

# POOL, POND and SPLASH: A Canadian Infrastructure for Learning Object Repositories

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## ABSTRACT

The Portal for Online Objects in Learning (POOL) Project is a consortium of several educational, private and public sector organizations to develop an infrastructure for learning object repositories. In this paper we address the issues of building such architectures including the metadata, software and hardware considerations and bootstrapping the system with initial content. We also describe the tools we have developed, some of which are available for download to help set up similar infrastructures elsewhere and to connect is to POOL. The main advantage of our solution is that it can potentially embrace all nature of individuals and organizations involved in the learning object economy.

**KEY WORDS:** Internet-based educational systems, Advanced technology in education, Learning object repositories, Learning objects metadata

## 1. INTRODUCTION

With a growing number of organizations moving their training and education programs into the web environment, there is an increasing demand for high-quality, reusable components – learning objects (LOs). The learning object is a definable, reusable chunk of digital content and process elements used for learning and instruction [1]. This demand comes from the realization that the development of high-quality learning objects is resource intensive and time consuming.

Preparing to teach a course used to be mainly a one-person task. For an online classroom in a distributed learning process it takes a team of academics, content designers, and technical staff, *with commitment from the organization*, to make it happen. Transferring course content to the Web is not a trivial process. The Web infrastructure technology has to be in place, suited to the developmental process and work smoothly for learners, instructors and developers. Learning organizations tend to employ technical staff to design and administer the multiple web sites, content stores and widely distributed data sets and some instructors/course designers as better than others in adapting their content to online formats. There is also a growing concern that since the course

content is really amalgamation of thousands of learning objects, widely dispersed and stored across multiple domains and systems, educational content is becoming increasingly difficult to track. It is no longer clear where the original learning objects are stored, whether they are maintained, if the assets are duplicated across devices and whether these objects can be reused in similar content reducing development efforts.

Furthermore, the final course package may not always be self-contained, and more and more frequently they point to resources or services that may not be there on a continual basis. Even when the course is self contained it may not allow access to various course components, eliminating many reuse opportunities. When we contrast this educational content development model with creating a book, our confidence in the system is shaken. It is not clear where the intellectual property is being managed. There is great concern across the education and training community that we may actually be losing our intellectual capital within the network. Similar concern can be felt that without an ability to replicate the learning experience the e-learning can become a transient experience for the e-learner.

In Canada, current publicly funded initiatives to build learning object repositories aim at establishing infrastructure for collections of high quality learning objects and related business models [2]. The immediate expansion of a learning object economy both nationally and internationally requires effective implementation of mechanisms for the tagging, storing and retrieval of object-based learning content. Standards for interchange in the search and retrieval of learning objects are a key enabling technology, developing working prototypes for these processes, and having them tested in the real world of learning objects are the principal outcomes of Phase II of the Portal for Online Objects in Learning (POOL) Project.

In Section 2 we describe the infrastructure for the learning object repositories that is being built in Canada by the POOL Project. Section 3 describes components of the infrastructure, which consists of three types of nodes and

communication protocol. In Section 4 we summarize the benefits of the LOR infrastructure. Finally, we conclude with the future plans in Section 5.

## 2. DISTRIBUTED POOL ARCHITECTURE: A HIERARCHICAL PEER-TO-PEER NETWORK FOR LEARNING OBJECT REPOSITORIES

### 2.1 Centralized Repositories

Several businesses, colleges and professional communities have gathered their learning assets into centralized repositories, essentially large collection spaces with storage capacity for the media elements and an indexing system for their classification, identification and retrieval. In earlier times, these collections were distributed as printed collections, or slide sets, and the index was usually a printed booklet or at best a key-sort card system. Some collections appeared on optical videodiscs that could be purchased with an accompanying computerized database. With the huge uptake of web technology in education and training, there has been a flurry of un-coordinated activity developing digital learning objects – images, animations, computer applets or textual content which could be used in the processes of education and training. Centralized digital repositories evolved as a means of collecting and cataloguing these assets with hopes of reducing the redundancy of development and enabling others to build on the aggregated ideas and designs, and in many cases to preserve the elements, and protect the rights of ownership and usage. The Prototype developed in Phase I of POOL is an example of a web-based client server repository where users can upload objects to the repository and in that process complete a description of the learning objects using the CanCore metadata specification [3].

In addition to centralized control, a centralized repository offers advantages in rapid indexing and object retrieval. Unfortunately, a single centralized repository is unlikely to be of sufficient size to accommodate all of the web-

based learning objects that have or will be created. Secondly, there are workflow disadvantages to the centralized repository as the objects are stored away from their point of origin and away from their point of use. Users have to be connected to the web for even the simplest operation, and off-line creation or modifications of learning objects are not captured until the object and its metadata are re-loaded. The optimal storage sites for a learning object are *close to the creator and close to the user*. Further, as workstation storage increases, it becomes feasible for each learner to curate a personal collection of the learning objects which have influenced their intellectual growth, and to be annotated for future reference and review, much in the manner that study notes enabled classroom learners to keep track of significant content and conceptualizations.

Recent developments in peer-to-peer web technology have made it possible for individuals to amass local collections of entertainment content. Although Napster and Gnutella may have been lacking support for rights management, the peer-to-peer model demonstrated that a global community can benefit from decentralized storage of content on the users' own hard drives. For learning objects this means that individual instructors, if provided with the standard metadata and communication protocol, can develop and store their materials so that others may directly search and access their public materials, or become aware of semi-public materials which the individual may wish to negotiate consideration for use. Individuals may also store private materials that are under development, or are not intended for mass consumption.

### 2.2 POOL Architecture

Learning objects are specialized resources developed mostly by individuals either for their individual purposes or for their organization needs. Typically, the learning object evolves during its lifetime as it is getting feedback from its usage. This evolution is possible through a

persistent ownership that exists through the object's lifetime, although it is possible that it changes from person to person.

To support an evolutionary nature of the learning objects we designed the POOL network as a network of individual peers communicating together using the POOL protocol (Figure 1). Three types of peers participate in the network: SPLASH, POND, and POOL Central.

SPLASH is a desktop client communicating with other peers via the peer-to-peer POOL protocol. It provides the metadata creation tools, a limited storage capacity for metadata records and searching capability for the POOL network. The SPLASH is developed using

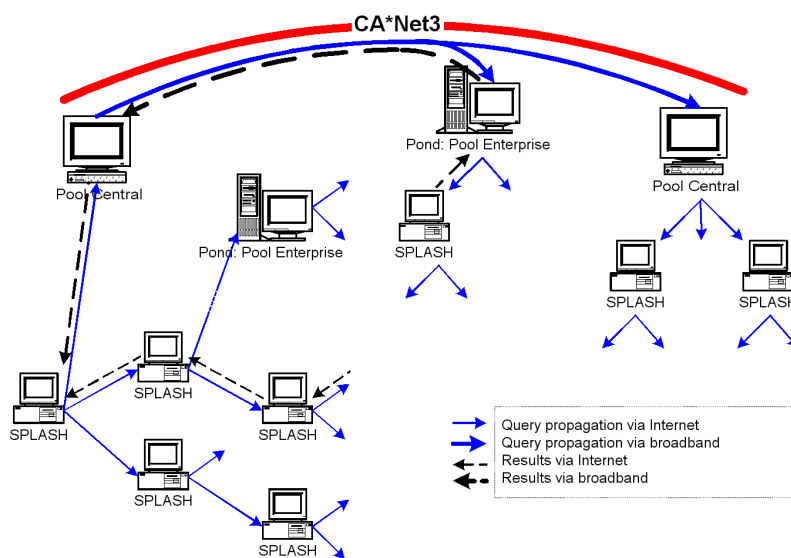


Figure 1: Pool network architecture

open source code, and distributed freely in the belief that 100,000 small repositories of learners and instructors will create a wide acceptance and use of both learning object technology and the CanCore protocol.

The wide distribution of SPLASH will not obviate the existence of community repositories. There is a role to be played for established collections of mature, accepted learning objects with common themes or purpose that can be stored in a selective gallery of learning objects. Indeed, an advantage of the SPLASH is that such galleries or PONDS can be set up with ease. Within the project we have test the concept by incorporating several community repositories to create PONDS – repositories that are accessible using the POOL protocols and searchable using the CanCore metadata standard. A POND may be simply a larger, community implementation of SPLASH, or it may involve building an interface to a third party repository system. The ability to include such proprietary systems is expected to be an advantage over a single centralized pool, and will hopefully enable organizations already committed to a particular repository technology to participate in the larger POOL movement. POND typically comes with a robust database support and a suite of tools for managing the learning objects workflow. These features are essential for organizations with intensive production of learning objects.

POOL Central is a specialized peer connected to the network and a high speed Internet. The purpose of the POOL Central is to replicate the queries through the other POOL Central peers over the broadband connection and enhancing the reach of the network. POOL Central does not necessarily have a storage capacity, although caching of records might be possible.

Also, within the proposed hybrid architecture we can see a role to be played by specialized nodes. An example of such a node is the LORI (Learning Object Review Instrument) which can be embedded in SPLASH and link reviewers to specialized nodes for learning object collaborative assessment (LOCA). A prototype of this is

Table 1 POOL network nodes functionality

	SPLASH	POND	POOL Central
Create/edit metadata record	+++	+	
View metadata records	+++	+	
Search for metadata records locally	++	+++	+
Search for metadata in the POOL network	++	++	+++
Respond to the search request from another peer	++	+++	+
Propagate search query and return collected results	++	+	+++
Robust database support	+	+++	
Management and workflow tools		+++	

+ supported ++ main functionality +++ specialized

currently being incorporated into the POOL network [5]. The appeal of specialized nodes is that they enable any user or interest group to add intrinsic value to the network without the need for centralized planning, resources or control.

Table 1 illustrates how the network functionality is spread over the network nodes.

### 2.3. CanCore: A Canadian protocol for metatagging learning objects

The Canadian Core Learning Resource Metadata Protocol (CanCore) [3] is creating a stir in the Canadian e-learning community. CanCore has provided a streamlined version of the complex IMS Metadata standard [4], and has developed application profiles for the national POOL and BELLE projects, as well as for New Brunswick's TeleCampus and the Alberta Learning Portal

CanCore is a metadata protocol specifically designed for the cataloguing of on-line learning objects. CanCore was developed in Phase I of the POOL project by the collaboration of Canadian researchers searching a level of sufficient specificity to enable the search of learning objects feasible. Putting objects “on the internet” does not necessarily make them available to others. General web search tools are too broad, and a simple search usually returns too much information rather than too little. Finding objects is a two part process: first the objects have to be indexed or “tagged” with metadata that identifies the object, its location and describes the object with sufficient detail that an on-line search will result in its location. Too little information in the tagging will result in too many false positive results. The Dublin Core protocol identifies only 15 fields. Too much information results in too much time spent cataloging that no one will bother. IMS specifies some 86 fields. CanCore is a concerted effort to identify a sufficient number of fields (36) to be useful for educators, without overburdening the indexing process. CanCore has sufficient flexibility in its protocol that not all fields need be completed, thus developers can ignore many fields that may be inappropriate for their purposes and define new fields that are important for them. CanCore elements are organized into 9 groups describing different characteristics of the learning object. Table 2 provides a description of these groups, more detail information can be found on the CanCore website.

Having a standard is of little use unless it is maintained and widely used. CanCore is fully compliant with the IMS metatagging specification. As IMS matures, additional development will be required of CanCore. CanCore must also be embedded in repository systems – this has been promoted by a general agreement in Phase I among Canarie Learning Program projects to use the CanCore protocol. Only if a critical mass of educational users standardizes their cataloging with CanCore can the POOL repository protocols search and locate learning objects with efficiency. To support CanCore adoption, the

Table 2 CanCore elements

General	Groups information describing learning object as a whole. <i>Active elements:</i> Identifier, Title, Catalogentry.Catalog, Catalogentry.Entry, Learning Object Language, Description, Coverage
Lifecycle	History and current state of resource. <i>Active elements:</i> Version, Contribute.Role, Contribute.Entity, Contribute.Date
Metametadata	Features of the description rather than the resource. <i>Active elements:</i> Identifier, Catalogentry.Catalog, Catalogentry.Entry, Contribute.Role, Contribute.Entity, Contribute.Date, Metadata Scheme, Metadata Language
Technical	Technical features of the learning object. <i>Active elements:</i> Format, Size, Location, Other Platform Requirements, Duration
Educational	Educational or pedagogic features of the learning object. <i>Active elements:</i> Learning Resource Type, Intended End User Role, Context, Typical Age Range, User's Language
Rights	Conditions of use of the resource. <i>Active elements:</i> Cost, Copyrightandotherrestrictions, Description
Relation	Features of the resource in relationship to other learning objects. <i>Active elements:</i> Kind, Resource.Identifier, Resource.Catalogentry
Classification	Description of a characteristic of the resource by entries in classifications. <i>Active elements:</i> Purpose, Taxonpath.Source, Taxonpath.Taxon.Entry, Keyword

documentation, indexing guidelines, training and support is provided to educators by the CanCore team.

#### 2.4 Target Audience

The POOL project plan targets audiences in the Canadian post-secondary and adult continuing and corporate education sectors, which includes instructional designers, instructors, trainers and learners. POOL has the potential to serve the global market for learning objects in education and training.

- Individual learners have the capability to download SPLASH and create a repository for the management of learning objects salient to the construction of their personal knowledge. Personal repositories can enable local control of learning and reduce the transience of web surfing, by being able to download and manage objects made available to them.
- Individual instructors can create their own repository of objects relevant to their instructional responsibilities.
- Individual creators of digital learning objects can catalogue and retain local control of their materials. They have minimal rights management to code entries as public (shareable), private (negotiable), or private (unseen). They also have some ability to give permissions to other users to access specific items.

Individual creators may also benefit from search flags that will tell them that private items have been requested in a search.

- Communities benefit by being able to collectively build repositories or learning objects related to their interests. A professional community may create a repository of case studies for its own use, but with CanCore and POOL, they may discover additional audiences for those cases, or additional cases that are available at another node.
- Organizations that have already adapted a repository for learning objects can create POOL/CanCore interfaces to allow cross searching to their metadata.
- Commercial developers or publishers of learning objects may profit from the enhanced opportunities for distributing their content made available by a common interface and metatagging protocol.
- Educational providers across Canada may benefit by better management of digital learning resources, and an increased opportunity to rationalize the development costs of digital learning objects. Better communication of what is available makes less likely the re-development of similar objects, and increases the likelihood that educators can collaborate to better spread scarce development resources across the broader curriculum.
- Informal learners, parents, tutors, employers and other less represented stakeholders in the learning objects revolution can benefit by having improved access to learning objects.

#### 2.5 Building the Canadian Learning Objects Metadata Repository (CanLOM)

Even in this world of POOL, POND and SPLASH there is a need to differentiate some roles of the network nodes. For example, Callisto Media Systems located in Hull, Quebec, has already implemented a peer-to-peer network for its video /IP server system simply because video objects take up tremendous amounts of storage and peering allows a family of servers to respond to client requests as if they were a single large virtual storage system. In this family setting, Callisto centralizes the metadata catalogue so that requests can be efficiently directed to the appropriate member. While a centralized catalogue is not essential for a peer-to-peer network, it can rapidly speed up the search for published learning objects, particularly when some nodes might not always be on-line. In Phase II of the POOL project, TeleCampus (www.telecampus.com) has volunteered to collect and centralize published metadata to enable creators of learning objects to post and update the metadata for their learning objects in a central catalogue. Any search initiated in the POOL network can thus include the CanLOM at TeleCampus as a logical first point to look. In a similar way, it may be possible for other nodes on the network to specialize as collector of third party reviews on learning objects, or as clearinghouses or publishers of domain specific learning objects.

### 3. IMPLEMENTATION AND DEPLOYMENT

This section describes ongoing efforts at the time of writing. Although we have finished most of the technical development we are still working on the improving the technical solutions. Our main focus now is on deploying the solution by supporting a creation of the community repositories both by connecting existing repositories into the POOL network as well as working with the repository solution providers on the making their products pluggable into the network.

#### 3.1 Technical Development

##### SPLASH

The beta version of the SPLASH desktop application is available for the public download free of charge as of the end of February 2002 ([www.edusplash.net](http://www.edusplash.net)). The version available implements all the functionality listed in the Table 1, it includes a tagging engine enabling the user to create metadata records using CanCore and search engine searching through POOL network. SPLASH can communicate with any SCORM-compatible LMS using SCORM [6] content packaging format. SPLASH is designed with nearly all components designed to be customizable by the user which makes it easy to tailor it for the individual user needs or for other metadata schemas.

Technically, SPLASH is a Java application running on the user's desktop computer. It uses MySQL as a database engine (bundled with the installation), which is replaceable by another SQL database. Figure 2 shows a snapshot of the SPLASH search page.

##### PONDS

We have implemented and deployed so far three PONDS to test different ways how to build or incorporate large

repositories going beyond desktop level. The repository at the Center for Curriculum, Transfer and Technology ([www.c2t2.ca](http://www.c2t2.ca)) in Vancouver has evolved from the SPLASH by dedicating one SPLASH application to play a role of the common repository for the community. Individual community members run they own SPLASH but have a choice of storing the metadata records either at the centralized repository or locally.

The same mechanism has been used for the CanLOM. CanLOM has been build on top of the existing TeleCampus database of over 50,000 learning objects which uses slightly different metadata schema. In the CanLOM case, the repository was a preexisting system where we built a wrapper to connect it to the POOL network. The wrapper is a networking module from SPLASH connected to the TeleCampus system that is built on Oracle database and ColdFusion. It also implements a registry protocol for the learning objects enabling the user to register the learning object in the CanLOM registry.

In the third case, we have connected CAREO repository in Alberta ([www.careo.org](http://www.careo.org)) that uses Web services. In this case, we have implemented a simple component translating between the POOL protocol and Web services.

##### POOL Central

At the time of writing we are in the process of implementation of the POOL Central with the deployment planed for the June 2002.

#### 3.2 Methodological Issues

Creating the infrastructure for learning objects which would bring instant benefits into the education community requires making some crucial decision. In this section we highlight some of these considerations.

To be able to benefit from the wealth of content available freely on the web the proposed solution has to employ *metadata schemas* that are compatible with the ones used to describe this content. Although not that well represented in the current practice, there is visible convergence towards the IMS standard. The CanCore protocol, fully compatible with IMS, solves the most of the problems early implementers of the IMS encounter.

System to be useful and well accepted has to be bootstrapped with the sufficient amount of initial *content*. There are three ways how to supply the content:

- make existing content available in the network by annotating it with metadata,
- connect an existing metadata repositories into the network,

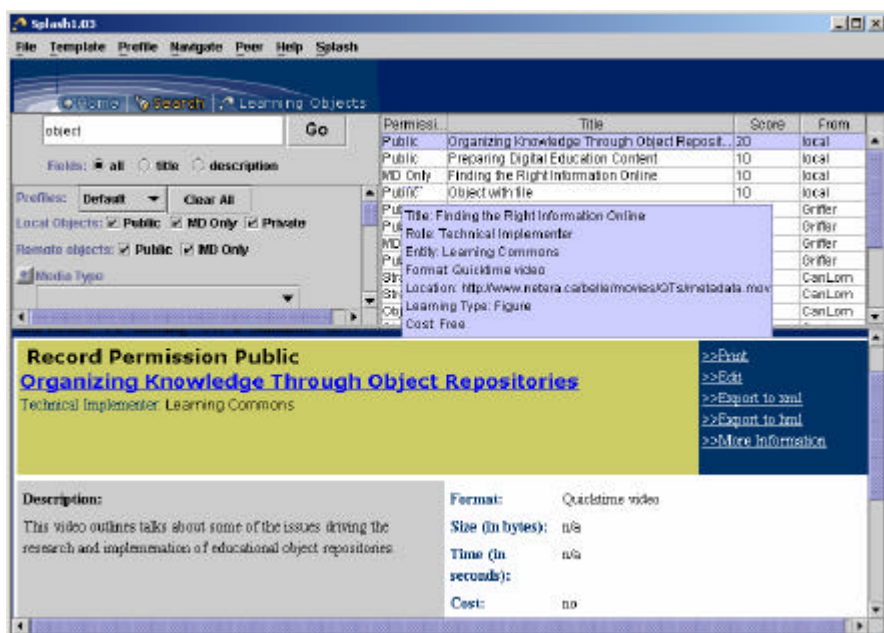


Figure 2: SPLASH Search page

- and/or use distributed models as peer-to-peer to access content individuals are willing to contribute.

The combination of all three approaches provides the biggest benefit. However, different cultural settings will require emphasizing one approach over another. It is worth noting that the distributed peer-to-peer model could enable educators to search and gather content with specified language or other characteristics from all over the world.

The *technical solution* to build an e-learning infrastructure can vary from the freely available solutions to the most expensive specialized systems. Although it is difficult to avoid specialized hardware and software when you are looking for streamlining video-based learning objects the general infrastructure can be build using open source or freely available systems and tools. SPLASH is a freely available application which can instantly engage education community into the learning object exchange. On the other side, the CAREO project provides an open source server based repository able to function as a POND in the POOL network.

#### 4. BENEFITS TO THE LEARNING COMMUNITY

The greatest benefit POOL offers to the greater Canadian learning community is the introduction of a viable demonstration of an object-based peer-to-peer learning management approach. POOL serves not only as a set of networked databases, but also as a distributed knowledge management system with the potential to:

- Create a model for a national learning object economy that can be made available to individuals, communities and organizations.
- Decrease loss of existing knowledge assets.
- Decrease time spent “re-inventing the wheel” and increase the probability of finding an appropriate existing learning object.
- Decrease the cost of resource storage and management for learning organizations.
- Increase collaboration between individuals, institutions and jurisdictions around common curriculum themes – transparent and measurable knowledge exchange.
- For learners, it can increase transparency of the instructional design process, and enable personal management of learning objects that have provide salient experiences in their personal knowledge constructions.
- Increase access to high-quality programs (through vetted course and program delivery in POOL) to the growing market of eLearners in Canada and internationally.
- Increase visibility of high-bandwidth solutions to instructional design, teaching and learning needs.
- Increased access to demand statistics from both the instructional and learner populations. These data will help organizations in their investment decision-making processes.

#### 5. CONCLUSIONS AND FUTURE WORK

The POOL consortium is a partnership of educational organizations striving to promote a collaborative approach to solving common problems in the new era of e-learning and digital learning objects. We have designed a hybrid infrastructure for learning object repositories – the POOL network. – which includes tools and protocols connecting individual users, communities and organizations. The POOL uses CanCore protocol to describe metadata for the learning objects.

POOL is closely collaborating with other projects of the Canarie Learning Program (LearnCanada, BELLE and CAREO) to increase our chances for significant impact in the Canadian learning community. This involves the sharing of products such as the POOL protocols, the development of CanCore, and repository systems.

Currently we are working on a number of test implementations of SPLASH and PONDS. Especially interesting is the POND adaptation of the Australian AVIRE project [7] so it can be searched from POOL. This work will not only give Canadians access to an extensive collection of architectural learning objects, but also provide international exposure for POOL and CanCore. As AVIRE uses different metadata schema, a communication layer between SPLASH and AVIRE will map CanCore metadata fields to AVIRE metadata fields, and return search requests coming from SPLASH

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