) Privacy

If a group is public, then all users can view and buy objects from this group, no matter the viewers' permissions. If a group is private, permissions are set according to users' permission.

### E. Submission Workflow

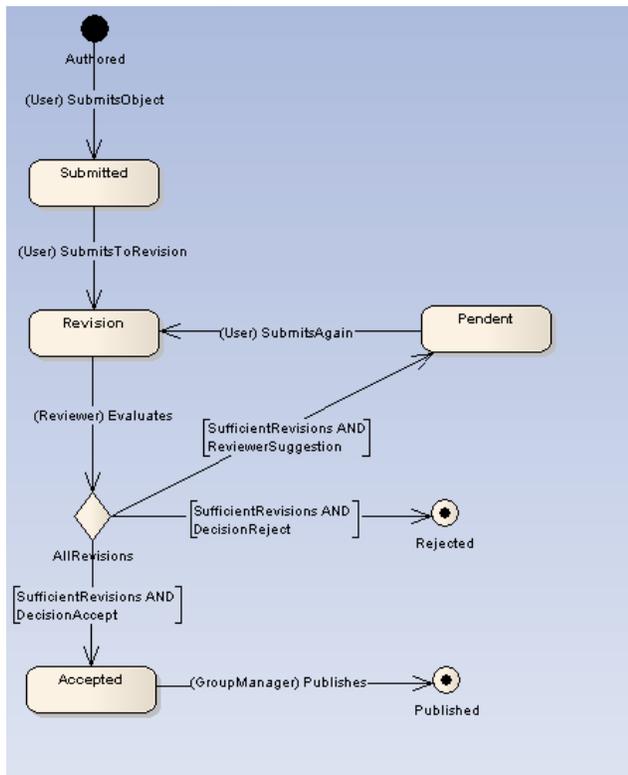


Figure 3. Object State Diagram

Before being published, the object must pass through some states. Figure 3 shows the respective state chart and briefly describes the actions that leads to each state.

When the user inserts an LO and fills the required metadata, the LO become in the “submitted” state. During the “submitted” state, user can make changes to it and modify its respective metadata. The Object stays in this state until submitter gives the order to submit it to revision. At this time, user can no longer change the submitted object. Because object has to belong to some group, the group reviewers can now evaluate the object. As described on the next section, reviewer can accept, reject or suggest changes to author. The state of the object will be “accepted”, “rejected” or “pendent”, respectively. When the decision process leads the object to the state pendent, author can obviously make changes to the object and submit to revision again, leading to another iteration (review process). Reviewers can always consult feedback of previous iterations.

Object will only be available in the system on the state published.

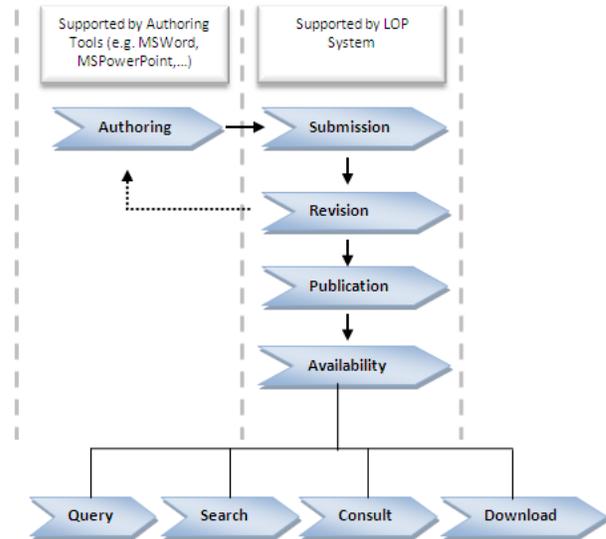


Figure 4. Workflow Overview

Figure 4 shows the operations supported by LOP. After the submission workflow users may query, search consult and download (buy) LOs. Authoring is not in the scope of this research.

### F. Revision Workflow

Although the system encourages users to submit high quality learning objects, they must pass through a review process before being published. The Reviewer Role is applicable to users that were included in the group's reviewers. Because a reviewer has to be someone specialist in a subject, reviewers are associated to topics. A reviewer is responsible to evaluate the objects of his respective topic. He may accept it, reject it, or even give feedback to the author suggesting modifications so that authors can re-submit the object. Reviewer can also give a classification to the object, write down some feedback, and give the authors a credit bonus.

The number of reviewers needed to take the decision and the minimum of reviews acceptance are also configurable options.

### G. Search

LOP provides a simple and an advanced search mechanisms.

Simple search consists on keywords based search, when users just insert a set of words and the system searches it against authors, titles or keywords. It is a simple and quick way of searching LOs.

On the other hand, advanced search (see Figure 5) allows users to search LOs by metadata. It is possible to search LOs by: Title; Keywords; Submission Date; Language; Group; Topic (after choosing the group); Type; Audience Level; Minimum and maximum values; or Revision classification.

### Advanced Search

**Title**   
**Subject and/or keywords**   
**Submission Date** [Any date]   
**Language** [Select a language]   
**Group** [Select a Group]   
**Topic**   
**Type** [Select a type]   
**Audience level** [Select an audience level]   
**Minimum Value**   
**Maximum Value**   
**Division Classification** From 0  to 5   
**Show** 5 entries per page

**Search**

[Simple Search](#)

UBMITTER	TITLE	SUBJECT	TOPICS	CURRENT VALUE	NO. OF PURCHASE
AS	Enunciado do Guia da Aula de Lab1	Introdução ao MS-Project	Outros	9,44	49
JC	Tutorial BOA - Submissão de OA	Tutorial; Submissão de OA	Outros	40,28	50
AS	Template Word para Exercícios de GPI	Template para Exercícios de GPI	Outros	58,29	115
DF	Tutorial MS Project 2007	MS Project 2007 Professional	Outros, Material de Apoio aos Labs	5,00	60
AS	Enunciado do Projecto de GPI - 2008/2009	Enunciado do Projecto	Projecto, Outros	90,28	135

[3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#) [10](#) ...

Figure 5. The LO's advanced search interface

#### H. Other features

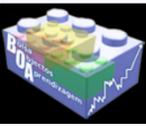
Besides the main features described on this chapter, LOP provides other features to maximize the potential of such system.

##### a) Learning Object Page

The LO Page (see Figure 6) shows the object metadata structured into information groups, such as general information, images, authoring, etc. It is on this page, where the user can get and buy the object, giving him the option to download it. After buying the object user can give feedback, such as improvement suggestions, educational experience,

comments, and give the object a classification. In this page it is showed all user feedback as well.

### Tutorial BOA - Submissão de OA



**Authors:** João Carlota (100%)  
**Users Classification:** ★★★★★ ( 2 classifications )  
**Reviewers Classification:** 3 ( 1 revisions )  
**Current Value:** 40,28  
**Keywords:** Tutorial; Submissão de OA  
**Number of purchases:** 50  
**Number of visits:** 242

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[BUY OBJECT](#)

**General Information**

- [General Information](#)
- [Images](#)
- [Reviewers Classification](#)
- [Users Classification](#)
- [Comments](#)
- [Improvement Suggestions](#)
- [Educational Experience](#)
- [Good Practices of Use](#)
- [Other Information](#)
- [Purchases](#)

**Description:** Tutorial de suporte ao sistema Bolsa de Objectos de tutorial tem o objectivo de indicar aos alunos as in de trabalhos no âmbito da disciplina de GPI.

**Creation Date:** 20-09-2008  
**Submission Date:** 27-09-2008  
**Language:** Portuguese  
**Initial Value:** 10  
**Size (KB):** 298  
**Audience:** Básico  
**Submitter:** João Carlota  
**Publisher:**  
**Format Types:** Texto, Exemplo  
**Group:** GPI2008  
**Topics:** Outros  
**Collaborators:**  
**Object Type:** Single Object

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[Download Metadata](#)

[Go to BOA Homepage](#)

**Object Value Evolution**

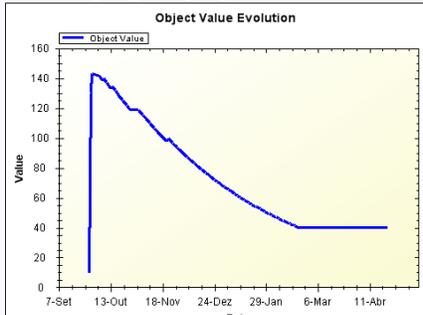


Figure 6. An example of a LO page

##### b) Ranking

Several statistics can be produce from LOP usage. Namely, LOP provides rankings for objects and users.

- User ranking: Objects sold, Credits, Objects purchased, and Authoring
- Learning Objects: Classification (by reviewers and by users), Current Value, Purchases, and Visits.

##### c) Import / Export Metadata

Submitting an object may be a bored task. Filling metadata information can be revealed as a long duration task. So, LOP provides the option of importing metadata instead of filling all the metadata fields in the system. This is useful for submitting objects very similar to others or for submitting metadata that was already inserted in another system. It is also possible to export the object metadata in the LO Page. Import and export of contents is usually done with an interface that converts content to XML and vice-versa [25]. LOP is no exceptions. It provides different formats for importing and exporting

metadata, namely: (i) Dublin Core standards; (ii) LOP specific metadata; and (iii) MS-Excel spreadsheet formats.

Additionally, RSS feature is related with exporting a metadata and is also available in LOP System.

#### IV. THE BOA-GPI CASE STUDY

##### A. The General Context

LOP system was used for supporting a university course, in particular the “Software Project Management” course of the MSc program at the Technical University of Lisbon (MEIC of IST/UTL). This experience was conducted during the fall semester of 2008/2009 where students were the main users (with the “author” role) while teachers performed mainly the roles of “LOP manager” and “reviewer”.

LOP was deployed and configured to support the BOA-GPI system (the Portuguese acronym for “Bolsa de Objectos de Aprendizagem – Gestão de Projectos Informáticos”) [26]. Students used the BOA-GPI to submit their assignments based on a few number of previously defined milestones. These assignments were then evaluated by teachers (with the reviewer role), also supported by the system.

BOA-GPI was used by 184 users, including 5 users with special privileges (LOP Managers, Group Managers and Group Reviewers).

##### B. LOs and BOA-GPI values

Figure 7 shows the plot of the global BOA-GPI value evolution, which corresponds to the sum of all submitted LOs’ values. Typically, the increase of the LOP value is caused by students submissions, and the line’s peaks correspond to the main defined milestones. After the submission due-dates, this value goes down slightly until further submission milestone. By the end of the course, the total number of LOs in the BOA-GPI was 638.

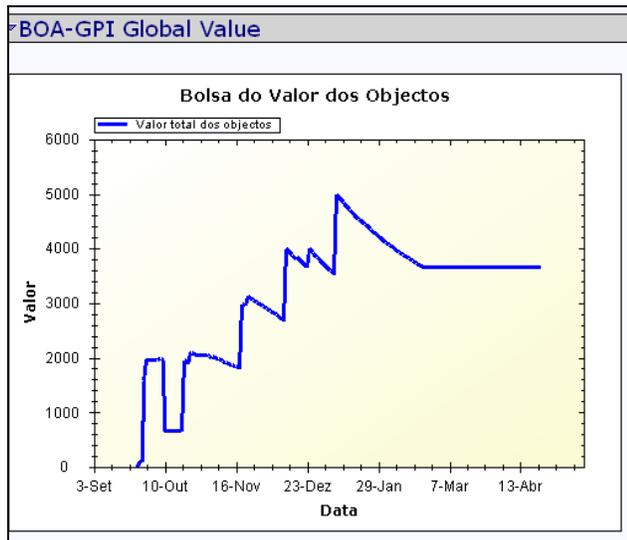


Figure 7. LOP Value Evolution

Figure 8 shows the group configuration for the course. It was divided in three main topics: Student Exercises, Students Project, Course Material and Students Presentations.

The system was used for a single course but, with the Group features presented above in this paper, it is possible to use it in other courses and even other universities, without the need to instantiate different LOP applications. In particular, we expect to use the BOA-GPI for the future editions of GPI course in the next 2009/2010 academic year. Eventually, BOA-GPI can be also used in the future by other students or practitioners interested in the subject of “Project Management” in general.

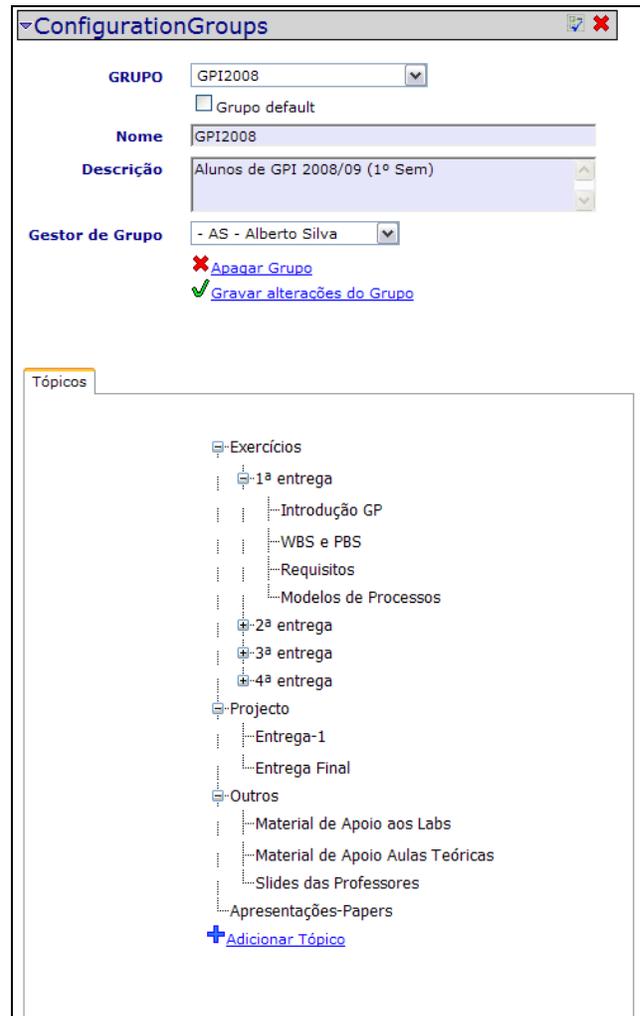


Figure 8. Group Definition

##### C. Survey

For evaluating BOA-GPI user satisfaction and its respective usability level, we conducted a survey among the involved students. Students were asked for their opinion about the use of the system through a simple survey. Tables 1 and 2 summarize the key results from this survey. Table 1 presents questions and corresponding users’ opinion about those questions, and Table

2 presents users' classifications regarding LOP overview and usability. This survey summarizes the information collected with 109 responses.

A first conclusion of this survey is that all students understood the main concepts under the LOP system.

TABLE I. SURVEY'S KEY QUESTIONS

Question	1 (agree)	2	3	4 (disagree)
1. LOP was useful to meet my goals	18%	44%	30%	8%
2. Search mechanism is appropriated to user needs	17%	28%	35%	20%
3. I would like to use LOP in the future	18%	32%	35%	15%
4. I used LOP system regularly (besides work submission)	20%	32%	30%	18%

Question 1 shows that most students found LOP useful. Students that agree, also think that it was very useful to have access to other LOs. Question 2 suggests that the search mechanism needs to be improved. Students suggested other ways of presenting the LOs returned from the search mechanism. This will also influence the user satisfaction (Table 2). Concerning Questions 3 and 4, students said they are interested in using LOP system in the future. The reason why the percentage of "agree" responses is not higher is explained by users: "the system was on a development phase" and "there were some technical errors which caused some user dissatisfaction".

TABLE II. LOP CLASSIFICATION

	1. General Classification	2. Usability
0 (bad)	1%	3%
1	10%	18%
2	18%	26%
3	52%	41%
4	17%	12%
5 (excellent)	2%	0%

As it is described in Table 1, the search mechanism caused a major percentage of users to give a lower classification to system usability. In spite of it, students said that it was reasonable.

## V. CONCLUSION

Learning objects repositories are useful for several situations in supporting learning and e-learning scenarios. In the reported case study, the students found the system interesting, in general.

With the time-frame topics feature it is possible to define milestones for delivering students' assignments. Each topic can correspond to a specific work or assignment deliverable by the students until a given due-date.

The fact of having a repository sharing all LOs can contribute to students' satisfaction and improvement. Students can search and access ("buy" in LOP terminology) to their colleagues LOs in a simple manner. The features regarding the possibility to give LOs' feedback was also well accepted among students, in spite they do not contribute a lot among themselves.

At the same time, submitting an object with all the required metadata fields was seen as a negative and positive aspect of applying the LOP system to this course. On one hand, students find a bored task have to insert all metadata information about the object instead of a simple upload of their assignments. On the other hand, students found easy and useful the possibility to search objects by metadata means.

Finally, this paper described and discussed how LOP system was applied to support an university course scenario in a real case study. However, it should be referred that LOP system can be applicable to other application scenarios, due to its configurable options, as discussed in another paper [23].

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