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Supporting the Reuse of Open Educational Resources through Open Standards

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Abstract: In this paper we analyse open standards for supporting the reuse of OER in different knowledge domains based on a generic architecture for content federation and higher-order services. Plenty OER are available at different institutions. We face the problem that the mere availability of these resources does not directly lead to their reuse. To increase the accessibility we integrated existing resource repositories to allow educational practitioners to discover appropriate resources. On top of this content federation we build higher order services to allow re-authoring and sharing of resources. Open standards play an important role in this process for developing high-level services for lowering the thresholds for the creation, distribution and reuse of OER in higher education.

Keywords: Open Educational Resources, Content Sharing, Educational Design, Open Standards

1. Introduction

Within the JISC E-Learning framework [1] different classes of E-Learning functionalities have been proposed. From the user perspective the core functionalities for the distributed management of open educational resources are search and browsing, viewing and publication of learning resources. The development of good resources for online teaching and learning easily becomes a time and resource-consuming task. Open educational resources (OER) are an approach for sharing and improving E-Learning material.

In the last years several initiatives have made OER available in many knowledge domains. While some examples of large OER repositories support the needs of communities from different knowledge domains, most OER repositories are focusing on learning objects from a discipline or a single institution. Although the availability of OER has been increased by several initiatives and projects, the accessibility for end-users remains low because useful OER are distributed across many different repositories. To identify these repositories and to search in each repository is one barrier for the large-scale uptake and reuse of OER. However, access to OER repositories and the ability to search them is not the only obstacle. Through our engagement in several international projects focussing on the improvement of accessibility of OER in different knowledge domains we developed a better understanding on the OER lifecycle. Open standards play an important role in this process for developing high-level services for lowering the thresholds for the creation, distribution and reuse of OER in higher education.

In this paper we share our experiences from these projects and report about how standards have been used for developing a generic basic infrastructure for search and browsing of OER as well as value-adding services. The projects related to this research share the assumption that a sufficient amount of educational resources is publicly available and that a better infrastructure and value-adding services are needed for increasing the resources' usage [2]. Two kinds of value adding services have been explored in the past and ongoing research. The first kind of services

refers to applications that *use* OER to create additional value for learners. The second kind of services refers to applications for enriching information and composing new resources *on top of* OER. The result of the former kind of service is disconnected from the OER life cycle, while the latter kind of service feeds back into the life cycle and extends the pool of resources. Open standards support the development of both kinds of services by reducing development overheads through standardized concepts and interfaces.

In this paper we analyse the standards and specifications that have been used for value adding services. The paper is structured in three parts. In the first part we introduce the projects that provided the main input to this research. We discuss the OER life cycle in the second part. Finally, we relate the standards and specifications that have been used in our research to the different parts of the OER life cycle.

2. Project descriptions

This paper is based on the experiences from three main international OER projects over the past years. The principal structure of the projects is similar, but each project has a different focus on challenges related to the OER life cycle. The first project is the MACE project, the second project is the OpenScout project , and the third project is the Share.TEC project. This section briefly outlines the objectives and the scope of these projects.

2.1 MACE Project

MACE stands for 'Metadata for Architectural Contents in Europe'. The project developed an internet-based information system that links up major international architectural archives with data records about completed and presently planned construction projects. The knowledge domain of MACE is Architecture and Construction Engineering. This 3-year project (2006-2009) is co-funded by the *e*Content*plus* programme.

MACE offers a set of tools and services for accessing several resource repositories for architecture and construction education. These tools and services are made available through a central portal. The portal offers several ways of searching and accessing architectural content from several European architecture repositories: 'Filtered Search', 'Browse by Classification', 'Browse by Competence', 'Browse by Location', and 'Social Search'. These interfaces allocate various contents and real world objects from all over the world that are stored in the connected repositories. Through these functions both, educators and learners, can search and explore architectural content by using metadata for filtering, visualizing results, or defining search parameters.

By connecting several repositories, MACE assures a critical mass of educational resources and provides access to rich multi-lingual resources in the knowledge domain. Besides the metadata provided by the content repositories, the MACE services provide additional data such as competence descriptions and peer-rating. The enriched meta-data enables educators and learners to identify appropriate resources for specific learning tasks in formal education and self-directed learning in ongoing professional development.

2.2 OpenScout

OpenScout stands for "Skill based scouting of open user-generated and community-improved content for management education and training" [3]. OpenScout is a project co-funded by the European Commission within the *e*Content*plus* Programme as a Targeted Project in the area of Educational Content. OpenScout started in September 2009 and runs for three years. The knowledge domain of OpenScout is Business and Management Education.

OpenScout aims at providing an education service in the Internet that enables users to easily find, access, use and exchange open content for management education and training.

The management education market is highly diversified, training topics range from general management and leadership to very specific issues like risk management in the banking sector. Despite the increasing need for management education and content, the potential of already existing open learning materials is hardly exploited. The same holds for the business sector and SMEs, in which the need for lifelong competence development is even greater.

In order to reduce the barriers for accessing OER for management education, OpenScout offers easy-to-use skill-based federated search and retrieval web services, provides an openly accessible tool library for improvement and re-publishing of open content, and establishes an open community [4]. This community opens up its content to the public and adopts OpenScout web-services in real application contexts. OpenScout is available to learners as well as to education and training institutions that search for learning content to be integrated into their educational programmes.

OpenScout integrates metadata from several connected learning-content repositories in Europe. This assures that OER for business and management education is available in different languages and different target user groups.

2.3 ShareTEC Project

Share.TEC stands for 'sharing digital resources and practices in the Teacher Education Community' throughout Europe. This 3-year project (2008-2011) is co-funded by the *e*Content*plus* programme and is devoted to foster a stronger digital culture in the teacher education (TE) field.

Share.TEC has three main objectives. Firstly, it makes quality content for TE across Europe more accessible, reusable and exploitable. Secondly, it initiates a European network of communities in the area of TE. Finally, the project supports the sustainable and coordinated expansion of federated TE content aggregation. The project addresses critical aspects of using digital resources in TE. These aspects are: bridging cultural differences in TE, unlocking TE resources & expertise, connecting TE networks, and providing an effective brokerage system for TE.

The Share.TEC project team develops an on-line platform that helps practitioners to search, access, and exchange OER for TE. Grounded on the critical mass of OER in the partners' repositories, Share.TEC encompasses a wide range of types of resources, including material suitable for formal, structured TE. Furthermore, the system covers content suitable for individual and self-guided continuing professional development, for supporting collaborative learning, as well as schemata or plans that model reusable learning paths.

With the focus on making quality content for TE across Europe more accessible, reusable and exploitable, Share.TEC provides integrated access to different databases. This integration is

supported by the development of new resources, which fosters constant enrichment and diversification of the available OER for TE.

3. The OER Life Cycle

All projects address several challenges related to the OER life cycle. The OER life cycle takes a holistic perspective on the creation, distribution, and reuse of OER. The OER life cycle adds collaborative authoring and knowledge extension to the value-adding process, while a typical value-chain perspective emphasizes content creation, distribution and usage of resources, in which the content users are the main beneficiaries. As this is a major concern for content developers and content owners, it is important to create solutions to support content users to re-inject their extensions, experiences, and solutions into the value-adding process.

The OER life cycle has four main phases: authoring and composing, publishing, finding and accessing, as well as content-federation and enrichment. Figure 1 illustrates the relation between the four phases.

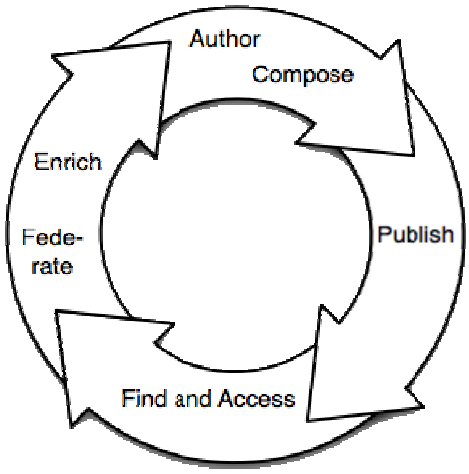

Fig. 1: OER Life Cycle

The cycle starts with the *authoring* of a resource. Resources can be pieces of text, images, multi-media documents, or videos, but also complex structures such as instructional designs, or course packages.

The second phase is *publishing* the resource to an OER repository. Typically, this phase includes not only the upload into a repository but also the licensing of the resource as well as the definition of meta-data for the resource.

The third phase include *finding and accessing* resources in a repository. In this phase an OER repository has to provide interfaces that allow to search and to retrieve the resources that are stored in the repository. These interfaces can be present for human-computer interaction, but also for automated agents to access the repository.

The fourth phase refers to *content-federation* and *enrichment* of the meta-data of a resource across repositories. *Content-federation* describes the integration of resources of different repositories into a single meta-repository. Meta-repositories do not store the resources themselves but only keep track of links to resources and resource meta-data. Therefore, they are

also called "referetory" as a short form of "reference repository". In these repositories it is also possible to *enrich* the meta-data for resources through community-based information, such as additional keywords (tags) or competence related information.

The last phase leads to an extension of the first phase in which existing resources are *re-authored* according to specific needs or in which several resources are *composed* into more complex resources. The task of composing new resources from existing resources is slightly different from normal authoring, because the resources that are used in this process typically remain unaltered.

The MACE project focused mainly on the phases: publishing, resource access, content-federation, and enrichment. Share.TEC addresses problems of content-federation, enrichment, and composition. OpenScout mainly focuses on practices of supporting enrichment, re-authoring and composition.

4. Open Standards and Specifications for Value-adding OER Services

In the presented projects we were heavily relying on open standards for developing new or integrating existing OER services. Through defined concepts, data formats, or interfaces open standards support the development of high-level services for adding value to OER. This section discusses which open standards and specifications were used for supporting the different phases of the OER life cycle. Figure 2 summarizes the relation between the OER life cycle and the standards and specifications used by the projects.

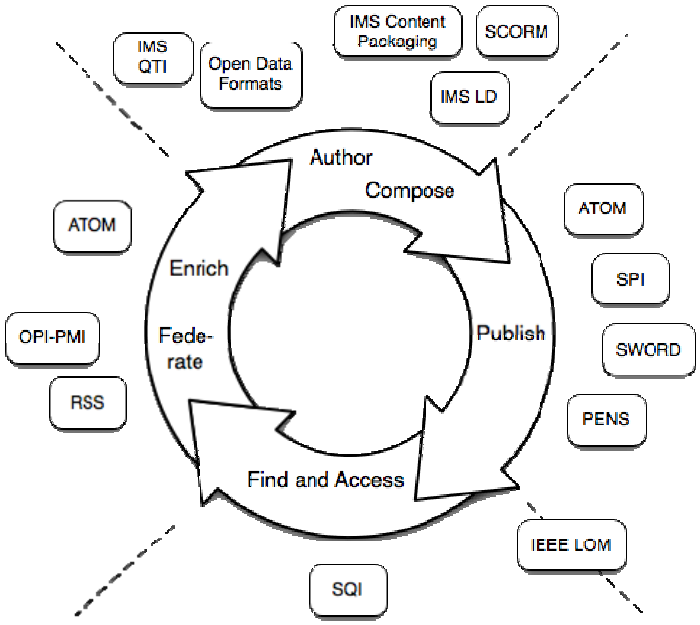

Fig. 2: OER life cycle and related open standards

Open document formats are an important foundation for authoring and re-authoring OER. Besides the prominent HTML format and its variants, the IMS QTI format [5] has been gained some attention for creating and exchanging test-based assessments. Although a range of open document formats exists, by far not all OER are available in these formats.

Another form of authoring educational resources is the composition of complex resource-packages from single resources. Composing of resources has been recently addressed on a large scale by the TENCompetence project [6]. The most prominent specification for composing resources is SCORM [7] and the related IMS Content Packaging specification [8]. These specifications mainly focus on the combination and sequencing of resources. For more complex educational arrangements the IMS Learning Design [9] specification is recommended. Within the GRAPPLE project Gruber and colleagues [10] have analyzed how MACE resources can get integrated into personalizing educational designs in IMS Learning design. While at large the integration is feasible, the interplay between interactive resources and the educational design rules required fundamental adaptation of existing resources.

Publishing resources to OER repositories is a key threshold for content authors. The process includes two aspects. Firstly, the authors need to be able to upload resources to a repository. Secondly, the authors need to specify appropriate meta-data for their resource.

For publishing exist several solutions. These include solutions include the Simple Publishing Interface (SPI) [11], the Simple Web-service Offering Repository Deposit (SWORD) or the Package Exchange Notification Services (PENS). Furthermore, the Atom Publishing Protocol [12] has gained increasing popularity for web-services. SPI allows publishing with bindings. This allows the development of publishing services and applications for repositories that support different publishing protocols. For example, an SPI binding for the Atom Publishing Protocol has been developed.

For exchanging meta-data the IEEE LOM specification [13] has been established for OER. This simplifies the publication and the exchange of resources. IEEE LOM provides a core vocabulary for educational meta-data.

At the level of finding and accessing resources in OER repositories, it is useful to provide interfaces that allow automated access to the repository. Particularly for integrating repositories for providing better access to OER in a domain this step is crucial. The ARIADNE foundation [9] developed an API to query learning objects within ARIADNE repositories from outside. Similarly, European Schoolnet developed a search API based on Java Messaging Service [15]. Edutella [16] and LOMster [17] wrap educational repositories in peer-2-peer networks. This work was brought to CEN ISSS for harmonisation resulting in the Simple Query Interface (SQI) [11]. Since then SQI has been widely implemented and supported by repository federations.

One of the first steps in the MACE project was to improve the accessibility of open educational resources from several repositories in a so-called *federated architecture*. The standards Atom [12], RSS [18] or OAI-PMH [19] are recommended for distributing metadata. Ternier and colleagues [14] compare two different main strategies to realize a distributed search in multiple learning object repositories. In the "federated search" strategy search requests are distributed to the original repositories. This has the disadvantage that the reliability and speed of the search process depends on the slowest repositories in the federation. The other alternative is the "metadata harvesting" strategy where the metadata are collected on a central server and search requests are only submitted to this local metadata repository. In the projects presented in this paper the second alternative has been proven to be the most reliable and the fastest solution.

On top of a federated architecture it is possible to build higher-level services to enrich the metadata in the federated repository, such as tagging, rating, or competence development services. Enrichment services can get built on top of the Atom Publication Protocol for injecting additional information into metadata system. These services often remain unused [20], although

they hold the potential to improve the quality of search results and to connect users and resources [21].

5. Conclusions

In this paper we analysed the relation of open standards for developing value-adding services for the OER life cycle. From the experiences of three international projects we identified the role of different standards and specifications for supporting the uptake of OER in higher education. The applications of open standards for publishing, for searching and for content-federation lead to a well-established value chain that support the development of OER services. This value chain is partially extended by open-standards-based services for content sharing, for content enrichment, for re-authoring, for repurposing, and for composing complex resources. However, it appears that the related standards and specifications require more alignment and support in order to lower the thresholds and make it easier for educational practitioners to benefit from the OER principle.

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