ABSTRACT

Learning object repositories is known as the systems that gather the knowledge materials or contents from the contributors in learning field. The main objective of LOR is to get as much learning object resources from them. This system emphasizes to disseminate reusable learning object for the educator’s community and they will be able to share knowledge content in the systematic ways. Facilitating interoperability into a learning object repository was a significant way to operate LO dissemination. Many LO repositories has been developed these days includes interoperability as their goal to support distributing sharable and reusable learning object among others. Therefore standards were being developed and enhanced in order to support interoperability. This paper is to review about well known learning object repositories that facilitate interoperability standards to enhance scalability of distributing and sharing learning objects. From the survey, we will select the most widely accepted interoperability standard being used by those well known repositories.

Keywords: Learning objects repositories, Interoperability.

INTRODUCTION

Learning Object Repository is the idea on how to distribute reusable learning object within the instructional society. Many researches have been made by numerous organizations whether it is corporate sector or academic institutions as their goal to dig up the surface into the most bottom knowledge about learning object repositories. Some of them have achieved their goal to develop the repository using the standard methods that has been created by the well known organization in learning technology like IEEE for producing metadata for learning object known as IEEE LOM and IMS Global Consortium for producing several reference model about learning object and interoperability. The result from what they have done is useful to the new comers in this field to learn and to get some idea on how to contribute frameworks, reference models, system applications, techniques and producing some proceeding papers or journals in this kind of area for learning environment. During technology support learning, the learning environment needs to evolve as for the rapid forward of the computer technology evolution.

The most common issues for sharing learning object is how to gather object contents from every part of resource learning fields. Although some organizations have good facility in providing platform for gathering learning objects such as high-tech repositories, but the major factor on gathering learning objects is from contribution of participators. Many participators such as educators, instructors and lecturers will affect learning object contribution exponentially.

Researches has been made by several individual in academic profession concluding their work by proposing results that something had to be done in order to ensure scalability in gathering learning resources. The best way to ensure this result is not only in paper writing is to facilitate repositories with interoperability.

There are several standards or interoperability reference models can be followed in developing repository with interoperability. The standard being produce by Open Archive Initiative, Edusource projects and IMS Global Consortium are among the current completed standards these days. These standards is successfully implemented numerous repository for learning objects.
Storing learning object in repository will have no meaning when there was no data describe the context and what is all about the learning object content. The solution to this problem will be settled down by the role of metadata. Metadata is the important component of learning object descriptions resources. These metadata is XML scheme with the set of metadata tags for describing resources content. The metadata is also important for interoperability operation. This is because metadata is the transferable scheme in interoperability standards.

**MAJOR LEARNING OBJECTS REPOSITORIES FACILITATE INTEROPERABILITY**

There are many repositories have been developed nowadays to increase knowledge sharing among instructional community. There are presenting themselves as open spaces for virtual learning communities. There are several differences between repositories. Some of the differences are about the metadata implementation for resources description, the architecture of the repositories, structure of learning object, interoperability for exchanging information of LO within repositories, subject domain and many more. Some of well known learning object repositories that have been developed and facilitated with interoperability are:

1. MERLOT – Multimedia Educational Resources of Learning and Online Teaching
2. SMETE – Science, Mathematics, Engineering and Technology Education.
3. NEEDS - National Engineering Education Delivery System.
4. CAREO – Campus Alberta Repository of Educational Objects.
5. JORUM – JISC Online Repository for Learning and Teaching Materials.
7. NSDL – National Science Digital Library

Other than these repositories, there are many more repositories that provide cross searching or federated search within the repositories and contributors. The main function is to provide open searching for learning object and course material whether for teachers, students, lectures or self-learners.

**INTEROPERABILITY STANDARDS**

Interoperability is the features that must have in the learning object repositories as the learning environment needs to gather learning contents in wide scalable of resources. Enabling cross searching between repositories means interoperable occurs to retrieve resources. Each repository that implemented interoperability method such as OAI-PMH, IMS DRI can gather other resources from other repositories.

There are several standards of interoperability that has been developed by some organizations. Those interoperability standards that being facilitate in well know repositories are OAI-Protocol metadata harvesting, Edusource Communication Language, OAI-Object Reuse and Exchange and IMS Digital Repository Interoperability.

**OAI-Protocol Metadata Harvesting**

OAI-PMH stands for Open Archives Initiative Protocol Metadata Harvesting, is one of the method for allowing interoperability between repositories. The protocol is develops by Open Archive Initiative to promote interoperability standards for content dissemination [1]. The protocol provides an application-independent interoperability framework based on metadata harvesting [2]. This protocol is using request and response of the Hyper Text Transfer Protocol in order to gather metadata searching of learning object trough several repositories.

The idea of this type of protocol is a client application on repositories (called harvesters) issues a metadata harvesting request through PMH embedding HTTP formatted to learning object repositories (provider) that response to the request. The harvesters can selectively harvest metadata from the provider and then the harvester can get the cumulative collection of metadata that being request from repositories.
Figure 1: The OAI-PMH data model [21]

Figure 1 introduces complex object formats in the OAI-PMH data model. The figure depicts descriptive metadata with an increasing degree of complexity and accuracy. Dublin Core metadata is a description of the resource according to the minimalist, resource discovery-oriented, Dublin Core metadata format. MARCXML metadata describes the resource according to the more complex, expressive and cataloging-oriented, MARC metadata format. And, an MPEG-21 DIDL XML document or a METS XML document describes the resource according to an even more complex format that focuses on the accurate representation of digital objects. These formats allow expression of a variety of secondary information pertaining to the resource, including descriptive, rights, technical, structural, and provenance metadata. They also allow unambiguously conveying identifiers and inclusion of the resource By-Reference or even By-Value. These formats can be used to represent digital objects of all kinds; they can represent digital objects irrespective of the type and number of contained data streams. It is worthwhile noting that the ability to describe resources of various classes is a core characteristic of metadata formats; it is a characteristic that distinguishes metadata formats from file formats. Based on these considerations, it is legitimate to consider complex object formats as metadata formats. This perspective is also supported by the name METS itself: Metadata Encoding and Transmission Standard [21].

Figure 2: An OAIS perspective on content transfer between archives using the OAI-PMH [21]
EduSource Communication Language (ECL)
EduSource Communication Language ECL is one of the interoperability methods for EduSource Canada project specifically for brings together major Canadian LOR players to create an open infrastructure for linking interoperable LORs. It is an implementation of the IMS DRI specification. This architecture use web services approach which services communicate using the ECL protocols. ECL only uses web services as basic communication between clients and service provider but not using WSDL for defining services. This is because ECL is much higher specification protocol that needs to provide enough coverage for edusource as heterogeneous network.

ECL is using SOAP as its communication layer and it is also closely follow IMS DRI specification. In that case, IMS DRI core functions is defined and implemented in edusource services to operate communication services between LORs.

Every repositories need to implement ECL connector to enable the repositories accessing eduSource network. This connector will hide complexity of communication between two repositories. As for that the repositories can facilitate to expose their resources and enabling sharable learning object. Other feature that also has in ECL is a gateway for communicating outside repositories or network from eduSource network. This feature has ability to mediate ECL with outside communication protocols.

![EduSource functional architecture](image)

**Figure 3:** EduSource functional architecture [1]

OAI-Object Reuse and Exchange
OAI-ORE stands for Open Archives Initiative Object Reuse and Exchange in another type of interoperability form the Open Archives organization. This method is the next enhancement of OAI-PMH, protocol for metadata response and request.

OAI-ORE will develop specifications that allow distributed repositories to exchange information about their constituent digital objects. These specifications will include approaches for representing digital objects and repository services that facilitate access and ingest of these representations. The specifications will enable development of a new
generation of cross-repository services that leverage the intrinsic value of digital objects beyond the borders of hosting repositories [20].

**IMS Digital Repository Interoperability**
The IMS Digital Repository Interoperability is a specification for the digital repository interoperability. IMS DRI is a reference model to facilitate repositories with interoperability and have several architecture projects of interoperable repositories using this reference model as the core functions to its interoperability services. One of them is ECL.

IMS DRI is released by IMS Global Consortium as the purpose to provide recommendations for the interoperation of the most common repository functions. This reference model is recommends existing protocol for implementation rather than proposing new model scheme.

Five basic functions defined by IMS DRI are: search/expose, gather/expose, submit/store, request/deliver, and alert/expose. For the search function, the specification recommends using either XQuery with SOAP protocol or Z39.50 [1]. This reference model also recommends OAI protocol as the function to harvest metadata from OAI service provider. With this specification IMS DRI has ability to search directly to the repositories or search through gateway to other repositories and also can search across repositories via metadata harvesting.

![Functional Architecture](image)

**Figure 4:** Functional Architecture [18].

**DISCUSSION**
Facilitating interoperability standard will require us to figure out what is the function that needs to be embedded in the systems. There are supposed some function or classes that operate with the system.

In order to embed the standards to the repositories, the first thing that supposes to be concern about is the system model must support the standards. This is important because without system model that support the standard, the system would be improperly produce result from what suppose to be produce. The second thing is the programming language that will be use for the development should operate with the standards. Basically, the standards documentation would tell what languages suppose to be use in order to facilitate the standard
to the repository and the last thing is all the function’s standards must be execute properly in order to get the result.

From the survey through the repositories, OAI-PMH is widely accepted in their repositories. This is because from every repository that mention in section 2, there are about 6 repositories that use OAI-PMH. From there we can conclude that OAI-PMH is the best interoperability standards that can be facilitate in LO repository.

### Table 1: Interoperability standards in LO repositories

<table>
<thead>
<tr>
<th>#</th>
<th>Repositories</th>
<th>Interopreability</th>
<th>Metadata</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MERLOT</td>
<td>OAI-PMH</td>
<td>IEEE-LOM</td>
</tr>
<tr>
<td>2</td>
<td>SMETE</td>
<td>OAI-PMH and SDLIP-Core</td>
<td>IEEE-LOM</td>
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<tr>
<td>3</td>
<td>NEEDS</td>
<td>OAI-PMH and SDLIP-Core</td>
<td>IEEE-LOM</td>
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<tr>
<td>4</td>
<td>CAREO</td>
<td>ECL</td>
<td>CanCORE (IEEE-LOM)</td>
</tr>
<tr>
<td>5</td>
<td>JORUM</td>
<td>OAI-PMH</td>
<td>UkLOMCore (IEEE-LOM)</td>
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<tr>
<td>6</td>
<td>EdNA</td>
<td>OAI-PMH</td>
<td>Dublin Core</td>
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<tr>
<td>7</td>
<td>DLNET</td>
<td>OAI-PMH</td>
<td>Dublin Core</td>
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### CONCLUSION

As for the conclusions, we can see that interoperability is the important feature that suppose to be facilitate in the LO repository in order to adapt an ability of sharable learning Object among repositories in the instructional community. With these standards, LO can be easy to find across repository and can provide federated search in order to have wide scale searching. The result from the wide searching content, teachers, lectures and instructors can make quality learning content material with lower cost. This will save large amount of fund for supplying instructional community with books and training that doesn’t have guarantee it will be fully useful for the instructional community. If the cost is reduces, the time will also affected. Much time can be save from being wasted because searching for learning content in books or paper based content can be painful. With the costly reduces and more effective in time, it will be much worth for the instructional community using interoperable learning object repositories. From the discussion above, OAI-PMH is the most widely accepted standards. Therefore, developing new repositories should include this standard in order to enable cross searching among repositories.

### REFERENCE

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