

# Policies for a Regulated and Distributed Repository of Learning Objects

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**Abstract.** Designing on-line courses is an expensive process, because to do that, the collaborative work of several experts is needed. To reuse on-line educational material, the learning object paradigm has been used in the last years. Learning Objects (LO) either can be stored in a central data base or they can be distributed along a network; the problem with public distribution and access is that the quality, the standardization and the updating of LO cannot be guaranteed. For this reason, a regulated and distributed repository of LO has been developed. Since such a repository works in a similar way than an electronic market, we have called it Learning Object Market. The market is conceived as a multi-agent system and to obtain good results in any transactions on it, several policies have been defined. The aims of this paper are first, to describe the different types of policies needed in a LOM and, second, to present an ontology to specify them.

**Keywords:** Agents, Market, Learning Objects, Policies, Contracts, Ontology.

## 1 Introduction

Designing on-line courses is an expensive process, due to the need of a collaborative work between several experts. To reuse on-line educative material, the learning object paradigm has been created and promoted in the last years. Learning Objects (LO) are electronic educational material designed in such a way that the student can easily obtain the contents of a particular topic. Generally, LO are made of multimedia material that can be logged in from a web page or from a learning management system.

A LO can be stored in a central data base or they can be distributed along a network; moreover, their use can be private or public. The problem with public distribution and access of LO is that their quality, standardization and updating cannot be guaranteed. For this reason, a regulated and distributed repository of LO has been developed. Since such a repository works in a similar way than an electronic market, we have called it Learning Object Market (LOM).

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The market was conceived as a multi-agent system where agents can play one of three different roles: producers, consumers or managers.

In order to obtain good results in any transactions in a market, several kinds of policies are needed. Furthermore, since the market is modeled as a multi-agent system, a way to represent policies that can be understood by agents is required. The work presented in this paper represents a first approach to do that. On the other hand it is necessary to follow the signed contracts inside the LOM, once the parts have reached an agreement about a determined LO. So, the main objective of the paper is to specify through an ontology, a set of policies that can be applied in a Learning Object Market and the formalized transaction contracts. The paper is organized as follows. First, a general description of the LOM is provided. Next section shows a typology of the policies that are needed by a market to work, and the contract that is handled in the LOM is defined. After that, the ontology is shown. Finally, our conclusions and future work are discussed.

## **2 The Model of Learning Object Market**

An electronic market can be considered as a virtual space where some encounters take place. There are providers of goods, and they use the market to shown their products and to find buyers of them. There are also buyers that, based on a need, go to the market to find and select the goods that satisfy their requirements. Once an encounter is made, a contract over the agreements can be signed by both providers and consumers. In an electronic market, there are also managers whose function is to monitor any transaction done in the market and, in the case of conflict, to apply punishment to any transgressor of an agreement.

In our case, we have used such metaphor to develop a virtual place to publish, to locate and to make deals in order to reuse learning objects. The reasons to prefer this metaphor over another (i.e. a distributed database) can be explained as follows. First, learning objects could be developed by experts that do not necessarily know in advance, the users of such objects. Second, the learning objects offered in the market must comply with certain requirements that can guarantee their quality and standardization. Third, the users of learning objects could have wider options from which an appropriated object can be selected. Fourth, once a consumer finds a learning object that satisfies the needs, it can start a negotiation process to make agreements over the rights to use the object, the time to use it or the frequency to update the content of the object. To formalize such agreements a contract must be signed. Fifth, since agents in this context may not know each other, it is necessary a third part that regulate both the members that can participate and the deals that are made in the market.

The proposed Multi-Agent System is formed by the following instances: Administrative Agent (AA), Interface Agent for the Administrative Agent (IAAA), Consumer Agent (CA), Register Agent (RA), Input Handler Agent (IHA), LO Localizer Agent (LOLA), Contract Register Agent (CRA).

These agents inhabit the market. But there are other agents that reside in the computers of the providers and consumers, such as: Interface Agent for the Consumer

Agent (IACA); Mini-Agent Reporter (MAR) invisible to the user; Provider Agent (PA); Provider Interface Agent (PIA).

This market is managed by an administrative user, which is responsible of verifying the compliance of the applied policies for login and permanence in the market. The market is represented by agents. Then the administrative user, the service providers and the service consumers are represented by an Administrative Agent (AA), provider agents (PA) and consumer agents (CA), respectively. The design of the LOM considers several internal agents that are launched by the AA to the market depending on the service requested there. To guarantee a good behavior of the agents in the LOM, it is necessary to specify policies for login, permanence and dropout of every agent in the market. Also a contract must be established between the negotiating parts, which includes terms and conditions of use of the requested LO. This latter part is the essence of this research.

The objectives and tasks that each one of these agents must perform have been previously defined. For the best performance of the market, all of the access, policies for register and permanence of the agents have been defined, so as the contract that must be signed by both the consumers and provider agents about the use and handling of a determined Learning Object.

### **3 Types of Policies for a LOM**

A policy is applied in practice to rule and solve conflicts. It can create coherence and obligatory rules to everyone “living in the same area”. Its purpose is to unify the interpretations about repetitive and concrete aspects [15].

It is important to mention that to define the LOM policies, three different electronic markets already functioning have been analyzed, and these are eBay [9], MercadoLibre [9] and Amazon [9].

According to the interactions that must be done in a market we identify 6 different types of policies:

1. To register new members.
2. To retire members that does not comply with the regulations of the market.
3. To publish a LO.
4. To evaluate a member of the LOM.
5. Contract following.
6. Enter an agent to the LOM.

For the purpose of this work we define policies as a set of norms that must be applied when certain kinds of interactions between agents in a LOM must be done. To do so, we based our work in the normative agent-based framework developed by López, Luck and d’Inverno [3]. In such framework, a normative agent is defined as an autonomous agent whose behavior is determined by the duties that must be satisfied, the prohibitions that limit the pursued goals and the social commitments that are created during social interactions.

Moreover, norms are defined as the mechanisms which are used by society to adequate the behavior of the agents that inhabit inside it. Its structure includes the following components.

**Normative Goal.** What shall be done.

**Receiver.** The entity which executes the goal.

**Beneficiary.** The entity for whom the goal is executed.

**Context.** The moment in which a norm shall be executed.

**Exception state.** The entities or situations when a goal shall not be obliged.

**Rewards.** If the norm is accomplished, what is obtained by the entity.

**Punishments.** If the norm is not accomplished, what is obtained by the entity.

Nowadays, many organizations offer their services on Internet. We can treat the involved entities as service producers and service consumers. It is necessary that these organizations develop their own frameworks where there can be negotiations between these producers and consumers, because certain restrictions must be applied – established by the organization itself- which are known as service policies. These policies must include at least the following:

- A form to verify the identity of the user (Authentication).
- Rules to determine what, when and where can be done inside the framework (Authorization).
- Rules that determine the penalties applied to any failing entity, for breach of contract or any abnormality registered during the compliance of a contract.

Based on de Roure [1], the lent of a service has a life cycle that consists on three phases:

- The creation of the service. In this step, the owner of the service puts it in disposal of any user. This system is considered as ‘dynamic’ because the providers are always creating and destroying services.
- Proxy of a service. This step includes a service provider and a service consumer. Here a contract is established in order to legalize the agreed services and the terms
- The use and disposal of the service.

#### **Policies to register new members Provider and Consumer Agents (PRPCA)**

- To become a member of the LOM, a provider or consumer agent must represent a professor of any of the following institutions: BUAP, CENIDET, UAEH and UNAM.
- The Provider/Consumer agent is responsible of its own access password for the LOM. It is much obliged to give the password to access to the market.
- The Provider/Consumer agent must be located on a server with a valid URL.
- The Provider/Consumer agent will be notified of any policy change on the LOM.

Now, according to our definition, policies 1, 2 and 3, which determine the behavior of an agent by considering the previous considered policy, can be expressed by using norms as follows.

#### **Norm 1. N1P1RPCA.**

**Normative Goal.** General data sent to the LOM.

**Receiver.** Provider or Customer Agent.

**Beneficiary.** Manager Agent.

**Context.** On the time when the agent sends its general information to register.

**Exception state.** Empty.

**Rewards.** The agent is registered to the LOM.

**Punishments.** The agent is not registered in the LOM.

**Norm 2. N2P1RPCA.**

**Normative Goal.** Knowledge areas sent to the LOM.

**Receiver.** Provider or Customer Agent.

**Beneficiary.** Manager Agent.

**Context.** On the time when the agent registers.

**Exception state.** Empty.

**Rewards.** The agent is registered to the LOM.

**Punishments.** The agent is not registered in the LOM.

**Norm 3. N3P1RPCA.**

**Normative Goal.** Access code of the user sent to the LOM.

**Receiver.** Provider or Customer Agent.

**Beneficiary.** Manager Agent.

**Context.** On the time when the agent fills correctly its register.

**Exception state.** Invalid access code.

**Rewards.** The agent enters to the LOM.

**Punishments.** The agent does not enter in the LOM.

From these, the following politics were defined.

**Policies to publish a new LO (applied only to providers) (PPLOS).** The purpose of these policies is to guarantee the requirements so the Producer Agent may publish a LO in the Market.

- Any LO must satisfy the quality and standardization requirements established by SCORM or LOM.
- The LO must include an academic guarantee.
- If both Policies 1 and 2 are satisfied, the LO will be published.

**Policies to Evaluate both Providers and Consumers (PEPC).** The intentions of these policies are to evaluate the behavior of the agents inside the LOM.

- For each agent, a reputation file will be created, referring its behavior in the LOM.
- The institutions that are part of the market will monthly receive a report of the behavior of their agents.

**Policies of Contract Following for Providers and Consumers (PCFPC)**

- Any contract will be registered in the LOM.
- The Manager Agent will monitor the compliance of the norms that will form part of the contract.
- The Provider/Consumer agent must agree with the conditions of use and terms of the LOM.

**Policies for Incoming Providers (PIP)**

- To enter to the LOM the PA must be registered.
- The PA can enter to the LOM only when publishing a LO, agreeing with the publishing policies.
- The PA can enter to the LOM only to delete a LO.
- The PA can enter to the LOM only to delete and to submit a new LO.

- The PA can enter to the LOM to unsubscribe itself from the LOM.

#### **Policies for Incoming Customers (PIC)**

- The CA must be registered on the LOM to get access to it, by agreeing with the register policies.
- The CA can enter to the LOM only to request the list of LO providers.
- The PA can enter to the LOM only to unsubscribe itself from the LOM.

To establish the process of negotiation for the LO, the following scheme for a contract is proposed. This contract will eventually be signed by both the PA and the CA involved on it.

## **4 Contracts in a LOM**

Another important component to make any deal in our LOM is a contract. A contract can be defined as a private agreement that can be oral or written, between parts that obligate and require the accomplishment of a good or service [14].

The general structure of a contract includes general and specific clauses. The general clauses are those written previously by a single person or entity in a general and abstract way, in order to fix the normative content of future contracts with their own elements. These clauses include Definitions, Object, Contract length, Price and Payment method, Communication, Confidentiality, and Contract resolution. The specific clauses are those which intend to satisfy certain conditions of high interests for most of the members which can operate inside the market. It includes: Description of the presented contents, Exclusivity, Outsourcing and Intellectual property.

Some general clauses include the agent ID, sheet, keyword, contract date, LO delivery date and payment for the LO. For the specific case of this work, we will use the following template for all contracts.

**FIRST CLAUSE.** Object of the contract. The CONSUMER AGENT (CA) is responsible of making the agreed payment on the negotiation for the LO. On the accorded date, the SUPPLIER AGENT (PA) will deliver the LO on a period of \_\_\_\_working days, as agreed on the same negotiation. The LO should not be modified on this period from the contract date until the delivery date.

**SECOND CLAUSE.** Value of the contract. The CA will pay to the PA the amount of \_\_\_\_for the total value of the LO, as agreed on the first clause of this contract. This amount does not include the Added Value Tax (IVA in Mexico), which represents the 21% of the contract value.

**THIRD CLAUSE.** Payment mode. The CA must pay to the PA the agreed price on the following way. A first payment of \_\_\_\_ on the moment of signing the current contract, and the rest of the payment \_\_\_\_ once the PA accomplishes this contract. The PA can cancel this contract in case of breach of the payment. If the CA is interested again on purchasing the LO, a new amount of \_\_\_\_should be paid by the CA. The PA can review the cancelled value and other offers by other agents in order to choose the best market option to renew the LO sale. The renewal of this contract should be made a year later from the sign of this contract.

**FOURTH CLAUSE.** Penalty for breach of payment of the contracted LO. The CA must pay to the PA an amount calculated as the 0.5% of the total contract value, for each delayed day of payment, and until a total amount of 10% of the total value of the contract. This amount will be discounted by the PA to the unpaid debts of the current contract from the account of the CA.

**FIFTH CLAUSE.** Duties acquired by the CA. The CA is obliged, not only to the duties acquired by purchasing a LO, but also to the followings. (a) To absolutely reserve the information on the LO and to maintain the exclusivity of the LO. (b) To make the payment accorded in this contract on time and form. (c) If the CA does fail on any of these duties, the PA has the right to penalize to the CA on the fail.

**SIXTH CLAUSE.** Duties of the PA. The PA is obliged, not only to the duties acquired by purchasing a LO, but also to the followings. (a) To deliver the LO named \_\_\_\_ on both date and form established on this contract. (b) If the PA does fail on any of these duties, the CA has the right to penalize to the PA on the fail.

**SEVENTH CLAUSE.** Unilateral ending or suspension of this contract by the CA. The Manager Agent (MA) may suspend or end this contract only on the following cases. (a) Breach of Contract by the CA on the established terms of the payment of the LO, or in the conditions and presentation of the object services of this contract. (b) If the PA decides to end or suspend this contract, the CA will pay, as maximum, the 20% of the first payment value. This amount does not imply any future duty for the CA with the PA.

**EIGHTH CLAUSE.** Unilateral ending or suspension of this contract by the PA. The Manager Agent (MA) may suspend or end this contract only on the following cases. (a) Breach of Contract by the PA on the established terms of the delivery of the LO, or in the conditions and presentation of the object services of this contract. (b) If the PA has not delivered the agreed LO on the following thirty (30) days of the contract signing, the CA is exonerated from any responsibility of any duty acquired by this contract, or for the delayment in the satisfaction of any assistance on its charge, only when the delayment is proved to be Force Majure or unforeseen circumstances. The CA is enabled to temporarily suspend the following contract under these situations, and only the PA is capable to continue with the goal task of this contract.

**NINTH CLAUSE.** Author Copyrights. The PA unconditionally guarantees that the elements used on text, figures, pictures, design and trademarks that are delivered to the CA as included on the LO, are properties of the PA or it has written permission to use them. The CA is free of any responsibility or complaint by the right owners of the material. Just in case that the CA requires certain material included on the LO, the CA may take its own files, or use free license files under public licenses, or reproduce the required material, in the latter they will be deducted on the current contract. All of the LO will have the written credits that correspond to the PA. The CA will keep the right of storing one copy of this LO. The PA will unconditionally retain its copyrights, including the invention rights and the author copyrights on the contracted design.

**TENTH CLAUSE.** Improvements. For security reasons and to prevent falsification by the steal of identity, this contract can only be considered as valid from the moment when both PA and CA obtain their keys.

**ELEVENTH CLAUSE.** Contract extension. In case that the contract can not be accomplished on the accorded terms, the CA is much obliged to make a written request for more time to satisfy the contract. This extension should be documented and delivered at least two days before the due date of the contract.

**TWELFTH CLAUSE.** Contract cancellation. This contract may be cancelled by an agreement between the PA and CA, in a period established in the current contract, or at least before two months since the sign of the contract, or due to the expedition of an administrative document that orders the termination, or at the accorded date by both parts of the contract. In the termination document the adjustments, revisions and acknowledges shall be accorded. The document shall also contain the agreements, conciliations and transactions that shall be reached to put an end on the presented situations, so the cancellations can be declared on peace and safe. As a proof, the current contract is subscribed in \_\_\_\_ at the \_\_\_\_days in the month of \_\_\_\_ of the year 20\_\_.

In order for the agents to interpret the policies previously described about access and control of the available transactions on the LOM, an ontology is currently under development. The main objective of this ontology is that the agents shall be enabled to respond with certain events to the analyzed information.

## **5 An Ontology for the Policies of a LOM**

An ontology is an explicit specification of a concept or some part of the whole concept. The ontology includes a list of terms and the specification of the meaning of each term. In this specification, objects, process, resources, capabilities and many other elements can be described [6].

The most important information that shall be considered on the LOM policies is described next. The information that shall be stored in the contract between a Consumer and a Provider Agent after a negotiation process shall be also considered, in order for the good use of a Learning Object.

There are many methodologies to develop ontologies, so in order to develop an ontology for the LOM, Methodology [2] is being used. Nowadays, this is one of the most used methodologies around the world. As a tool for development, Protégé\_3.1 [18] is also being used. Protégé is based on the ontological language OWL (Ontology Web Language).

The first step on Methodology is to create the glossary of terms that belong to the developed domain –also known as Taxonomy. For the LOM, the domain considers the policies and the contract. The taxonomy is composed by the following concepts – in Spanish:-



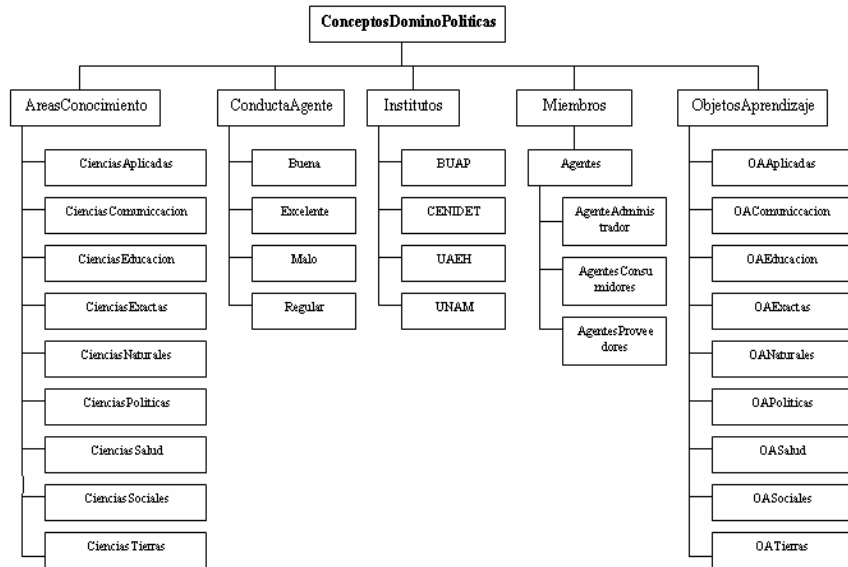


Fig. 1. Concepts of Command of Policies

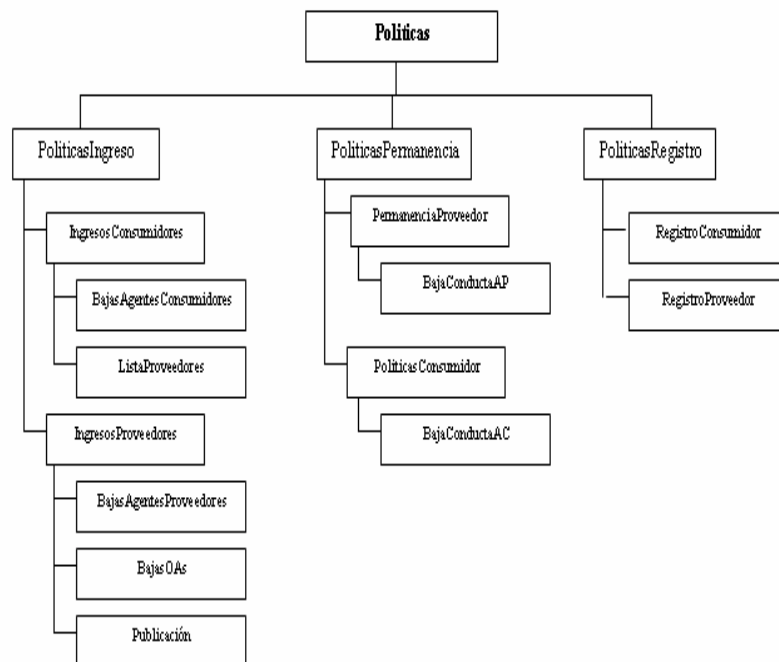
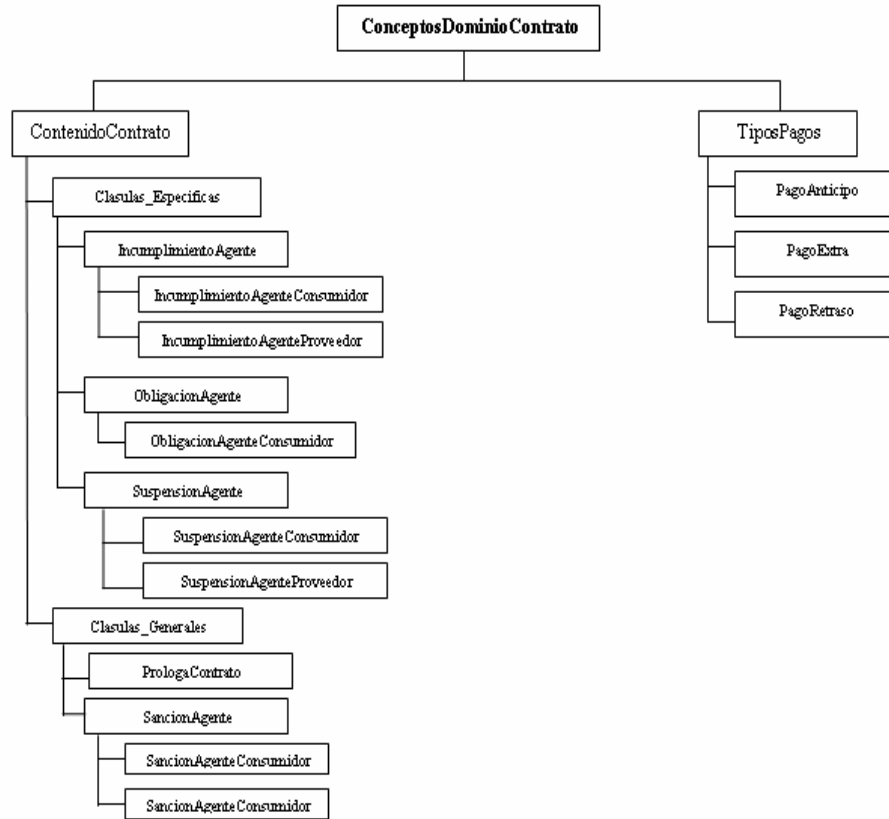


Fig. 2. Policies.



**Fig. 3.** Concepts of Command of Contract

The relationship between classes has been established, for each relation a group of rules and axioms have also been defined. With these rules the inferences are made and with the axioms the conditions that shall be accomplished by the different concepts are declared. In order to find inconsistencies, the current ontology has been validated with the RACER software tool -Renamed ABox and Concept Expression Reasoner [13].

## 6 Conclusions

In order to develop the Multi-Agent System, the platform JADE\_has been chosen because it satisfies the FIPA standards. The agents have been implemented and based on behaviors, and depending on the sent and received messages. The communication language that is used for the agents is ACL. Currently the LOM is in testing phase. It can be tested on the website: [www/dgmae/mercadoOA](http://www/dgmae/mercadoOA)

In the current work the policies for login and permanence of any agent in the LOM have been defined. It also explains the contract that any provider and consumer will sign about the use of a LO. This has been developed by using domain ontology.

Nevertheless, it is necessary that the agents shall be enabled to interpret the ontology to create new behaviors, in order to create new actions to be performed. The research is currently centered in this topic.

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