The Open Learning Object model to promote Open Educational Resources

Giovanni Fulantelli, Manuel Gentile, Davide Taibi, and Mario Allegra
Italian National Research Council,
Institute for Educational Technologies
Via Ugo La Malfa 153
90146 Palermo
Italy
www.itd.cnr.it

Abstract: In this paper we present the results of research work, that forms part of the activities of the EU-funded project SLOOP: Sharing Learning Objects in an Open Perspective, aimed at encouraging the definition, development and management of Open Educational Resources based on the Learning Object paradigm (Wiley, 2000). We present a model of Open Learning Object (OpenLO) for a greater awareness in the use of LOs by teachers, giving them a more active role in the evolution of educational resources; the OpenLO model extends the concept of reusability, providing pedagogical sustainability. Moreover, we compare FreeLOms, a Learning Object Management System that implements the proposed OpenLO model, to traditional tools for handling LOs.

Keywords: Open Educational Resource, Open Learning Objects, Communities of practice, Learning Object Management Systems, Web 2.0

1   Introduction

Open Educational Resources (OER) are key elements of policies aimed at improving education and learning in the knowledge society. Well known examples of initiatives based on Open Educational Resources are the *OpenCourseWare Initiative* at the Massachusetts Institute of Technology; the *Connexions* repository managed by Rice University; the *Open Learning Initiative* at the Carnegie Mellon University; the *Center for Open and Sustainable Learning* at Utah State University.

Three reports include wide ranging discussions about the opportunities offered by the OER, the obstacles to their development and the challenges faced by the OER movement (Atkins, Brown, Hammond, 2007; OECD, 2007; OLCOS, 2007). The three reports all agree that the success of initiatives based on the Open Educational Resource concept is threatened by many different factors, ranging from the technical difficulties in developing open digital resources to the lack of open practices of teaching and learning; from the lack of experience in supporting communities of practice involved in the development of OER to the scarcity of business models in OER.

In this paper, we report the results of a project which tries to overcome some of the obstacles described above. The research work, that forms part of the activities of the EU-funded project SLOOP: Sharing Learning Objects in an Open Perspective (Masseroni, Ravotto, 2005), concerns the definition, development and management of Open Educational Resources based on the Learning Object paradigm (Wiley, 2000).

The use of Learning Objects (LO) in schools has been seen as an opportunity for teachers and students. The description of LOs through metadata facilitates the search for didactic materials on the web, and the LO paradigm claims that they can easily be reused through their aggregation; moreover, the adoption of standards that sustain the production of LOs permits the interoperability of didactical resources in different Learning Management Systems.

At the same time it is necessary to consider the objections raised to the use of LOs in school contexts. Generally, the description of LOs is lacking in pedagogical aspects; for example, there are no references to the educational context or to the didactic process in which the learning object can be used. The model of learning resources currently in use does not permit the reuse of learning resources in a constructivist approach (Piaget, 1976; Novak, 2002). Moreover, the use of standards such as SCORM (ADL, 2004), on the one hand facilitates the interoperability of learning resources but, on the other, complicates the task of developing learning objects for the teacher.

In order to achieve the trade-off that can guarantee the transformation of the potential of LOs into real pedagogical benefits, we claim that it is necessary to rethink the concept and role of LOs in the learning processes, with particular focus on the reusability issue, an aspect where the potential of LOs has so far appeared particularly disappointing to school operators.

To overcome this problem, we need to rethink the current model of LOs, moving to a new model that we call Open Learning Object (OpenLO), that will be described in section 2.

At present, there is a lack of available tools to work with learning Objects in order to implement the OpenLO model, since such tools do not manage the evolution of open content; so we need new environments that we have called Learning Object Management Systems (LOMS). LOMS must have innovative features to manage learning objects: they have to support versioning mechanisms for LOs, both for metadata and content; they must provide an environment for sharing resources and tools to support collaborative work; they must support e-learning standards to guarantee interoperability between learning environments; and, finally, they should permit the development of learning resources using an open license (e.g. Creative Commons) in order to guarantee editing and effective reuse. These concepts will be presented in sections 3 and 4. Finally, in section 5 we illustrate the main features of FreeLOms (Gentile, Taibi, Allegra, Fulantelli, 2006), a Learning Object Management System aiming to manage learning objects according to the OpenLO model presented in this paper.

2   The Open Learning Object Model

Starting from Wiley's definition of learning object (Wiley, 2000), we define *open* learning object as "any *open* digital resource that can be reused to support learning". In this definition the term *open* indicates open content, namely content developed in open format (e.g. Open Document) or content in closed format whose source files are also available (e.g. Adobe Flash). Moreover, our vision of reusability is not simply based on combining LOs but goes beyond this towards a pedagogical concept of reusability in which a LO can evolve to meet specific educational requirements.

The OpenLO model allows users to edit LOs created by different authors, and customize the LOs according to their own pedagogical needs; in addition, communities of educational professionals can work on the same LO and contribute to its collaborative evolution at content level. Finally, the replication of this process of adaptation of LOs at content level over time is a mechanism that can provide pedagogical sustainability of the LOs.

In the implementation of the OpenLO model, and in the definition of educational methodologies based on this model, it is relevant to focus on three main aspects:
- changing the life cycle of Learning Objects and consequently the methodologies for producing these resources
- assigning a dynamic role to metadata, which should evolve in parallel with the life of the learning object.
- moving from current Learning Object Repositories (LOR) to innovative Learning Object Management Systems (LOMS).
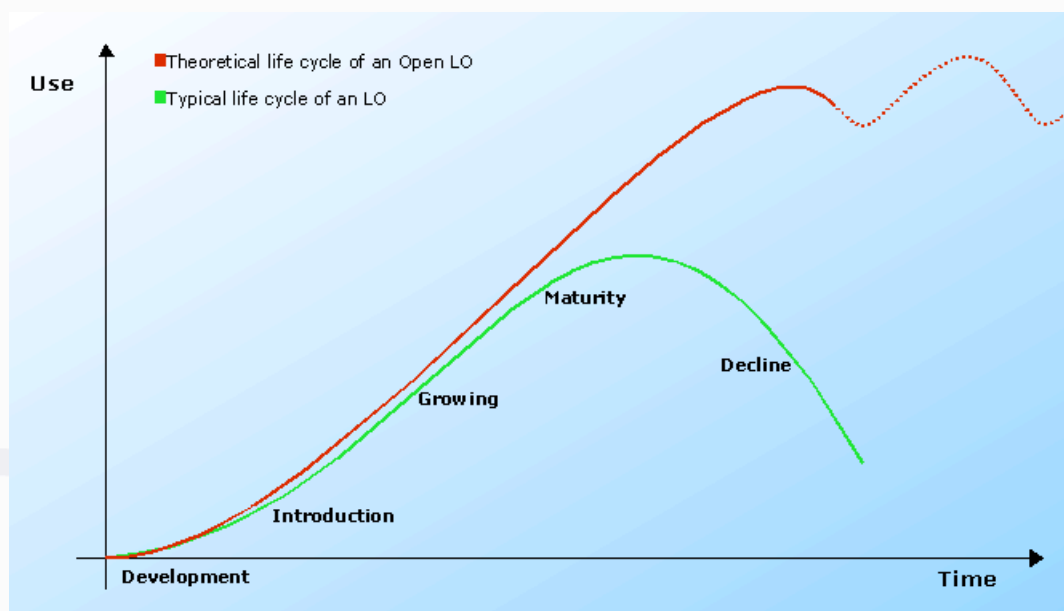
Fig. 1: Comparison of the evolving life cycles of a LO and an OpenLO

The theoretical comparison of the lifecycle of a LO with the lifecycle of an OpenLO demonstrates that the latter never reaches obsolescence, since an OpenLO in its mature stage could undergo several phases of elaboration, thus avoiding the risks of obsolescence and overcoming the limitations of a closed LO (fig. 1).

In order to cope with the development of an OpenLO, that is an intrinsic dynamic resource, we need to go beyond the methodologies of *waterfall development* presently used in LO production and move towards newer *agile methodologies*.

Considering how the latter methodologies have improved the management of many open source software projects, we expect that the adoption of the same methodologies in the collaborative production of LOs can bring about similar improvements.

The OpenLO model reconsiders the role and opportunities offered by the use of LO metadata. Increasingly often, the merits of metadata are not appreciated, except for their capability to improve learning object retrieval. In the OpenLO model, metadata assume a key role as essential tools in supporting the evolution of learning resources. This role was also assigned to metadata by the IEEE learning technology standard committee in the definition of the IEEE LOM Specification (IEEE, 2002).

According to this standard, the *LifeCycle* and *MetaMetadata* sections can be used to guide the evolution of a resource, specifying motivations and information pertinent to this evolution.

Metadata, from this point of view, act as descriptors of the evolving process of the resources. These considerations reveal the need for new tools which can treat metadata not only as static data but as information in constant evolution, thus supporting the effective development of educational resources.

3 Categories of tools for the Learning Object lifecycle

Teachers' communities have shown remarkable interest in the use of learning objects in learning activities; this led to numerous tools created to manage the different identifiable phases of LO lifecycle. According to the report on Free and Open Source Software (FOSS) for Open Educational Resources (2006), the tools available to manage the elaboration of LOs can be divided into: authoring tools, tools to implement learning

technology standards, learning object repositories, learning management systems, collaborative environments for sharing LOs. These tools are used respectively in the phases of production, description in conformity to standards, searching, fruition and sharing of LOs.

It is important to note that generally each category of tools covers only one aspect of the LO lifecycle. For example, authoring tools are closely related to the production phase. There are several types of media that can be produced (e.g. text, audio, video, animations, and so on), and typically each tool handles only a few types and produces digital objects in a proprietary format. It should be noted that most of the tools belonging to this category are not specifically designed to develop LOs; in the past, they could support the production of generic multimedia content while now they have been modified by adding some functionalities to transform multimedia contents to SCORM compliant contents (as for example in the case of Camtasia and Flash).

Tools for supporting the management of learning technology standards are developed with the aim of facilitating the enhancement of the descriptions of LOs, so they comply with the main standards adopted in the field of education. Generally, these tools are used only by expert users that have the appropriate technical background to manage standards correctly. Specifically, these tools are used for the operations of improving LO descriptions by means of metadata (for example using IEEE LOM) or supplying the necessary information for packaging and delivering LOs. Both operations are very important, because the former permits a better description of the resources and a more refined search, while the latter makes the resources usable by the numerous SCORM compliant learning environments, and thus guarantees the interoperability at LMS level.

Learning Object Repositories aim to facilitate the retrieval of LOs, overcoming the limitations of a generic search engine which often provides inaccurate results. Learning Object Repositories can generally be divided into two categories: repositories that store Learning Objects and their metadata descriptions, and repositories that store only the archives of meta-data associated to Learning Objects and the references for retrieving the Learning Objects (Verhaart, 2004). Besides, repositories belonging to the first category are further divided into those that follow a centralized model, in which Learning Objects are stored in a single location, and those that follow a distributed model, in which information is distributed among different connected locations. As far as the search mechanisms are concerned, there are normally two approaches used by Learning Object Repositories for finding stored Learning Objects: in the first, the organization of the content in categories is linked to a taxonomy of the topics; in the second, free searching is allowed by means of the keywords present in the content (when the format allows this) or in the metadata associated to the content.

Learning Management Systems play a key role in the delivery phase of LOs, as they provide student access to e-learning courses. At present, most of them support e-learning standards such as SCORM in order to provide teachers with the tools for the traceability of student activities during on-line learning. Collaborative environments for sharing LOs are a more recent development and provide teachers with specific tools to support resource sharing and collaborative work.

According to this analysis, there is a clear lack of integrated tools to support teachers in the management of LOs. In order to implement the OpenLO model, and to manage the evolution of open contents throughout their life-cycle, in the next section we present a new kind of environment that we have called Learning Object Management Systems (LOMS).

4   Learning Object Management System

The traditional tools introduced in section 3 are not suitable for managing the evolution of LOs and controlling the dynamics introduced by the new OpenLO model. A teacher wishing to develop a LO needs to have all the skills required for using different tools to handle the LOs in the different phases. This represents

a major obstacle for teachers in adopting the LO paradigm, but it can be overcome by using tools which integrate the functionalities of the tools presented in the previous section.

For this reason it is essential to design a new kind of environment which can manage LOs throughout their entire lifecycle. This kind of platform, that we call Learning Object Management System, allows teachers and experts to create a network where they can participate collaboratively in the processes of design, development, sharing, reusing and evaluation of open learning resources through a typical Web 2.0 approach.

In our vision, a LOMS is a Rich Internet Application; at the same time a LOMS can be seen as a set of services accessible through the Web from different applications. The goal is to make it easy to use the services provided by a LOMS, and not to impose specific software, but rather to propose a philosophy that makes the creation, management and reuse of digital educational resources efficient and effective.

In the following paragraphs we describe how a LOMS can support the teacher in the management of an OpenLO throughout its lifecycle, and analyze and compare the features offered by this type of environment with tools normally used to manage LOs (Fig. 2).
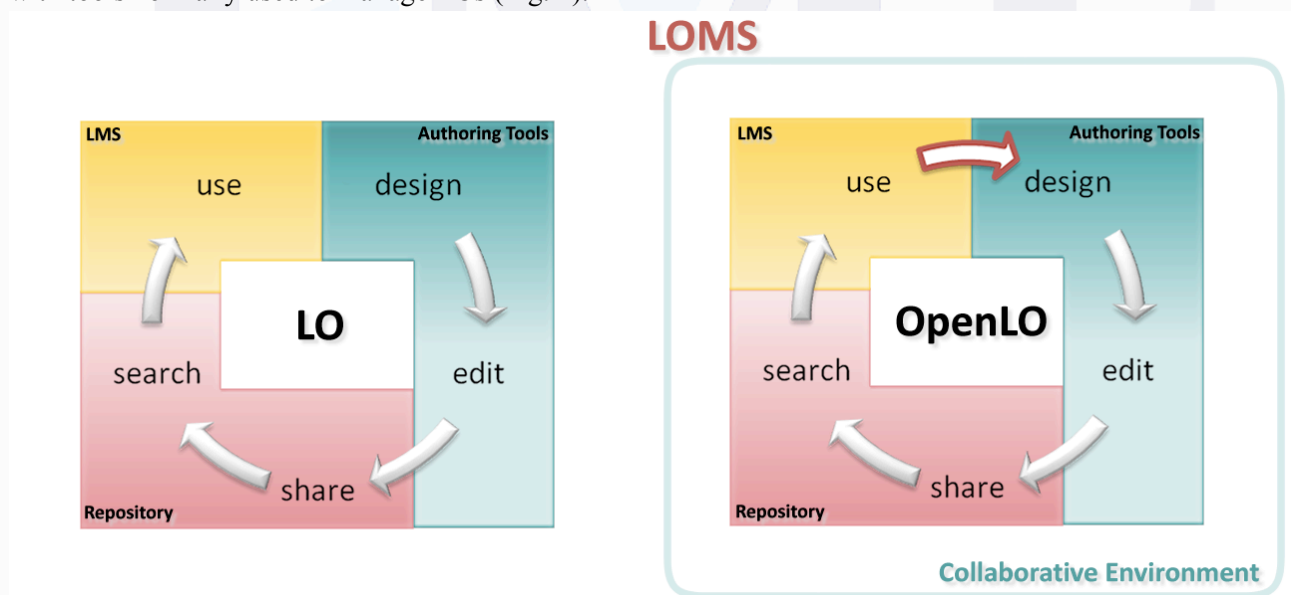

Fig. 2: Traditional tools developed to manage the different phases of LO lifecycle vs. a Learning Object Management System

4.1 LOMS vs. tools to design and edit learning objects

As stated above, we can choose from different tools to design and edit a learning resource, since there are many typologies of didactic contents e.g. textual content, images, videos and materials produced in an open or proprietary format. A LOMS should allow the management of all kinds of digital resources.

However, it may be over ambitious to think of setting up a system which allows users to edit any digital format cheaply and easily. In addition, stand-alone applications are normally used to design and create digital learning resources and are located on the user's personal computer. Finally, these applications are often proprietary, making it difficult or impossible to include new features and make them compatible with a cooperative environment.

To resolve these issues a LOMS can provide easy access to the repository by emulating the Common Internet File System standard (CIFS), allowing end users to access the repository as though they were accessing a shared drive, permitting on-line synchronization, drive mounting and so on.

In this way the user can access the learning resources stored in the LOMS from any external authoring tools, can modify them and finally store the new LO version in the LOMS as if the resources were in his/her own computer.

Further authoring features of a LOMS could even include standard editing tools available with Rich Internet Application for some common formats (e.g. HTML) to allow users to edit these kinds of contents through their browser.

Considering the best practices in the collaborative construction of learning resources and taking into account that the typologies of didactic content can be very different, a LOMS must provide the essential tools to support collaborative activities during the whole lifecycle of a LO.

A LOMS must provide:
- a mechanism to manage the versioning of content;
- a private space in which users can organize the resources needed for the production of LOs;
- a public workspace in which the LOs can be shared;
- a forum associated with each resource in order to encourage interaction and collaboration between users for the evolution of the resource;
- an RSS channel related to a resource in order to communicate updates to subscribers.

The main aim of a LOMS is to encourage collaborative development of resources and the re-use of existing resources. The combination of these functionalities would provide the type of solution that allows users to modify the learning resources through an extremely user-friendly mechanism.

4.2   LOMS vs. tools to implement learning object technology standards

A LOMS should support e-learning standards to ensure interoperability between learning environments; with the introduction of the OpenLO model it is necessary to reconsider the role and the possibilities offered by the learning technology standards used in the delivery and description of LOs.

The standards that guarantee the interoperability of LOs, such as SCORM, as well as the metadata standards to describe learning resources, e.g. IEEE LOM, are often perceived as technological issues and not as opportunities for helping teachers in the use of LOs. However, if we consider the lifecycle of an OpenLO, the standards assume a key role in supporting the evolution of learning resources.

With respect to current tools, a LOMS proposes an innovative and different use of the standards in order to improve their function and to promote their use in more effective and efficient ways. In particular, a LOMS has to simplify the use of these standards, such as SCORM, because they include concepts such as ASSET, SCO, Content Aggregation that are difficult to understand although they are essential in the content organization. A LOMS must provide users with tools to organize and re-organize contents, concealing the technical aspects and simplifying their organization.

Moreover, metadata must play a dynamic role not only in improving the description of the resources so they can be found more easily, but also in providing essential information to guide the evolution of the resource within the whole lifecycle of LOs. For example, metadata can contain useful information to describe why changes have been made in the evolution of the resource.

To reach this goal a LOMS must provide, when possible, an automatic mechanism for creating and modifying and, in particular, improving this additional information during the whole process of LO production, not just at the end.

4.3   LOMS vs. Learning Object Repositories

The importance of sharing didactic materials has led to the diffusion of Content Repositories which are specialized in the storage of didactic contents and have become known as Learning Object Repositories (LOR) (Neven, Duval, 2002).

LORs are used to improve the management of categorization and retrieval of learning materials. A LOMS must have the typical features of a LOR, like searching for LOs, browsing repository folders, importing LO Metadata.

Compared to the most popular repositories such as Merlot (Cafolla, 2006), that gathers the references of learning resources, a LOMS must store the learning resources, allowing users to search for learning resources by content and not only through metadata. In addition, unlike systems such as Careo or Connexions (Henry, 2004) that can manage only html contents, a LOMS should not impose a limit on the typologies of didactic content to be managed; in fact, an analysis of the main definitions adopted in literature for the term "Learning Object" reveals that any digital content used in a learning context may be considered as a Learning Object.

4.4   LOMS and Learning Management Systems

Generally, the different tools involved in the LO lifecycle are not integrated in Learning Management Systems. In fact, the learning resources delivery and deploy phases are considered as the final phases in the production of LOs, or they are considered separately from the production stage. However, if the learning resources are considered as evolving objects, according to the new OpenLO model, we have to reconsider the mechanisms of integration between LMSs and the other tools.

In order to build a complete environment in which the entire LO lifecycle can take place, a LOMS has to assemble the features of all the kinds of tools involved and, at the same time, ensure the extension points that make the integration with an LMS possible.
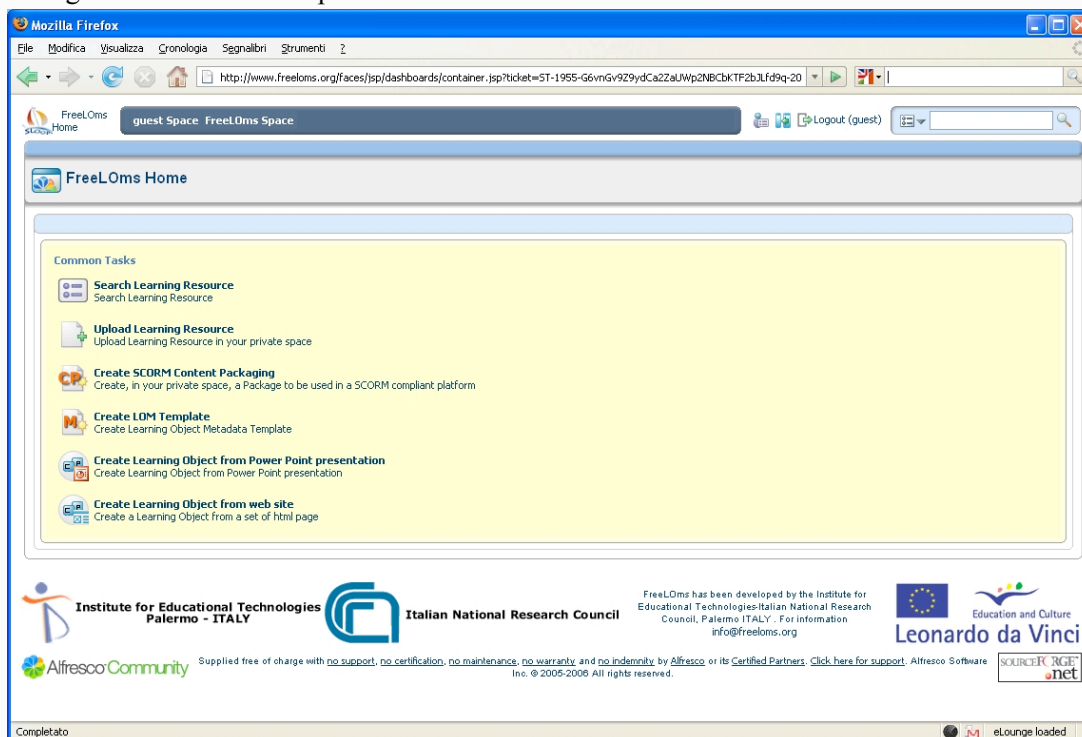

Fig. 3: The FreeLOms Homepage (available at http://www.freeloms.org)

5 FreeLOms

Within the framework of the EU-funded SLOOP Project, Sharing Learning Objects in an Open perspective, we have developed FreeLOms (Gentile et al., 2006), a Learning Object Management System aimed at managing learning objects according to the OpenLO model presented in section 2.

The main objective of FreeLOms is to provide a community of teachers with an on-line platform to share and produce learning resources collaboratively: new learning objects can be developed as the evolution of LOs already stored on the platform. FreeLOms is inspired by the philosophy behind the Open and Free Source Movement, and is based on the idea that not only can the software be freely developed by a community of practice, but also the educational digital contents can be developed by a community of teachers and educational experts. This vision is reinforced by the adoption of the new OpenLO model.

FreeLOms includes functionalities for:

- uploading digital educational resources into a repository (LOs in SCORM terminology: Assets, SCOs or Content Aggregations);
- editing LO Metadata (IEEE Standard for Learning Object Metadata); editing of metadata can occur at any stage of the LO lifecycle, not only when it is uploaded onto the platform;
- searching for LOs shared by the users; specialized and personalized searches can also be defined in order to meet the needs of authors who usually apply the same search criteria (e.g. to search for some specific topics in their field);
- managing existing LOs in a SCORM vision, by allowing users to edit Assets, SCOs and Content Aggregations (CAs);
- creating Content Aggregations by using the resources available in the repository;
- managing the changes made to the didactic contents through versioning and differencing, both at metadata and content levels; more precisely, these features will make it possible to handle the contributions supplied by each user on the same LO, also through RSS feed, thus guaranteeing the "collaborative evolution" of LOs;
- allowing end users to access the repository as though they were accessing a shared drive through CIFS;
- transforming digital contents developed in technical formats unsuitable for learning platforms, into contents compliant with the SCORM standards;
- communicating asynchronously and/or synchronously with other users in order to support group processes; this reflects the typical functionalities available in a Computer Supported Collaborative Work system, providing an efficient environment for the collaborative management of didactic re-sources.

In order to create a complete environment for managing, sharing and also using learning objects, we have developed a FreeLOms module that combines the learning objects repository features of FreeLOms with the Learning Management System features of Moodle (Dougiamas, Taylor, 2003). This module has been developed by modifying the SCORM module used by Moodle in order to provide direct access to the learning objects stored within FreeLOms. Moodle was chosen as the LMS to be integrated with FreeLOms for the following reasons: they share a similar approach to e-learning policies, since both are based on communities of practice and both are directed toward the collaborative approach to knowledge sharing; moreover, both projects are based on the Open Source development model.
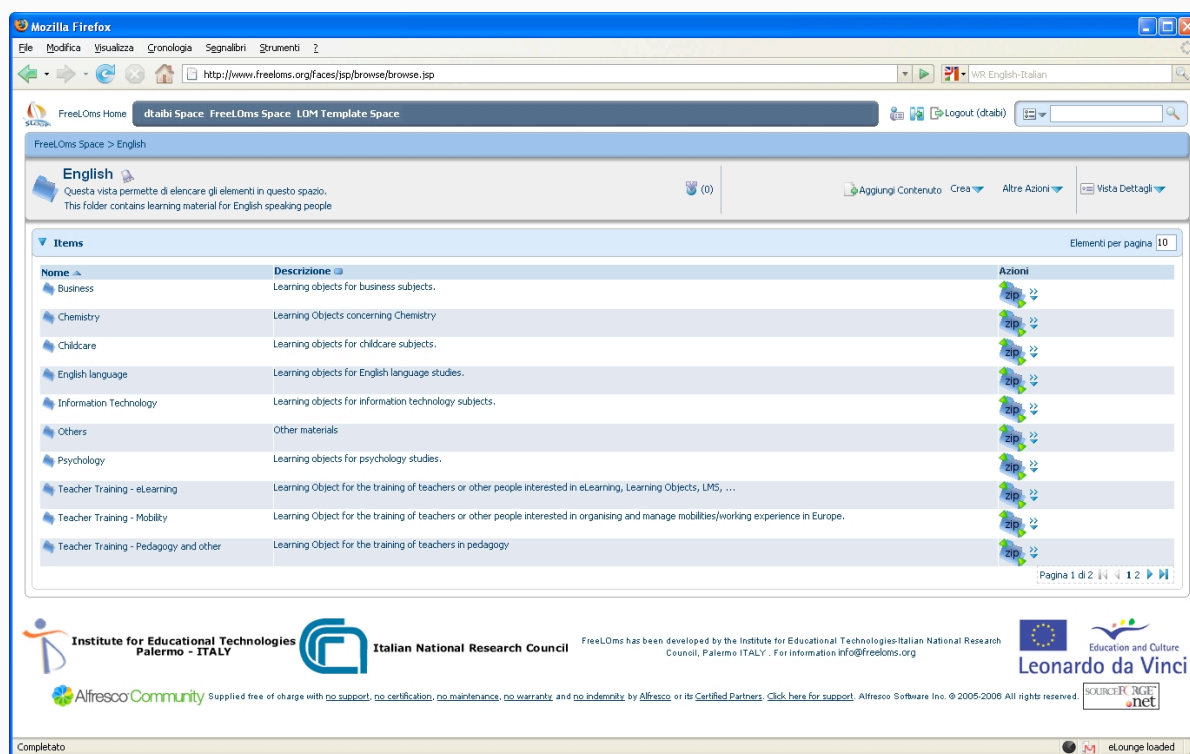
Fig. 4: A folder from the FreeLOms repository

6 Conclusions and future proposals

In this paper we have presented a new model of open learning objects, aimed at considering LOs as evolving resources and not as final products. In addition, we have developed a new type of web-based environment to support teacher communities in the cooperative evolution of LOs that we have called LOMS, Learning Object Management System. This work is based on the experience in using the FreeLOms platform, developed within the framework of the SLOOP project, co-funded by the EU. Through FreeLOms teachers use a single system to search for, modify, reuse and share LOs. More than 800 users from 20 countries worldwide have registered to FreeLOms (http://www.freeloms.org).

We think that the proposed OpenLO model can actively contribute to the Open Educational Resource Movement by accelerating the following fundamental educational processes:
- the involvement of teachers in a more active role in the production of OERs; this permits them to improve didactic strategies based on knowledge building rather than on the use of units of learning;
- the creation of a community of practice that adopts the concept of OpenLO, in order to promote OERs within a community,
- the activation of collaborative processes in the authoring phase of LOs and above all during the steps which follow;
- the involvement of students in the production of OERs, in order to reinforce learning processes based on constructivism.

One of the main issues to be investigated in the future concerns how to exploit the potentials of the SLOOP results and the sustainability of the project. As stated in the introduction to this paper, there are no validated business models in the OER field; to make things worse, OER initiatives are not supported at a political level as they should be: the 2007 OECD report "*Giving Knowledge for Free: The Emergence of **Open Educational Resources***" highlights how the increasing number of schools and universities in Europe and in the world that have started to share open digital educational resources through the Internet have not received

adequate support at a political level. The potential of OER initiatives, such as the one reported in this paper, risk being seriously compromised by these political shortcomings.

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