Chapter 2
The Open Discovery Space Portal: A Socially-Powered and Open Federated Infrastructure

Athanasiadis Nikolas, Sofoklis Sotiriou, Panagiotis Zervas and Demetrios G. Sampson

1 Introduction

Over the past years, the term open educational resources (OERs) has emerged, aiming to promote open access to digital educational resources, in the form of learning objects (LOs) that are openly licensed and available online for everyone to use (Caswell et al. 2008). UNESCO (2002) has defined OERs as the "technology-enabled, open provision of educational resources for consultation, use and adaptation by a community of users for non-commercial purposes".

The expected benefits of OERs for learners and teachers can be summarized as follows (Geser 2007): (a) They are free to use and publicly available, (b) they can be used and/or reused in teaching and learning (usually with attribution to the creator), (c) they can be repurposed, that is, modified/adapted for different educational

A. Nikolas (✉)
INTRASOFT International S.A., 2b rue Nicolas Bove, 1253 Luxembourg City
e-mail: Nikolas.Athanasiadis@intrasoft-intl.com

S. Sotiriou
Ellinogermaniki Agogi, Dimitriou Panagea Str. 153 51 Pallini Attikis, Greece
e-mail: sotiriou@ea.gr

P. Zervas
Department of Digital Systems, University of Piraeus,
150 Androutsou Odyssea Street, GR-18532 Piraeus, Greece
e-mail: pzervas@iti.gr

Information Technologies Institute, Centre for Research and Technology—Hellas, Thessaloniki, Greece

D. G. Sampson
Department of Digital Systems, University of Piraeus,150 Androutsou Odyssea Street, GR-18532 Piraeus, Greece
e-mail: sampson@unipi.gr

Information Technologies Institute, Centre for Research and Technology—Hellas, Thessaloniki, Greece
e-mail: sampson@iti.gr

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context of use, (d) they can improve teaching by building on other people's work and (e) their development is a global movement and as a result educational communities across borders can be created around them.

In response to this emerging term, several OER initiatives have been developed worldwide by large institutions such as MIT's OpenCourseWare (OCW), Stanford's iTunes and Rice University's Connexions, or by communities (or consortiums) such as MERLOT and OER Commons (Ehlers 2011; Walsh 2010). The main aim of such initiatives is to support the process of organizing, classifying and storing LOs and their associated metadata in web-based repositories which are called learning object repositories (LORs; McGreal 2008). As a result, a variety of LORs are currently operating online, facilitating end users (namely, students and teachers) to have access to numerous collections of LOs (Ehlers 2011)

However, with many LORs implemented and maintained independently, valuable LOs are scattered over different LORs and it might be difficult for end users to easily access them (Klerkx et al. 2010). A suggested solution towards addressing this issue is to create infrastructures that enable the discovery and identification of LOs across different LORs. As a result, several federated infrastructures have been developed and are currently operating online such as ARIADNE (Ternier et al. 2009), Metadata for Architectural Contents in Europe (MACE; Prause et al. 2007), Interoperable Content for Performance in a Competency-driven Society (iCOPER; Totschnig 2007), Organic.Edunet (Manouselis et al. 2009), OpenScout (Kalz et al. 2010) and Learning Resource Exchange (Massart 2009)

Within this context, a prominent European initiative has been launched, namely the Open Discovery Space (ODS) portal, which aims to (a) build a federated infrastructure for a super-repository on top of existing LORs and federated infrastructures and (b) provide social features for building and sustaining web-based educational communities and communities of best teaching practices from 2,000 European schools. To this end, the aim of this book chapter is to present the architecture of the ODS portal, as well as its current implementation and future plans.

The book chapter is structured as follows. Following this introduction, Sect. 2.2 describes the requirements of the ODS portal, based on which we compare existing federated infrastructures in Sect. 2.3. Afterwards, Sect. 2.4 presents the conceptual architecture of the ODS infrastructure and its main components, while Sect. 2.5 presents the implementation of the ODS portal. Finally, we discuss our main conclusions and ideas for further work.

2 Requirements of the ODS Portal

This section focuses on the first step of the development life cycle (Avison and Shah 1997), namely requirements analysis, by first setting a common terminology, identifying the main portal users and afterwards discussing functional and non-functional requirements.

2.1 Terminology

The ODS portal aims to include LOs organized in three aggregation levels as follows:

- *Educational resources* are typically digital materials such as video and audio lectures (podcasts), references and readings, workbooks and textbooks, multimedia animations, simulations and demonstrations.
- *Lesson plans* provide teachers with guidelines for conducting a lesson, and contain information about the students, the educational resources and tools that should be used, the educational objectives, the teaching method to be used, as well as the assessment method. Lesson plans can be (re)used by the same teacher, as well as by other teachers.
- *Educational scenarios* follow the same structure as the lesson plans but are of more extended duration. Educational scenarios either can be performed inside the formal classroom or can be combined with non-formal settings such as museums and field trips.

2.2 Users

We identify two main types of portal users as follows:

- *Teachers*: They are the main recipient of the functionality offered by the ODS portal. They are able to create an account, which allows them to access personalized services based on their profile. Teachers are able to search for LOs, as well as create and upload their own LOs. Moreover, they can build communities and formulate groups of interest. Finally, they can engage in full social network interactions, such as participation in activities, events, polls, discussions and blogs.
- *Parents*: They use the ODS portal, in order to interact with the teachers of their children. More precisely, parents can create an account, which allows them to join teachers' communities, groups, activities or events, so as to communicate with teachers.

2.3 Functional Requirements

In this section, we present the main functionalities that are required by the ODS portal users to address their needs. These functionalities can be summarized as below:

- *User profiling*: Users should be able to create their profile and access a dashboard with the activities that they have performed in the ODS portal.
- *Uploading LOs*: Users should be able to upload and store LOs to the ODS portal by describing them with appropriate educational metadata.

- *Authoring LOs*: Users should be able to use authoring tools for developing LOs in the form of lesson plans and educational scenarios.
- *Annotating LOs*: Users should be able to rate, comment, tag and bookmark LOs. These annotations are expected to be used by other users for assessing the quality of the LOs during searching.
- *Searching LOs*: Users should be able to search for LOs across existing repositories by using formal metadata added by the authors of the LOs, e.g. grade level, subject domain, etc., as well as by using social metadata added by the users of the LOs such as social tags and ratings.
- *Recommending LOs and Users*: Users should be able to receive recommendations for LOs based on their preferences, as well as recommendations for users to connect and communicate.
- *Managing communities*: Users should be able to organize their own lightweight portals, by creating open and/or private communities at international, national or thematic levels, to create and share their LOs.
- *Communicating with users*: Users should have proper tools available for communicating with other users in order to create their own networks into the lightweight portals, to share and discuss LOs, events and news of their interest and to have direct communication with their connections.
- *Participating to in training academies*: Users should have access to training academies that offer them training opportunities towards enhancing their competences about using information and communications technology (ICT) in education.

2.4 Non-Functional Requirements

Next to the previous requirements, there are also non-functional requirements that can influence the design of the ODS portal as follows:

- *Scalability*: The ODS portal is expected to involve 2,000 schools around Europe. Therefore, it is clear that the underling network, hardware and software infrastructure should have sufficient capacity and employ appropriate techniques such as load balancing.
- *Internationalization*: The ODS portal should be available in 17 EU languages, so as to overcome the language barrier and involve smoothly the anticipated number of 2,000 schools.
- *API*: The ODS portal should be extensible and allow for the reuse of the LOs metadata it harvests and stores. A search API will be provided in order for third parties to utilize the ODS infrastructure.
- *Usability*: The ODS portal should deliver various tools (such as metadata-authoring and scenario-authoring tools) which should be intuitive and easy to use in order to reduce the workload of users and keep them involved.
- *Privacy*: The ODS portal will store users' personal information. Therefore, the portal should protect any personal or private information belonging to the user.

- *Spam filters*: In a social environment with high volume of communication, there will be users who will attempt to exploit the community to send messages unrelated to the purpose of the portal. The ODS portal should employ spam filters to allow users to control and block unwanted messages and report abuse.

3 Related Work

In this section, we provide an overview of existing federated infrastructures and we compare their features with the functional requirements presented in Sect. 2.2.2. We have identified six existing federated infrastructures, namely: (a) the ARIADNE Finder,[1] developed by the ARIADNE Foundation, (b) the MACE portal[2] that was developed in the framework of an EU-funded project, referred to as "Metadata for Architectural Contents in Europe", (c) the iCOPER portal,[3] developed in the framework of an EU-funded best practice network, referred to as "Interoperable Content for Performance in a Competency-Driven Society," (d) the OpenScout[4] portal, developed in the framework of an EU-funded project, referred to as "Skill-based scouting of open user-generated and community-improved content for management education and training," (e) the Organic.Edunet Portal,[5] developed in the framework of an EU-funded project, referred to as "A Multilingual Federation of Learning Repositories with Quality Content for the Awareness and Education of European Youth about Organic Agriculture and Agroecology" and (f) the European Schoolnet's LRE Portal.[6] Table 2.1 summarizes these federated infrastructures.

As we can notice from Table 2.1, the main requirements that are supported by existing federated infrastructures are: user profiling, annotating LOs, searching LOs and communicating with users. On the other hand, there are several requirements that are not supported or partially supported by existing federated infrastructures such as: uploading LOs, authoring LOs, recommending LOs and users, managing communities and participating in training academies. As a result, it is evident that ODS portal aims to advance existing solutions and offer an enhanced federated infrastructure.

[1] http://ariadne.cs.kuleuven.be/finder/ariadne/.

[2] http://portal.mace-project.eu/.

[3] http://www.icoper.org/open-content-space.

[4] http://www.openscout.net/.

[5] http://organic-edunet.eu/.

[6] http://lreforschools.eun.org.

Table 2.1 Comparing existing federated infrastructures with ODS portal's functional requirements

Functional requirements	Ariadne	MACE	iCOPER	OpenScout	Organic. Edunet	LRE
User profiling	×	✓	✓	✓	✓	✓
Uploading LOs	×	✓	×	✓	×	×
Authoring LOs	×	×	✓	✓	×	×
Annotating LOs	×	✓	✓	✓	✓	✓
Searching LOs	✓	✓	✓	✓	✓	✓
Recommending LOs and users	×	×	×	~	×	~
Managing communities	×	×	×	~	×	×
Communicating with users	×	✓	✓	✓	×	✓
Participating in training academies	×	×	~	×	×	×

Legend: requirement supported (✓), partially supported (~), not supported (×)

4 The ODS Portal Architecture

This section presents the ODS portal architecture that has been designed based on the functional requirements defined in Sect. 2.2.

4.1 Overview

The overall architecture of the ODS portal is presented in Fig. 2.1. As we can notice, at the lower level there are existing repositories. The metadata of these repositories are harvested and stored in the ODS repository, which is located in the middle level of the architecture. Moreover, in the middle level of the architecture there are two types of metadata harvesters, namely: (a) educational metadata harvester, which aims to harvest metadata that have been created by the authors of the LOs and they are stored in the external repositories and (b) social data harvester, which aims to harvest social data that are also stored in the external repositories. Social data consist of (Bienkowski et al. 2012): (a) social tags and evaluative metadata, which are user-generated data derived by the interaction of the users with an LO (e.g. comments, rating, tagging) and (b) paradata, which are system-generated data and indicate the usage of an LO within an appropriate context (e.g. how many users have used, share or bookmarked an LO)

Finally, in the upper level of the architecture there is the ODS portal interface which includes (a) a searching mechanism for accessing the ODS repository, (b) the community pages, which are created by the teachers and they are using and storing LOs from/to the ODS repository, (c) authoring tools for metadata and educational scenario authoring and (d) a recommender system for recommending suitable LOs and appropriate users for communication.

The next section elaborates on the components of the architecture in more detail.

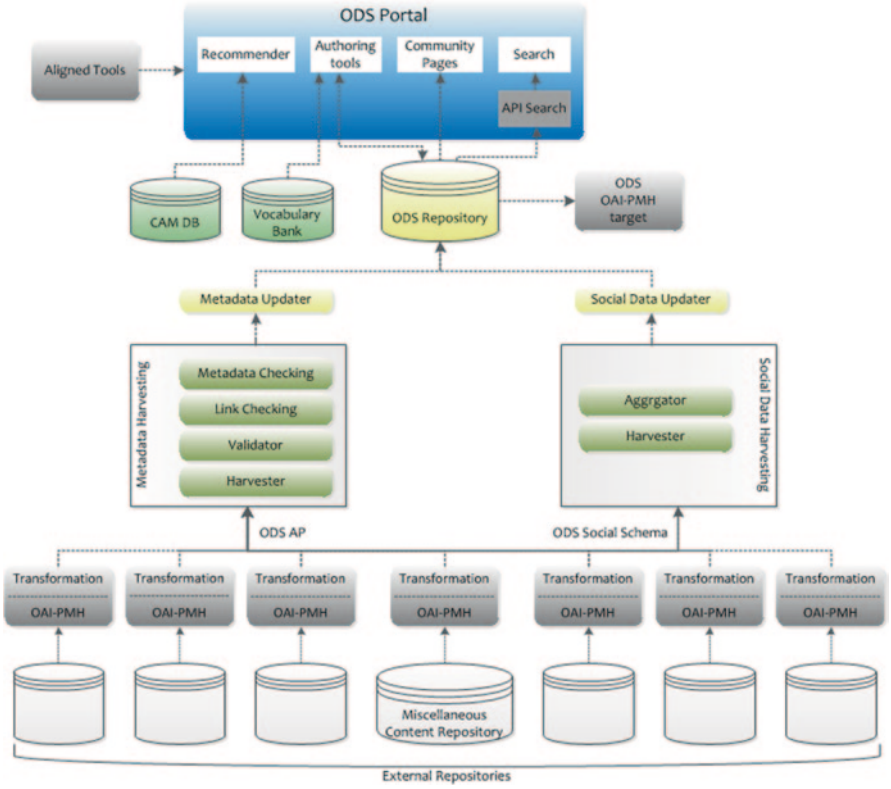

Fig. 2.1 ODS portal architecture

4.2 Components

External Repositories include LORs that have been developed in the framework of previous EU-funded or national-funded projects and the ODS portal aims to federate them. Moreover, this component includes repositories with miscellaneous resources (not only related to school education) such as cultural heritage resources, video archives, etc.

Metadata Harvester collects educational metadata from the external repositories. It includes four subcomponents, which are the following:

- *Harvester*: It harvests metadata records provided by external repositories. In order to ensure interoperability of the harvesting process, the harvester has been based on open standards such as the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH). Moreover, all metadata records from external repositories are transformed to ODS metadata application profile (ODS AP). ODS AP is based on the IEEE Learning Object Metadata (IEEE LOM) standard (IEEE

LTSC 2005) and it has been tailored specifically to support the classification of LOs based on their learning context of use, that is, the pedagogical approach adopted, the subject domain, the intended educational objectives and the environment within which the LOs are used. ODS AP is used to describe all LOs made available through the ODS portal. Apart from ensuring a unified way of describing LOs, it serves as basis for enriching incomplete metadata.

- *Validator*: It validates the metadata records that are harvested by the harvester, so as to ensure that they conform to the ODS AP.
- *Link checking*: It is used in order to verify that the metadata record includes a valid URL to the respective LO of the external repository. If the URL doesn't work then the metadata record is excluded from the harvesting process.
- *Metadata checking*: It performs a completeness check of the metadata records that are harvested based on the ODS AP. If there are metadata records that are incomplete, they are flagged, so to be enriched in the future by appropriate ODS portal users.

Social data Harvester collects social data from the external repositories. It includes two subcomponents, which are the following:

- *Harvester*: It harvests social data provided by external repositories. This subcomponent also uses the OAI-PMH, so as to ensure interoperability of the harvesting process. Moreover, all social data from external repositories are transformed to the ODS social schema, which is used to describe in a machine-readable way the social data of the ODS portal.
- *Aggregator*: It aggregates the social data that are harvested by the external repositories, in order to transfer them to the upper layer.

The ODS Repository aggregates the metadata and the social data of the LOs that are produced from the ODS portal and harvested from external repositories.

The ODS Portal is the interface that is presented to the portal's users. It includes four main subcomponents, namely:

- *Search*: It facilitates users to search for LOs by following different approaches such as: (a) *Simple keyword search*: Using keywords and combinations, the user is able to search through the LOs within the ODS portal. The keyword search uses the metadata that describes the LOs, taking into account metadata provided by external repositories as well as social tags provided by users. (b) *Browse by classification*: Many of the LOs included within the ODS portal are classified using vocabularies and taxonomies for different metadata elements of the ODS AP. The user is able to browse LOs by clicking on the terms of these vocabularies and taxonomies. (c) *Facetted search*: The user is able to qualify the keyword search with several additional facets such as the external repositories in which to search, the language of the results, the LO type, etc. When a value is selected for a facet, the interface dynamically changes and provides the numbers of results for each facet that match the selected criteria. (d) *Social tagging search*: The user is presented with the most popular tags contributed by ODS portal's users,

visualized by a tag cloud. A tag links to the respective LO(s). (e) *Personalized search*: The users are presented with search results that are ranked based on their competence profile. This requires that the users have previously completed their competence profile, which is based on the UNESCO ICT Competency Framework for Teachers (UNESCO 2011).

- *Community pages*: It enables users to easily set-up and deploy their own lightweight portal versions (named MyDiscoverySpace) that will fit to their community needs (e.g. thematic or linguistic). The MyDiscoverySpace sites have their own repositories and their members are able to create and share LOs with other members of these sites.
- *Authoring tools*: This subcomponent enables users to create and upload their LOs to the ODS portal. The subcomponent includes a metadata authoring tool for adding educational metadata following the ODS AP and an educational scenario authoring tool that facilitates users to create their own lesson plans and educational scenarios. Both tools are communicating with a vocabulary bank where all vocabularies and taxonomies of the ODS AP are stored for easiest management and maintenance. These tools are also used by the ODS portal users to edit and enrich the LOs that are harvested by the external repositories, creating new versions of these LOs and redefining them in different educational contexts of use.
- *Recommendation system*: The purpose of this component is to predict the user preferences on items such as LOs and user connections, so as to recommend appropriate LOs and users for connect and communicate. The recommendation system stores its data by following the Contextualized Attention Metadata (CAM), which is a format to describe events conducted by a human user (Schmitz et al. 2012).

Aligned Tools include tools for LOs' authoring and publishing that have been developed in the framework of other EU-funded or national-funded projects and the ODS portal aims to align them so that they can expose ODS AP-compliant metadata, so as to be directly harvested by the ODS portal.

5 Implementation of the Ods Portal

Based on the presented design, the ODS portal[7] has been developed following an iterative and incremental approach. The home page of the ODS portal, at the time of writing,[8] is presented in Fig. 2.2.

An important element of the ODS portal architecture is the ODS AP. The ODS AP has been implemented in accordance with the steps of the guidelines proposed by international organizations such as IMS Global Learning Consortium (IMS

[7] http://portal.opendiscoveryspace.eu/.

[8] November 2013.

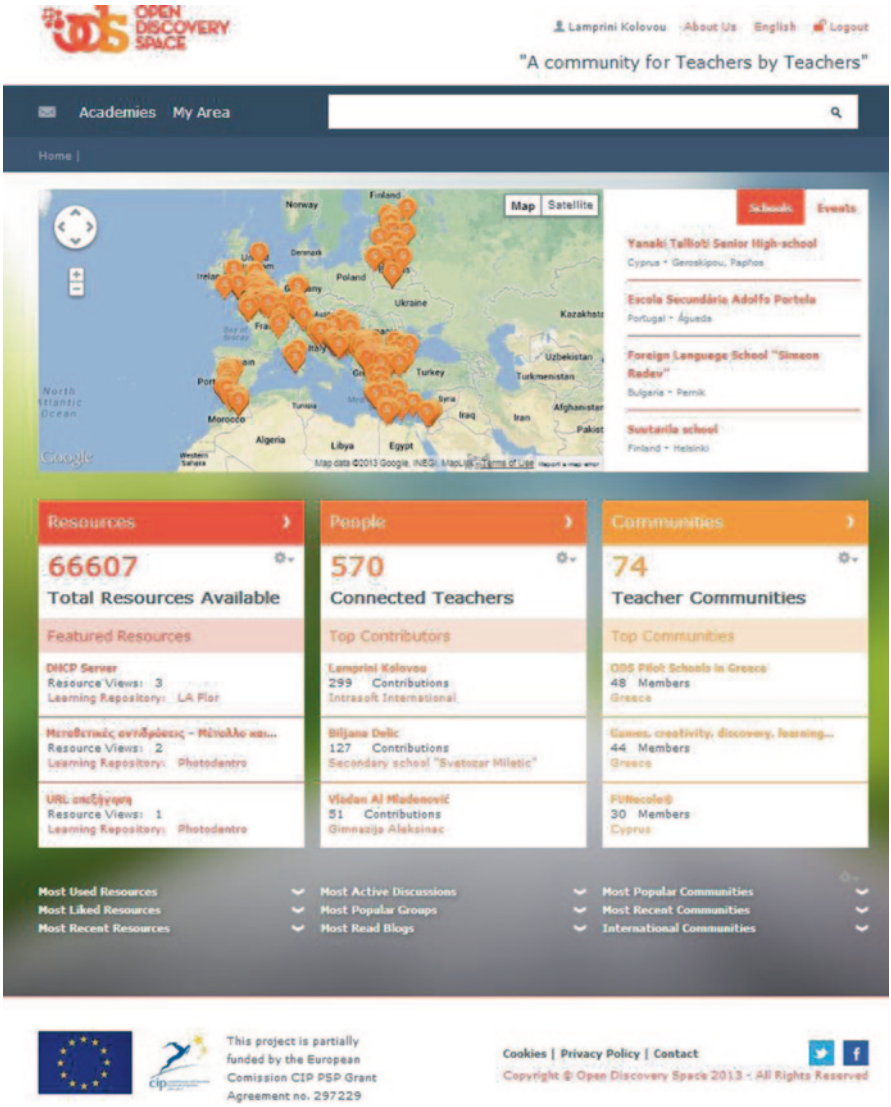

Fig. 2.2 The ODS portal home page

GLC) and European Committee for Standardization (CEN/ISSS) for developing IEEE LOM APs (Duval et al. 2006; IMS GLC 2005). The ODS AP consists of 2 mandatory elements, 18 recommended elements and 25 optional elements. ODS LOM AP's mandatory elements derive from the general and technical category of the IEEE LOM standard, whereas the recommended elements derive from the General, LifeCycle, Meta-Metadata, Educational, Rights and Classification Category of the IEEE LOM standard.

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