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Stephen Downes is Editor at Large for this Journal. He is Author-Publisher of OLDaily and Stephen's Web. This month he is Guest Editor and introduces the theme for the first three articles.

The Rise of Learning Objects

Stephen Downes
Editor at Large

I remember in 1999 or so getting my printout of the first IMS learning object metadata specifications. It landed with a satisfactory "thud" on my desk at Assiniboine Community College. I had been working on a similar concept for our home-brew learning management system and welcomed this new way to describe what we called course "modules."

The first hint of trouble arose when I tried to share this wonderful news with my colleagues. The web page designer picked it up, thumbed through the hundreds of pages, and put it back on the desk without comment. The course designer wrote me an email saying, essentially, "I don't know what this means." We never did implement the IMS specifications, and little did I know that it would be five years before learning objects achieved any sort of real currency.

The idea, of course, was attractive in principle. I had written in "The Future of Online Learning" (1998) that learning materials would be distributed in bite sized chunks that could be mixed and matched to create custom online learning. A couple of years later, in "Learning Objects," I outlined the economic argument for sharing reusable learning resources. And all around, the buzz increased on a monthly basis. People began creating learning objects. People began the tagging process to create metadata files. The IMS specifications multiplied and IEEE formalized that first specification a LOM.

But a funny thing happened on the way to the form. Observers began reporting that 87 fields were too many for people to complete. The first major application, SCORM, seemed designed for training and not for learning at all. Dan Rehak wrote that SCORM might not be useful for universities. David Wiley questioned the reusability of learning objects. And Norm Friesen, a pioneer of the CanCore profile, leveled a devastating critique with his "Three Objections to Learning Objects." The standard notwithstanding, it appeared that nobody knew what a learning object was, nobody knew where to find them, and nobody knew how to use them. Discontent grew.

Now it is 2004 and despite the concerns and objections, we are beginning to see the first really widespread use of learning objects. As the papers in this volume illustrate, the use of learning objects was not nearly so simple as we may have at first assumed. For one thing, the use of learning objects requires some means of locating and distributing these objects. Only now are we seeing the large scale development of learning object repositories, as described by Rory McGreal in this month's issue. And for another, the reuse of learning objects requires the creation of objects people want to reuse, as is described by Jo-An Christiansen and Terry Anderson in *Feasibility of Course Development Based on Learning Objects: Research Analysis of Three Case Studies and by* Jinan Fiaidhi and Sabah Mohammed in *Design Issues involved in Using Learning Objects for Teaching a Programming Language within a Collaborative eLearning Environment.*

As it turns out, the emerging paradigm for the reuse of learning objects is nothing like the automated course creation tools some of us may have envisioned when the specifications first rolled off the presses half a decade ago. As I discovered in the reaction to my paper "Design, Standards and Reusability," in which I criticized IMS Learning Design because it could not be automated, people expect still to create new learning resources by hand, with subject matter experts searching for, retrieving, modifying and organizing learning objects to create customized online courses.

Indeed, it appears that this is the preferred use of learning objects, at least as expressed by the learning design community. The idea that learning might be designed automatically was disparaged and the discussion forum at CETIS was replete with criticisms. Unless human designers were used (whatever the cost), the result would be nothing but sterile, cookie-cutter learning design, something of no learning value at all. And the use of learning design tools and learning objects saved enough time and effort as is, without needing to obtain further savings by factoring humans out of the process all together.

Well this may be, but I think that this remains only one more front of contention as the new learning object paradigm begins to roll over the field. With a recent proposal emanating from ADL for the use of 'resources' in addition to learning objects, with the rise of automated content distribution services created by bloggers using RSS technology, with the emergence of OAI and open content initiatives, it becomes clear - to me, at least - that the use of human labor to search for and reorganize learning objects for each new use is problematic.

Therefore, I think that although we are reaching the end of the introductory phase of learning objects, though we are finally beginning to see the use of learning objects on a wider scale, I feel that what we have in fact reached is only the first stage of the eventual transformation of learning. What we have reached today, in my view, is the successful transition of traditional learning from the pre-electronic age to the post-electronic age. But what we are doing is still rooted in this traditional approach to learning.

The full benefits of learning objects may take another five years to realize, as we move through the second phase of the transition. Once learning objects are widely available and widely used, the traditional thinking surrounding the organization of learning will be increasingly questioned. People will begin to ask why learning resources must be organized by hand by a designer before they can be used by students. Systems will emerge that allow students to be their own designers. Instead of viewing learning design as some sort of script in which students are actors, following directions, we will begin to see a model where students are players, following no script at all.

But we're not there yet, nor will we be for a good number of years. So it is appropriate, for now, to revel in what we have created. And that, it seems to me, is what this month's issue is all about.

Editor's Note: Many years ago I attended a meeting at Stanford University where Steve Jobs did his first public demonstration of the NEXT computer. He amazed his audience by selecting a series of visual objects, each of which functioned like a pert in a machine. By drawing lines between them on the screen, he made them function together as one machine where the functions integrated seamlessly. These were reusable objects designed to function in any context. These same principles are applied in Object Oriented (computer) Programming, which combines modules to create larger programs. The same principles are used to build custom learning experiences using Learning Objects.

An alliance of Canadian Universities and government agencies pooled their resources to establish a network to share and combine Learning Objects from a variety of sources and further develop this technology. In the process, they resolved many learning, logistical, and legal problems and moved this technology forward by an order of magnitude. Principal goals include: nationwide interoperability, network of repositories, linked servers, repository software programs, national and international standards, digital rights management, business and management models, evaluation and feedback, dissemination of results, and bilingual access to all Canadians, particularly learners with disabilities.

The defined tasks were sub-divided into nine work packages, each with a lead institution as package manager.

Donald G. Perrin

EduSource:
Canada's Learning Object Repository Network

Rory McGreal,
Terry Anderson, Gilbert Babin, Stephen Downes, Norm Friesen,
Kevin Harrigan, Marek Hatala, Doug MacLeod, Mike Mattson, Gilbert Paquette,
Griff Richards, Toni Roberts, Steve Schafer

Background

The eduSource project is a collaborative venture among Canadian public and private sector partners to create the prototype for a working network of interoperable learning object (LO) repositories. The project uses Canada's broadband Internet network CA*Net4 as a development and application platform, with capacity to operate as well on the commercial Internet. The project is charged with the creation and development of the associated tools, systems, protocols and practices that support a distributed LO repository infrastructure. EduSource is committed to the implementation using international standards; it is bilingual (French and English); and it is accessible to all Canadians including those with physical disabilities.

Each of the partners and their associates are bringing considerable resources to the project. Collectively, the contributions of the partners from 2002 to 2004 amount to C$5,330,000 of the total project value of C$9,830,000. CANARIE, Canada's advanced Internet development organization (*CANARIE home page*, 2003) and Industry Canada are contributing up to $4,700,000.

EduSource Organizational Structure

EduSource is a CANARIE project with six designated primary partners: Athabasca University AU), the Netera Alliance (Netera), New Brunswick Distance Education Network/TeleEducation NB (NBDEN), the New Media Innovation Centre (NewMIC), Téléuniversité du Québec (TÉLUQ), and the University of Waterloo (UofW). The Netera Alliance serves as the lead contractor. The consortium includes several associates in the private and public sector representing companies and learning institutions from across Canada including the National Research Council (NRC). In addition, a team from the University of Alberta (UofA) is conducting a formal evaluation of the project (See Figure 1).

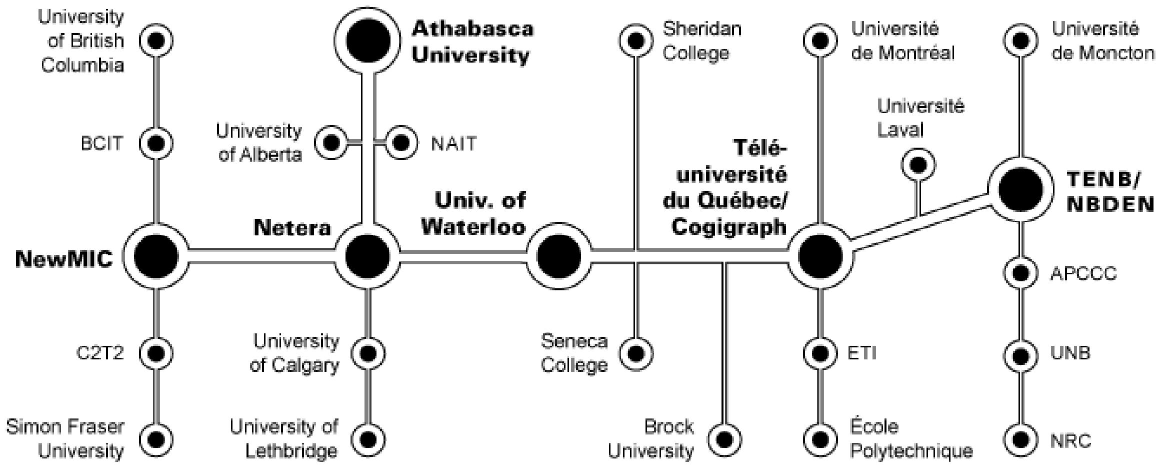

Figure 1. eduSource Organizational Structure

A principal objective of eduSource is the creation and deployment of a functional suite of tools capable of supporting the infrastructure for a national network of LO repositories. To accomplish this, eduSource is promoting a set of guidelines for the practical implementation of the IEEE LOM and SCORM standards for metadata, known as CanCore (*CanCore home page*, 2003). Research for the implementation is also being conducted in the areas of protocols, network engineering, hardware/software integration, software applications, service quality, security, and digital rights, while paying special attention to the requirements for quality pedagogy and accessibility for the physically challenged. The tools are being used to investigate problems involved in the repurposing of educational materials as LOs, user support, professional development, peer review and community building.

To achieve these goals, the EduSource team identified ten specific objectives:

1. *Address and examine issues of interoperability by connecting a critical, mass of LOs housed in repositories across the country.*
2. *Play a leadership role in developing and promoting national and international standards.*
3. *Develop a blueprint for the rights management of LOs.*
4. *Link and integrate the development of repository software programs.*
5. *Create a physical test bed of servers linked together through CA*Net 4.*
6. *Build a bilingual pan-Canadian community of practice.*
7. *Examine new business and management models for object repositories.*
8. *Develop a communications plan for the dissemination of these results.*
9. *Accomplish these goals within the context of a comprehensive program of evaluation and feedback. And*
10. *Ensure that that these repositories will be accessible to all Canadians and particularly to those learners with disabilities*. (*eduSource Canada*, no date)

The EduSource project has been sub-divided into nine work packages, each with a lead institution as package manager (See Figure 2):

1. *Repository Content Development*: NBDEN and NewMIC

2. *Metadata Development*: AU
3. *Software Development*: Cogigraph (TÉLUQ)
4. *Hardware Integration:* Netera and NewMIC
5. *Digital Rights Management*: NRC
6. *Evaluation & Testing*: UofA
7. *Business and Management Models*: Netera
8. *Community Building*: UofW
9. *Project Management, Co-ordination and Communications*: Netera

Repository Content Development is led by NBDEN and NewMic. This group is charged with leading the development of LO repositories and LO metadata repositories. The team along with other partners is developing interfaces, templates and protocols necessary to connect existing and emergent learning object repositories (LORs) such as Alberta's CAREO (Campus Alberta Repository of Educational Objects) (*CAREO*, no date), New Brunswick's CanLOM/TeleCampus (*TeleCampus*, no date), Ontario's CLOE (Co-operative Learning Object Exchange) (*CLOE*, no date) , the Athabasca University's Digital Library in a Box (ADLib) (*ADLIB*, 2003), and others across Canada and internationally, ensuring interoperability. Content of various types from the different project partners and associates is being repurposed, and adapted to form LOs. This includes the storage, indexing and segmentation of media types ranging from text to Java Applets; the development of archival standards for digital masters; and an evaluation of the effectiveness of the delivery of these objects through a variety of media including broadband, medium band, and wireless networks.

NBDEN is using the CanCore specification to build a next generation metadata directory, based on the TeleCampus engine, known as CanLOM. The University of Calgary (UofC) Learning Commons is also developing the CAREO metadata and LO repository using CanCore and is developing a sophisticated standalone tagging and content packaging tool known as ALOHA (*ALOHA*, 2003). Similarly, Athabasca University is building ADLIB as their university LO repository using the same standards and specifications thus ensuring interoperability.

Metadata Development is led by AU. Metadata is what separates repositories from the chaos of the World Wide Web. In this respect, the development of the CanCore metadata application profile is one of the most important deliverables of the entire project. EduSource is building on this success and furthering Canada's leadership in this area. The team is developing, extending and reinforcing CanCore, which is being translated/adapted into French. The most recent version is available at the CanCore web site (*CanCore home page*, 2003). EduSource is not merely conforming to internationally recognized metadata specifications. Its members are actively engaged in setting those standards. This project acts as a springboard for promoting the use of interoperable common vocabularies when implementing the IEEE LOM standard.

Software Development is crucial to the success of the entire project. TÉLUQ is leading the partners in the development of an integrated suite of software tools for the implementation and management of the LO metadata and LO repositories. These software tools form the foundation of the pan-Canadian repository network. This basic project infrastructure is built on open source solutions to ensure the adoption and use of these tools across a full spectrum of Canadian and international educational organizations.

A crucial dimension of this work is the integration of existing software tools developed during the first phases of the E-Learning Program. These include eduSPLASH (*EduSPLASH*, 2002) for the creation of peer-to-peer networks of repositories; Explor@ II (*Explor@ 2*, 2003) for the management of repositories and the integration of resource into courses; ALOHA (*ALOHA*, 2003) for managing a LOR from the Learning Commons at the UofC, as well as ADLIB (*ADLIB*, 2003) and the MARC to LOM convertor (*MARC - LOM converter*, 2003) from Athabasca University for the metatagging of LOs. By making these tools and others work together and augmenting them with new applications and some strategic software 'bridges', eduSource is providing a comprehensive suite of repository building tools.

EduSource is experimenting in new areas of research and development such as the semantic web. "The Semantic Web is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation." (Berners-Lee, Hendler, & Lassila, 2001). In other words, it makes it possible for information on the Web to be both syntactically and semantically understood by computer applications.

Most projects to date have focused on the formal description, tagging and distribution of educational objects. While this is an important first step, successful learning experiences are known to be dependent upon many other factors besides the availability of content. Recognizing this limitation, researchers have developed educational modeling languages (EML) that formally describe other critical components of the learning transaction. The IMS Learning Design specification (*IMS Learning design specification*, no date) based on EML from the Dutch Open University is expressed in formalized notation (using XML) to facilitate the searching and retrieval of LOs as well as the automated application of knowledge resources of various types on the semantic web not only by humans but also by autonomous agent software applications. AU, TÉLUQ, and UofW are working together on prototype implementations using IMS Learning Design. They are developing Open source tools for editing, packaging and playing Learning Design files.

Hardware Integration. As project managers responsible overall for project integration, Netera is working as the lead with NewMIC on this work package. The national eduSource test bed is designed to accommodate servers from various users and of various sizes, capacities and operating systems as well as exploring different architectures including both peer-to-peer and centralized server models. In all cases this package is informed by the principles of open systems and interoperability. The primary delivery mechanism for this network is the broadband Internet (CA*Net 4), but it is also investigating the delivery of LOs by other means. This includes the commercial Internet and wireless and satellite systems as well as the use of caching servers and other devices to enhance delivery and performance.

Digital Rights Management is being led by the NRC in Moncton, New Brunswick. This package began with a comprehensive survey of the literature in the fields of commerce and information management, on the current state of DRM theory and technology, and an examination of emerging international standards such as the ODRL or Open Digital Rights Language (*Open digital rights language initiative*, 2003). Based on this research, a series of recommendations regarding DRM has been prepared and work is underway based on an XML DRM schema (See (Downes & Babin, 2003).

Evaluation and Testing is being led by the University of Alberta, which has implemented a project evaluation strategy. Upon completion of the project, a summative evaluation will assess the impact of the project on practice within the participating organizations. It will also assess the project's success at meeting the initial project goals. Formative and summative data is being gathered through extensive interviews with key partners, associates, funders, surveys of end users and functional reviews of products created during the project.

Business and Management Models are being led by Netera, which is developing a business and management strategy. To this end a variety of funding models have been assessed. These include memberships, subscriptions, support and service contracts, licences and pay-per-use. This work is closely coupled with the Digital Rights Management Package. This work package also explores the sustainability of the LOR infrastructures among and within educational institutions.

Community Building is led by the University of Waterloo, which is developing networks of exemplary Canadian communities for the design, development, evaluation and exchange of LOs. COHERE (Canada's Collaboration for Online Higher Education and E-Research) is one such network in the post-secondary domain, where it demonstrates the use of online subject area communities to achieve efficiencies and promote cost-effectiveness (*COHERE*, no date). This community building is being extended into the K12 environment in collaboration with the Council of Ministers of Education Canada and provincial ministries of education.

Instructors at universities, colleges, schools, adult training centres, and the workplace are critical to the development of robust networks of communities. Project partners are developing exemplary proto-type networks of discipline-specific online communities to integrate local collaborations within their larger communities of use linking them to eduSource's pan-Canadian network of repositories.

Project Management, co-ordination and communication is the responsibility of the Netera Alliance which is providing central management functions, accounting and administration for the project as well as fulfilling the reporting requirements as stipulated by CANARIE.

Working Groups

There are three eduSource working groups: 1. the vision group; 2. the development group; and 3. the solutions & sustainability group. In addition, a management committee and a steering committee oversee and provide direction for the overall project. Figure 2 shows that the development group is coordinating activities in work packages 1, 2, 3, 4 and 5 (on the left of the figure) while the solutions and sustainability group is acting to coordinate activities 6, 7, 8, and 9. The vision group has been created to identify overall orientations of the project and provide them to the other two groups as well as the management and steering committees. The three working groups meet regularly to help the steering committee orient and coordinate work in the nine work packages. The steering committee is responsible for taking the final decisions.

The vision group is responsible for continuously monitoring the norms and standards, elaborating the general orientation principles, defining use case requirements and functional architecture orientations, taking into account implementation specifications from the development group. It also ensures the preparation of proper user documentation, approves the evaluation process and suggests requirements on business models to the solutions & sustainability group.

The development group defines the system's architecture taking in account use case requirements and the functional architecture from the vision group. It selects the technologies, protocols and development tools, defines the implementation and deployment specifications, develops the software infrastructure for LORs, provides unitary testing and writes the developers' documentation.

The solutions and sustainability group organizes product evaluation and a deployment strategy to obtain useful feedback and recommendations from potential users. It develops partnership frameworks for content providers and specialized service providers, coordinates the integration of digital rights and other business tools and defines a framework for the sustainability of open source components, including both software and protocols. While keeping their own managing responsibilities, the five primary partners provide the human resources to achieve the eduSource deliverables (*EduSource software development and integration work package plan, Version 0.3*, 2002).

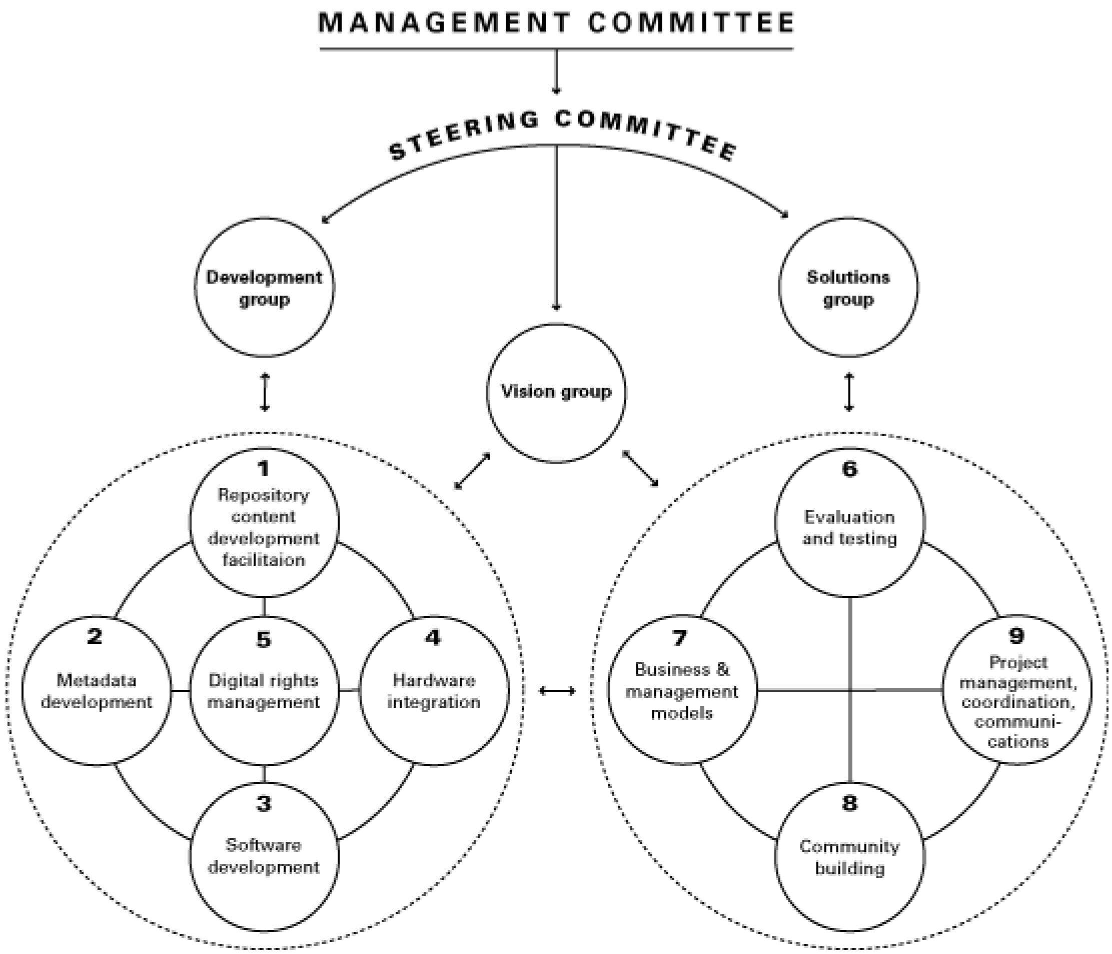

Figure 2. Working Groups

Canarie funded projects are dependent upon the participants paying for 50% of costs of the project. To ensure accountability for the project extensive book keeping, time sheet completetion and rigourous accounting standards are required. To facilitate effective implementation of these accountability standards, the management committee, led by the lead Netera group, meets to ensure that fiscal planning and accounting is given a high priority.

Principles

The following design principles have been adopted in order to guide the development of the architecture for the creation of a distributed LO repository network (Downes et al., 2002).

1. *Network model* as opposed to a silo model with separate repositories fed by publishers often on the basis of separate licensing agreements that increases the cost and restricts the choice of learning materials for all users and especially for small users.
2. *Royalty free standards and protocols.* Wherever possible, the eduSource software system infrastructure is providing open source solutions to ensure the adoption and use of these tools across a full spectrum of Canadian and international educational organizations. However, this open source approach is limited to the distributed infrastructure. The applications and services built upon the infrastructure can be either open or commercial or both.

3. *Implementation and support for emerging specifications* such as the CanCore metadata application profile and related IMS specifications, whenever practical, including support for the use of defined and controlled vocabularies so as to provide semantic interoperability and functionality to end users searching for and retrieving LOs.
4. *Enable, don't require*, such that applications work using the widest variety of open standards, recommending and not dictating, aiming to achieve a consensus among core participants where possible and allowing dissent when it occurs without imposing conditions for use of the applications.
5. *Infrastructure layer and service layer.* The set of software tools comprising the infrastructure layer are to be distributed as royalty-free open source applications. Over and above the infrastructure layer, some components with increased functionality are being developed as free and open applications, while others include commercial and proprietary components.
6. *Distributed architecture.* EduSource infrastructure and services are being designed as a set of related components, each of which fulfills a specific function in the network as a whole. Any given software tool provided by eduSource may be replicated and offered as an independent service to provide robustness and ensure that no single service provider or software developer may exercise control over the network.
7. *Open marketplace.* EduSource supports the registration and indexing of various providers, this registration will be free and optional. EduSource will accommodate free, co-operative or shared, and commercial fee-based content distribution.
8. *Multiple metadata descriptions* of a given learning resource are possible, ensuring that different users of the same learning resources can obtain, input, and access multiple descriptions of that material.
9. *EduSource is an implementation and extension of the semantic web,* accommodating sector-specific ontologies in the design to support the widest reach possible and reduce the duplication of effort between developers working in specific domains and educators working in the same domain.
10. *Open digital rights Management.* Where possible, the acquisition of rights and the exchange of funds is automated. Multiple digital rights models are being provided for free materials, cooperative sharing, and commercial offering on pay-per-view, or subscription-based, or other models. No single rights agency will govern all transactions. A given provider of learning materials may work with one of many brokers who sell to multiple purchasers, and a given patron may use one of many agents who conduct transactions with multiple vendors.

Edusource tools and services

The eduSource suite of applications consists of a set of inter-related components distributed over the Internet and capable of communicating with each other. This is accomplished by rejecting an integrated system architecture, and adopting a distributed model made up of distinct, stand-alone components that communicate over TCP/IP. Rather than one big application, the eduSource project allows for multiple components (even multiple similar components) as well as multiple LO metadata and object repositories. These repositories may be highly specialized (e. g., Egyptian Archaeology objects; a Blues music archive) or more generic (e. g., a large museum collection; a picture archive; a school board LO collection). This model is more in keeping with the distributed ideal of the World Wide Web.

The core components of the network are the LO repositories, which are hosted by the LO copyright holders and the LO metadata repositories, which may or may not be housed with the LO repository. Metadata repositories harvest metadata from LO repositories using applications like the OAI-MHP (Open Archives Initiative Metadata Harvesting Protocol) (Friesen, 2002) or directly from a Learning Content Management System (LCMS) or Learning Management System (LMS) using queries.

This core functionality is relatively simple and is already established in other domains, for example, in news syndication (Dumbill, 2000). Other implementations, including IEEE/P1484.1/D9 (Sonwalkar, 2002) employ a model whereby learning materials are treated like books in a library (or, in some other way, as "content" to be managed). Consequently, implementations of the architecture enable access to collections of this content, typically (but not always) stored on location. The process is therefore: acquire, index, and deploy

In a network model, there is no need to manage collections of content. So, instead of working solely with formally structured LOs, the network works with "learning resources", or "learning opportunities". This includes, but is not limited to LOs. Journal articles, academic papers, seminars, instruments, games, actual in-person classes, or the instructors themselves. They can all be accessed using this model. EduSource enables this by tolerating the use of different schemas in LO metadata repositories.

Other features that are enabled by eduSource include component registry services by which organizations can provide indexing or registration assistance (see (Friesen, 2002). These and other components stand alone and are not dependent on the other functions in the system to become operational. You implement them only if you need them. You can choose among a variety of different components that can reside inside or outside of your particular system. EduSource also supports multiple instances of third party metadata. This is metadata that is created by diverse users and housed on different servers, but describing the same LO (See (Nilsson, Palmér, & Naeve, no date). For example, a library may create Dublin Core metadata; a university might use the IEEE LOM for its metadata; a private company might use its own proprietary metadata. These and other eduSource components such as that for Digital Rights Management, Middleware and Resource Management communicate with each other using a common communication language called the EduSource Communication Language (ECL).

EduSource Communication Language (ECL)

The ECL messaging protocol is based on a SOAP specification. It supports communications among a variety of communities, providing applications that map between different languages and ontologies. Using the eduSource suite of tools, user communities can render their repositories interoperable using the most up-to-date, internationally recognized specifications and standards (See Figure 3). This is accomplished in four different ways:

- Communication protocol (HTTP, SOAP, XML-RPC, Peer-to-peer, etc.);
- Communication language (OAI, ECL, eduSplash, etc.);
- Metadata (IMS, CanCore, Dublin core); and
- Ontologies made up of vocabularies for metadata.

Two middleware components support interoperability: 1) Semantic cobblestone, which enables new repositories to connect into the eduSource network by supporting mappings on the metadata and ontology layers (See (Richards & Hatala, in press) and 2) a gateway that supports interoperability between the communication protocol and language layers. This ensures interoperability with other repository initiatives whether they be legacy using Z39.50 or new using the IEEE LOM.

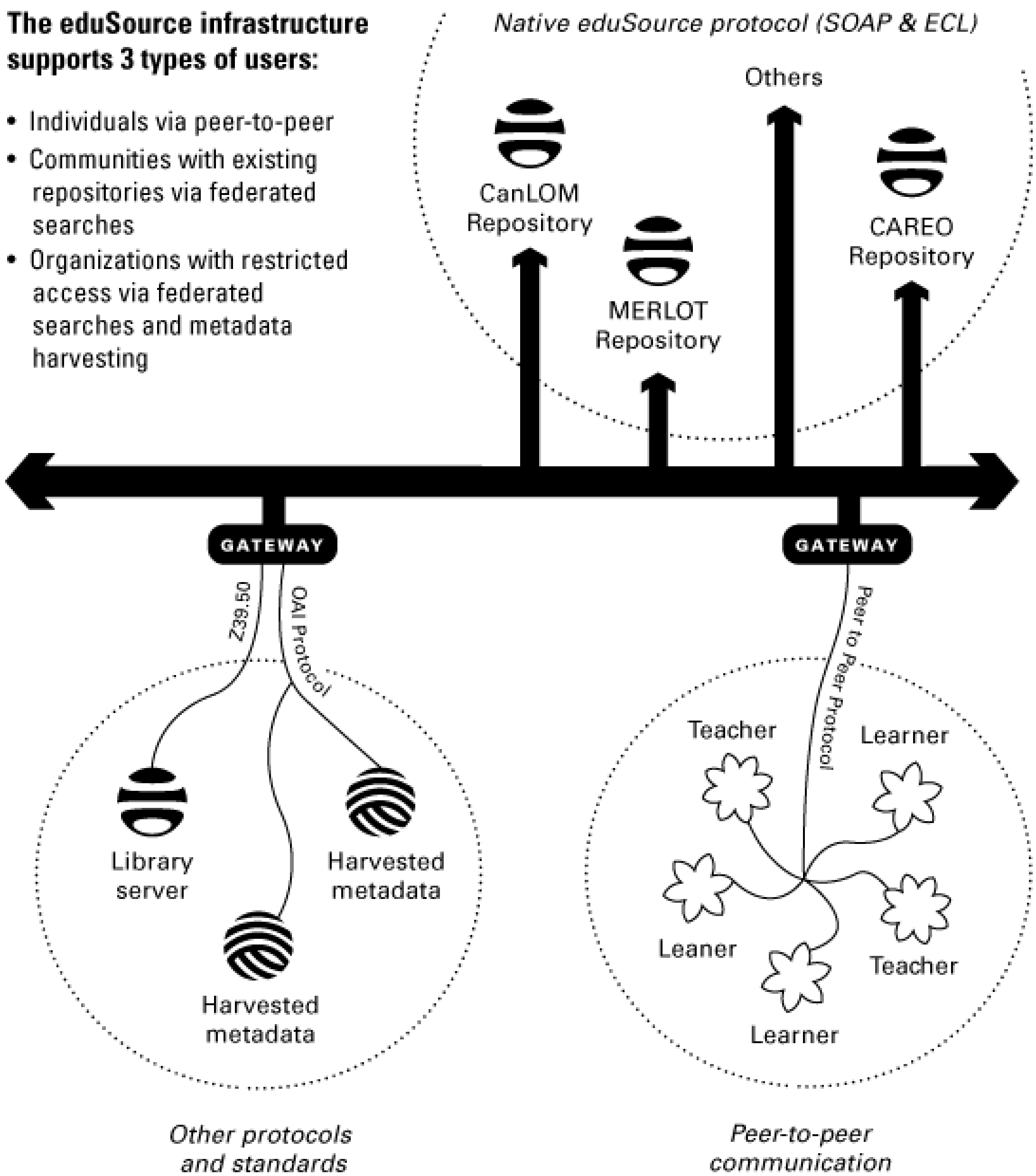

Figure 3. EduSource Communication Language

EduSource infrastructure

The Java programming language is being used for the implementation. J2SE (Java 2 Standard Edition) version 1.4.1 is required along with SOAP 1.2 with an attachment compliant engine to run it. AXIS (See (*The Apache XML Project*, 2003) has been chosen as the default SOAP engine. The source code repository tool is CVS (*Concurrent Versions System*, 2002). The following features are presently under development and testing.

An application programming interface (API) for ECL is being specified at the gateway and at the client level. This forms the gateway framework for the suite of tools and communications among repositories. The first translators under construction are those between OAI and ECL and MARC and LOM. A Z39.50 translator is also being built along with other translators between different metadata profiles. And, to enlarge the communication capabilities of the existing systems, a generic ECL client API is being implemented, together with the specific code needed to link ECL with each of the CAREO, eduSplash, Athabasca University (ADLIB), and Explor@ systems. A Web services publishing registry, possibly using the UDDI standard, is being implemented to make the above services, and services from the other work packages, available and interoperable to internal and external LMS, LCMS or software agents.

EduSource middleware services consist of different components including a searched metadata viewer and resource launcher hook, which displays the result of searching metadata repositories using harvesting, federated or distributed search methods. It provides different views on the record set and it outputs the address and other information (for example DRM information) for a resource launcher to either facilitate or prevent launching. An IMS-LD graphical editor is being constructed that provides a user interface to create Learning Design components and produce the corresponding XML files according to the IMS-LD specification.

Metadata repositories services include bilingual (French/English) metadata indexing user guidelines. The levels are defined in the Cancore metadata application profile. Special guidelines addressing some difficult issues regarding catalog entries and unique identifiers have been analyzed and incorporated into the "good practice" recommendations. In addition, the guidelines present knowledge representation solutions linking metadata and the semantic web.

The IMS Digital Repositories Interoperability (DRI) specifications are being implemented for both federated searching and harvesting in multiple repositories, taking into account different communication protocols and different metadata application profiles, specifications and standards. Software components for peer-to-peer and client-server storage and deployment of metadata are also being developed, based on a network architecture of metadata repositories and resource repositories. A test bed network is being used to trial the components.

An open source content packaging tool is being constructed, based on the IMS and SCORM specifications. In conjunction with existing tools this application can enable the transfer of resources and their metadata for use by different eLearning systems or agents. This includes a robust version of the IMS-DRI submit/store specification enabling the movement of resources to and from repositories linked to network-accessible locations. One version of this IMS-DRI request/deliver specification is being implemented to transport, launch and deliver resources to and from LMSs. In addition, different resource aggregation methods are being studied, including those proposed by the EML-based IMS Learning Design specifications, to define an abstraction level for elearning system building.

A Digital Rights Management (DRM) software component is being implemented enabling any eLearning system or agent to display any type of provider-defined DRM model. A user searching for LOs or other resources will be informed of the conditions and methods for accessing them. Another software component enables a user-agent to make requests to provider-agents, allowing them to access the resources if they possess the required permissions.

Figure 4 offers a general functional view of the suite of eduSource software tools and services. It presents three sets of components based on an open network approach. On the right side, there are two classes of repositories, one for metadata and the other for digitized resources (assets). In the Centre, five groups of services compose the infrastructure of the eduSource suite of tools. On the left side are existing or future e-learning systems, Learning Management Systems (LMS), Learning Content Management Systems (LCMS), agents or tools that can contribute to build and/or use repositories.

Each *Metadata Repository* houses a set of metadata files describing educational resources sometimes referred to as learning objects. Here we use a very broad definition of a LO as in the IEEE LOM document and the IMS Learning Design specification. This definition is also in line with the taxonomy of resources provided by the MISA instructional engineering method (*MISA learning systems design tool*, 2003). It includes the following categories of resources:

- Documents and educational materials (multimedia, Web pages, texts, software, data records, etc.) that hold information and knowledge;
- Tools and applications that support the processing of information and knowledge;
- Services provided by people such as subject matter experts, trainers, technical assistants, managers;
- Events (or learning opportunities) such as courses, seminars, learning activities, conferences, and discussion group meetings;

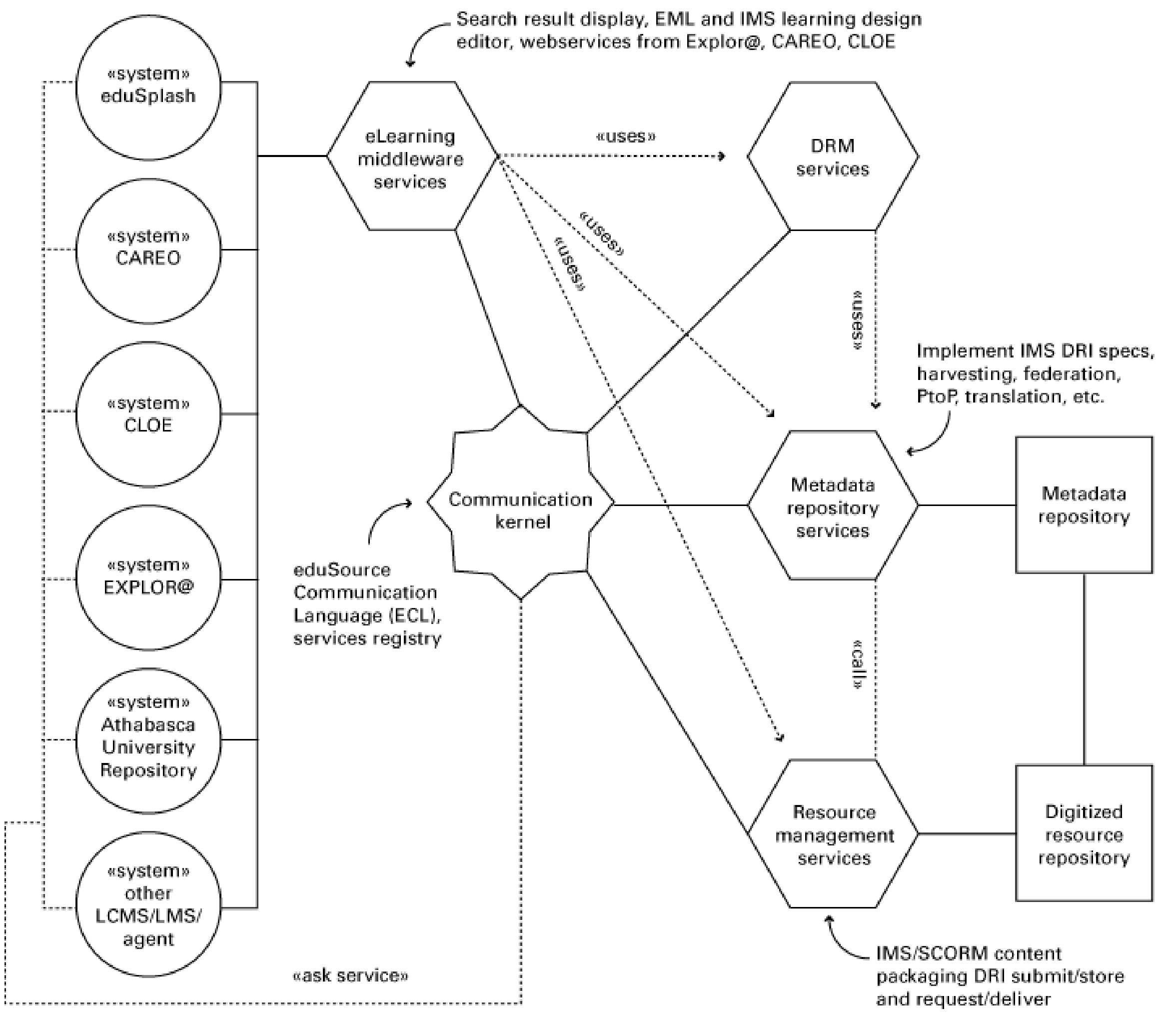

Figure 4. EduSource general functional diagram

Each *Digital Resource Repository* holds a set of digitized resources. The core of the system lies in the **five main software packages** at the centre. They hold the suite of software components that are being developed by the eduSource team. These services are all being referenced in one or more *eduSource Service Registries* available from the Web. Any service can be called upon by any e-Learning System or agent.

- *The Communication Kernel* includes the ECL, which (as previously mentioned) is a meta-protocol offered to all eduSource users that enables interactions between tools, services and communication protocols, in particular OAI and Z39.50. It also contains the eduSource Services Registry (ESR) that references all the components in the infrastructure from which an eduSource user can select the services that he or she wishes to use.
- *The E-Learning Middleware Services* component groups all the interactions to functionalities in elearning systems or agents whose providers agree to be referenced in eduSource. It includes services giving access to functionalities supported by Explor@, eduSplash, CAREO, ADLib and other systems external to the eduSource infrastructure. It includes one or more tools to display metadata and the associated resources resulting from searches implemented in the metadata repository services. It also includes a Graphic Learning Design Editor producing EML/IMS-LD code that can be passed on to a content packager producing content to be read by any compliant elearning system.
- *Metadata Repository Services* is a package that implements the most essential functionalities to fully exploit a set of (partly redundant) metadata repositories. In particular, this package is implementing some of the IMS DRI specifications for searching, harvesting, and federating such as gather/expose and search/expose, as well as peer-to-peer distributed search. It also includes translation services between metadata specifications or standards such as DC, IEEE LOM, and MARC, and also between natural languages, including French-English translations of metadata.
- *Resource Management Services* is a package that takes care of operations needed to launch, aggregate, package, or transport the actual resources required by any other service or system. It is implementing an IMS-SCORM content packaging service, and DRI submit/store and request/deliver functions.
- *Digital Rights Management Services* is a package grouping all the components for the management of interactions on digital rights and intellectual property between providers and users of resources and services. It houses a *Provider Broker* to enable a LO provider to select a particular DRM model and produce the associated DRM metadata. This service contains a *Purchaser Broker* providing user identification, payment transactions and authorization to deliver the LO. It provides a simple encryption mechanism to secure transactions and adapt the LOM metadata for digital rights management.

The links between these components show a variety of attributes maximizing the flexibility of interactions between existing systems and new components. There is a many to many correspondence between metadata repositories and the LO repositories. This is a way to implement a full network approach as opposed to a silo approach. It enables (but does not require) a metadata repository to reference resources in more than one resource repository and, conversely, a resource repository to be referenced by more than one metadata repository. At the individual LOM level, it supports multiple metadata descriptions of the same resource.

There is no central piece in the system and components can be duplicated for redundancy and robustness. Registries can be one or many. And services can be offered in more than one version. The architecture of the eduSource system embeds these principles right from the start, providing for future evolution.

Community Building

As previously noted, eduSource is also charged with building the community of LO users. After examining different organizations, the UofW work package leaders chose MERLOT (*CAREO*, no date) as a model for community building. Using the MERLOT concept and starting in Ontario, the team created a consortium of post-secondary institutions called CLOE (Co-operative Learning Object Exchange). A vibrant CLOE community has been established with representatives from each CLOE partner institution. They attend quarterly face-to-face meetings and participate in monthly teleconferences. All CLOE partners are promoting LO repositories on their campuses. For example, CLOE advertisements are posted in appropriate areas at all CLOE partner institutions. As well, many talks have been given at partner institutions regarding LO repositories. CLOE partners have established various initiatives within their institutions. For example, Queens has established CLOE@QUEENS as a Community of Practice regarding LOs and repositories (*CLOE@QUEENS*, no date).

Although based on MERLOT, CLOE has made some significant alterations to the original MERLOT concept. For example, MERLOT does not host LOs but rather is a 'referatory' to the LO which continues to reside on the author's site. The LOs and the relevant metadata are both actually hosted at the CLOE web site. This gives CLOE much more control over versions and control over ensuring that materials does not get deleted or changed significantly. It also allows producers and managers to quantify the number and, type of LOs as well as the context for which each object is being downloaded.

MERLOT also has an established peer review process (having completed more than 1000 reviews by the Fall of 2003). The CLOE team is using the MERLOT peer review process as a guideline, and is examining the entire system with a view to making the peer review robust and auditable so as it can be used to enhance an author's professional portfolio for purposes of promotion and tenure (see Kestner, in press). In addition, MERLOT has no way of tracking what LOs have been reused. CLOE on the other hand produces reports each semester that detail all the reuses of LOs in CLOE. This information, coupled with the peer review, can often be valuable in enhancing an author's professional portfolio.

The original community building focus has been on Ontario universities (through CLOE) and internationally through MERLOT. The experience of getting the CLOE group 'on track' is seen as a necessary 'first step' before attempting any significant national community building. The chief effort so far, has been to host the MERLOT International conference in Vancouver (*MERLOT International Conference*, 2003). This conference brought Canadians together with Americans in a forum to discuss issues associated with LOs and repositories. This major international conference has been supplemented by an ongoing series of workshops in cities across Canada and international presentations at a variety of different venues.

The different eduSource partners continue to disseminate their vision and results of their research among the eduSource community and a variety of stakeholder communities. These include other universities, community colleges, school boards and departments of education, other government departments, private companies and interested organizations. International connections have been established with ARIADNE in Europe (*ARIADNE*, 2002), the Education Network of Australia (*EdNA Online*, 2003), the IMS in the USA (*IMS*, 2003), and other groups in Japan, Korea, Taiwan, Singapore and China.

The eduSource Canada website is also being used for community building (*eduSource Canada*, no date). It has been live since October 2003. It changes and develops along with the project to reflect the needs of emerging user communities and internal project evaluative feedback. Added components include an internal web-based document sharing system, a digital rights clearing house component and a detailed presentation and news information section.

The eduSource site is bilingual (French and English) and all relevant documents are posted in both official languages.

Summary

This eduSource project represents a constructive collaboration among a diverse group of participants who have accepted common basic principles for the design and construction of an open network of learning repositories. The initial goals have been outlined along with descriptions of the actual work in progress including descriptions of the organizational structure, the workgroups, work packages, and the tools and services to be integrated into the eduSource suite of tools. This project aims to provide leadership in Canada and internationally in the development of interoperable repositories using the developing semantic web.

Abbreviations and Acronyms

ADLIB Athabasca University Digital Library in a box

API Application Program Interface

AU Athabasca University

AXIS a specific implementation of SOAP

CANARIE Canada's broadband Internet organization

CANet 4* Canada's broadband network

CLOE Co-operative Learning Object Exchange

CVS Concurrent Versions System

DRI Digital Repositories Interoperability (from IMS)

DRM Digital Rights Management

ECL eduSource Communication Language

EML Educational Modeling Language

HTTP HyperText Transfer Protocol

IEEE Institute of Electrical and Electronic Engineers

IMS Instructional Management System

J2SE Java 2 Standard Edition

LCMS Learning Content Management System

LMS Learning Management System

LD Learning Design

LO Learning object

LOM LO Metadata

LOR LO Repository

MERLOT Multimedia Educational Resource for Learning and Online Teaching

NBDEN New Brunswick Distance Education Network Inc. (TeleEducation NB)

NewMIC New Media Information Centre of British Columbia

NRC National Research Council of Canada

OAI Open Archive Initiative

OAI-MHP OAI Metadata Harvesting Protocol

ODRL Open Digital Rights Language

SCORM Shareable Courseware Object Reference Model

SOAP Simple Object Access Protocol

TÉLUQ Téléuniversité du Québec

UDDI Universal Description, Discovery, and Integration

UML Unified Modeling Language

UofA University of Alberta

UofC University of Calgary

UofW University of Waterloo

XML Extensible Markup Language

XML-RPC XML Remote Procedure Calls

Z39.50 (Protocol for library information retrieval)

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About the Authors

Rory McGreal is Associate Vice President, Research at Athabasca University, Canada's Open University and the 2002 winner of the Wedemeyer Award for Distance Education practitioner. Previously he was director of TeleEducation New Brunswick, a province-wide distributed distance learning network. His Ph.D. degree (1999) in Computer Technology in Education at Nova Southeastern University's School for Computer and Information Science was taken at a distance using the Internet. rory@athabascau.ca

Terry Anderson, Ph.D. is a professor and Canada Research Chair in Distance Education at Athabasca University – Canada's Open University. He has published widely in the area of distance education and educational technology and has recently co-authored two new books: Anderson and Kanuka.(2002) eResearch: Methods, Issues and Strategies and Garrison, D & Anderson, T. (2003). E-Learning in the 21st Century: A framework for research and practice. Terrya@athabascau.ca

Stephen Downes is a senior research officer with the National Research Council of Canada in Moncton, New Brunswick, Canada. Affiliated with the Council's Institute for Information Technology, he works with the E-Learning Research Group. His principle work involves research and development in elearning, working with institutions and companies to improve their competitive position in the industry, and outreach through articles, seminars and workshops. stephen@downes.ca

Kevin Harrigan is the Co-director of Learning Objects Programs at the Centre for Learning and Teaching Through Technology at the University of Waterloo where he is also a Research Associate Professor in Applied Health Sciences. He is the Director of Ontario's Co-operative Learnware Object Exchange (cloe.on.ca) and a Project Director of MERLOT (www.merlot.org) kevinh@uwaterlool.ca

Marek Hatala Ph.D. 1997, Technical University of Kosice, Slovakia in Cybernetics and Artificial Intelligence. Dr Hatala works at the School of Interactive Arts and technology at Simon Fraser University in Surrey, BC. His main research interests are knowledge representation and management, ontologies and semantic web, intelligent information retrieval, organizational learning and eLearning. mhatala@sfu.ca

Deborah Kaloudis with Netera Alliance is the Communications Manager on the eduSourceCanada project. She brings to the project over eight years of communications experience and holds a diverse track record in implementing and managing large stakeholder relations campaigns. deborah@netera.ca

Michael Magee currently works for the Netera Alliance. He has focused his research for the past few years on the issues surrounding the delivery, use and adoption of educational objects at K-12 and post-secondary institutions. This research has resulted in the development and implementation of the several online repositories and metadata workflow tools. magee@ucalgary.ca

Douglas MacLeod is the Director of the eduSourceCanada Project and Director of Projects for the Netera Alliance that is building Internet infrastructure in Alberta. He was Project Director of the BELLE (Broadband Enabled Lifelong Learning Environments) and of the Art and Virtual Environments Project at the Banff Centre for the Arts. MacLeod is a registered architect and a contributing editor to The Canadian Architect Magazine. dmacleod@netera.ca

Gilbert Paquette holds a Ph.D from the Université du Maine (FRANCE) in Artificial Intelligence and Education. Researcher at the Center for Interuniversity Research on Telelearning Applications, (CIRTA-LICEF) he has founded in 1992, Gilbert Paquette holds a Canada research chair in knowledge-based instructional engineering, acts as the Scientific Director of the LORNET Canadian research network and is a professor at Télé-université du Québec in Montreal. gpaquett@licef.teluq.uquebec.ca

Griff Richards, PhD(Educational Technology), is a Program Head with the British Columbia Institute of Technology. He currently is a lead in eduSource Canada. His research interests concern interoperability among learning object repositories and e-learning portfolios. He is a principle investigator in two other national research projects in elearning. griff@sfu.ca.

Janelle Ring is the Project Manager on the eduSource Canada project and a Project Manager for the Netera Alliance. Janelle was also the Project Manager on the BELLE (Broadband Enabled Lifelong Learning Environments) project and has earned an MA in Communications and Culture from the University of Calgary. janelle@netera.ca

Anthony Roberts (B.Sc, B.A., M.A., M.E.S.) has a broad spectrum of skills. These include analytical skills, technical knowledge and deconstructive proficiencies. Anthony has over four years of management experience with educational repositories/directories. He is the Work Package Manager for the eastern partnership in eduSourceCanada, a national learning object and metadata repository project. toni@teleeducation.nb.ca

Steve Schafer is Director Library Services at Athabasca University. His primary interests are in the provision of information and library services to off-campus students, the development of research skills of distance students in a highly digitized environment, and the collaboration of library collections and learning object repositories. steves@athabascau.ca

Editor's Note: This project assesses feasibility of working with learning objects and implications for course development. It seeks practical answers to context and research questions such as: How do instructors use learning objects? Are there sufficient learning objects available? Can an instructor create an effective post-secondary course by (re)using learning objects? Despite a shortage of available objects, the three study teams, business, nursing, and literature, were enthusiastic about benefits for instructional design, production, implementation, monitoring student progress, and evaluation. They found value in the graphics, interactivity, and feedback data. They also noted ease of keeping content relevant and up to date.

Feasibility of Course Development Based on Learning Objects: Research Analysis of Three Case Studies

Jo-An Christiansen and Terry Anderson

Introduction

Learning objects offer potential for cost and time savings (Downes, 2000; Hodgins, 2003;Wiley, 2002c). However are these benefits being realized in current practices? This investigation examines the course development implications of a learning object approach to the design and production of online courses. This paper presents three case studies that seek to maximize the use of freely available and reusable learning objects in their course design. The three case studies originated in different university-level disciplines – Nursing, Business and English writing. Using the Internet, each group searched for and selected learning objects to integrate into a specific course. Throughout the course development process, the individuals documented and shared their experiences. They reflected on the availability, benefits and barriers encountered when working with publicly available learning objects. This paper discusses the feasibility, pedagogy, and cost-effectiveness of searching, retrieving and integrating online learning objects into a post-secondary distance education course.

Literature Review

The potential impact of information and communications technologies on all knowledge-based activities is far-reaching. Paradigm shifts have occurred in most disciplines, including education as these tools are applied to production, distribution and knowledge-building activities. In distance education, the use of technologies has transformed mail-based correspondence courses into interactive distance education, often referred to as e-learning. Previously, the greatest impact in distance education was the capacity to sustain communications and interaction in multiple formats [This needs an explanation. I don't understand]. More recently, we see these technologies used to enhance the storage, retrieval and modification of content, providing opportunities for reuse in different contexts beyond their original purpose. A key factor for facilitating re-usability has been the use of object-oriented designs, in which digital learning content is designed in modular formats. These formats can be recombined, edited and annotated for reuse within and across disciplines. Wiley (2002b) writes that "the fundamental idea behind learning objects is that instructional designers can build small (relative to the size of the entire course) instructional components that can be reused a number of times in different learning contexts" (p. 4).

Numerous authors have offered definitions, characteristics and perspectives regarding the use and reuse of learning objects. Authors who have provided wide-ranging descriptions such as the potential and use of learning objects, theoretical examinations of appropriate size, taxonomies and means of evaluation, etc. include: Campbell (2003); Downes (2000); Gibbons, Nelson, &

Richards (2002); Hodgins (2002); Littlejohn (2003); Longmire (2000); Martinez (2002); McGreal (in press); Muzio, Heins & Mundell (2001); Naidu (2002); Olivier & Liber (2003); Orrill (2002); Rogers (2002); Thorpe, Kubiak & Thorpe (2003); Weller, Pegler & Mason (2003); Wiley, Recker & Gibbons (2000a; 2000b); Williams (2002); and Wiley (1999a; 1999b; 2000; 2002a; 2002b; 2002c; 2002d; 2002e; 2002f; 2003).

Three works are particularly noteworthy. Wiley (2002c), Littlejohn (2003), and McGreal (in press) have each edited a book dedicated to online resources or learning objects. The array of subjects, authors' methodologies and case studies provide an excellent knowledge-base relating to learning objects. Weller, Pegler & Mason (2003) also provide an excellent empirical analysis similar in nature to this research undertaking though they focused on the creation, rather than reuse of existing objects. Weller, Pegler & Mason conclude that the use of objects did in fact improve the creation process through increased flexibility in incorporating different author styles, improved communications amongst course team members, increased speed of development and greater potential for reuse of content. However, many of these benefits accrued through use of better communications and distributed work tools among team members that are not necessarily related to a learning object approach to course design.

Despite the plethora of writings, it is challenging to extract a concise and agreed upon definition of learning objects. The widest definition of a learning object may be "any entity, digital or non-digital, that may be used for learning, education or training" (IEEE Learning Technology Standards Committee (LTSC), 2002, p. 6). This definition has been criticized as being too all encompassing to be of little use. Wiley (2002b) limits the definition to "any digital resource that can be reused to support learning" (p. 6). Many educators prefer to differentiate a learning object from information or content. For example, Weller, Pegler & Mason (2003) add that a learning object "addresses a clearly identifiable topic or learning outcome and has the potential to be reused in different contexts."

McGreal (in press) analyses different definitions and places them on a scale contrasting digital to non-digital and learning specific to anything and everything. He proposes a broad yet practical definition "any reusable digital resource that is encapsulated in a lesson or assemblage of lessons grouped in units, modules, courses, and even programmes."

Operationalizing this reuse capacity adds characteristics to the definition, such as the necessity for metatags for indexing, storing and retrieving learning objects. Some authors have also added a size or granularity requirement in their definition. For example, the UKeU defines a learning object as "the smallest element within an online course that defines a learning activity" (Darby, 2003). Some authors have defined learning objects in terms of their capacity to revolutionize the creation, storage and distribution of learning content. For example, Tom Barron (2000) has defined learning objects as "a new model for digital learning - one in which learning content is free from proprietary "containers," can flow among different systems, and can be mixed and reused, and updated continuously."

Koper (2001) attempts to differentiate between content resources and the learning design that is often developed around that content by formalizing the description of a "unit of study" that can model all of the related concerns of objectives, assessment, differing roles and other educational variables. In summary, the lack of a precise and agreed upon definition of learning objects, besides making any serious study seem fuzzy and ill planned, also limits productive dialogue and theoretical understanding of the application of learning objects in real-world implementations. For the purposes of this paper, we use a rather generic and functional definition of a learning object as a digital resource that is used within a formal course to support individual or group learning.

Learning objects have been created in nearly all formal educational disciplines, in a wide variety of multi-media formats. They have been designed for students at all levels. studying both at a distance and in classroom contexts. Despite this variety, an explicit or implicit methodology is required to effectively integrate learning objects into course design. The object-orientation of learning objects enhances their interoperability and reuse giving rise to a "Lego" block metaphor (Hodgins, 2002) for course construction using learning objects. This rather simplistic idea was criticized by Wiley (1999a) who favors a molecular model, in which only certain atoms (learning objects) can be combined to create stable molecules (units and courses).

Wiley (2000a) noted the inverse relationship between the size of a learning object and its re-usability. As the learning object's size decreases (lower granularity) its potential for reuse in multiple applications increases. For example, a single image of a tree can be reused in many learning contexts, while a complete unit on tree botany is most likely confined to a limited number of applications unless the language, learning objectives, reception technology, etc. are altered (2000a). Hamel and Ryan-Jones (2002) also believe smaller learning objects better support flexible instructional design. Clark Quinn (2000) argues

> *First, with smaller granularity, there's greater potential for reuse of objects. … By keeping objects smaller, they are more likely to be able to be reused in different contexts. Second, there's the opportunity to allow flexibility on the part of the learner, or even to support intelligent processing. If the objects are small enough, and instructional experiences are composed of these objects, then different learners can have different instructional experiences. (Quinn & Hobbs, 2000)*

Note how this use of learning objects assumes that the instructional design is embedded in the learning object. Despite the lack of consensus as to a definition and appropriate building metaphor, there is greater consensus as to the benefits (realized or potential) of course development based on a learning object approach. Longmire (2000) categorizes the arguments in support of learning object course design as:

- Flexibility: Learning objects are simple versus aggregate elements, resulting in the ability to contextualize at the time of use.
- Ease of updates, searches, and content management: Metadata tags can facilitate filtering, selecting, updating, and managing objects.
- Customization: The use of annotation tools and placement of objects within teacher-created web pages allows teachers to customize the object by focusing attention, rewarding certain practices, changing sequences and other ways of contextualizing the learning object content to the needs of a defined class of learners.
- Interoperability: The greatest potential strength of learning objects is the ability to be applied in multiple uses as they flow freely between learning systems and a variety of contexts.
- Facilitation of competency-based learning: Core competency skills, knowledge, attitudes and measurable outcomes can be achieved.
- Increased value of content: The commercial exchange of learning objects is enabled through a learning object economy.

The potential to reuse, rather than recreate, drives much of the discussion of learning objects. Besides the savings in original production costs, the accessibility and search-ability of learning objects provides at least the potential for commercial endeavors. However, as Johnson (2003) and Downes (2003) argue, this may be an illusive vision with many challenges yet to overcome.

An exponential growth in the inventory of learning objects available through the World Wide Web is creating opportunities for institutions and instructors in their course development and delivery. As this inventory grows, learning institutions are able to profit from having instant access to a vast store of pedagogical content environments, simulations, applications and other learning aids organized into manageable units. Organizations such as CAREO in Alberta, MERLOT in California, and the TeleCampus in New Brunswick are providing accessibility to learning objects by implementing common metadata standards (most often the IEEE LOM).

Classification (and subsequent retrieval) of learning objects in repositories is based on standardized ways to describe or annotate the objects using metadata (data describing data). The process of applying these metatags is much like cataloguing books in a library, with the addition of metadata relating directly to their pedagogical function, ownership, version and access provisions. The implementation of meta-tags is critical for interoperability and accuracy in searching and retrieving learning objects.

Downes (2003) argues that the system for locating and distributing learning objects "is currently poorly constructed, based essentially on what may be called a silo model of distribution." He proposes a distributed model which "would create an open and accessible marketplace for learning objects, in essence, a learning object economy" (Ibid.). The lack of sharing and accessibility is considered to serve as a formidable barrier to developing learning object repositories. "The silo model is dysfunctional because it prevents, in some essential way, the location and sharing of learning resources" (Ibid.). Contributing factors to the existence of "silos" is believed to be proprietary standards, overly strict standards, monolithic software applications (enterprise solutions), closed marketplace through exclusive distribution agreements, disintermediation due to a lack of peer review or other means of independent evaluation, selective semantics attributable to a network application which standardizes an application profile and restricts use, and the issue of digital rights management. To counter these "silo" characteristics, Downes proposes "the development of an architecture for a distributed learning object repository network (DLORN)" (Ibid.). His proposed design has been incorporated by the EduSource development project that is building a distributed network of object repositories. It is characterized by an open-source infrastructure, component-based software, distributed architecture (no single service provider or software developer), open standards for interoperability with various networks, royalty-free standards, multiple data types and metadata classification schemes, integration with the semantic web, open access to prepare and distribute learning objects, open market for content distribution, as well as permission-based and brokered digital rights management (Ibid.). Wiley (2003) similarly (but wishfully) concludes that "when intellectual property issues and concerns disappear, money, effort, and other resources can be allocated to building up a library of free, nonrivalrous educational resources" (p. 7).

Learning objects are granular learning resources which can be used in a multitude of contexts. The inherent flexibility of this approach is appealing to the many course developers seeking to design courses efficiently and effectively. Learning objects are espoused as cost and time efficient by emphasizing search, retrieval and reuse over individual creation. The ability to create customized courses by offering personalized learning environments for students is considered effective for learning. We conclude this brief review by quoting a rather fervent claim by one of the best known proponents of this new technology. Hodgins (2002) argues that:

> *Learning objects represent a completely new conceptual model for the mass of content used in the context of learning. They are destined to forever change the shape and form of learning and, in so doing, it is anticipated that they will also*

> *usher in an unprecedented efficiency of learning content design, development and delivery. However, the most significant promise of learning objects is to truly increase and improve human learning and performance. (p. 281)*

This project strives to assess the feasibility of working with learning objects and the course development implications of the learning object approach against Hodgins' lofty vision.

Context and Research Questions

Athabasca University (AU) is Canada's Open University established in 1970. The mission of AU is a dedication "to the removal of barriers that restrict access to and success in, university-level studies and to increasing equality of educational opportunity for adult learners worldwide." As well, AU is "committed to excellence in teaching, research and scholarship and to being of service to the general public" (Mission Statement, 2002). AU currently serves over 29,000 students predominantly through individualized distance education study.. AU currently offers 60 programs (master, bachelor, diploma and certificate levels) and more than 500 courses. In the large undergraduate programs, courses are predominantly offered for individualized study with continuous intake and personal tutor support. Individualized study presents special challenges in course design as it is much more difficult to rely on peer-to-peer interaction or "on the fly" teacher to class interactions to customize and contextualize students learning experiences. "For all courses, optional use of e-mail and attachments, voice mail, and Web access to services has been a major enhancement to "traditional" distance education, which relied on a print course package, fixed telephone office hours for tutors, occasional fax use and the postal service" (Davis, 2001).

The 2002 AU E-Learning Plan (2002) notes that 93% of non-computing program students have access to networked computers. AU strives to include a variety of online support services incorporated in every course by 2005. AU is moving aggressively to a development model in which learning objects are used as the principal methodology in the design, development and deployment of course materials across all subject areas.

Learning objects offer the possibility of re-using content and designs across disciplines and courses. Questions arise however as to the feasibility and cost-effectiveness of accessing generic learning objects from a variety of sources, contextualizing them for use in a particular course context and deploying them in online courses. To date, there has been little research on the feasibility and cost-effectiveness of such a learning object approach – most of the literature has been focused on developing, storing, tagging and assessing learning objects. Issues to be examined in this investigation include the viability, costing, technical operation, copyright and pedagogical considerations of using a learning object approach in course design.

This research analysis seeks to test the feasibility, benefits and barriers associated with assembling previously constructed learning objects into viable course packages. The principal question to be addressed is "What are the advantages and barriers associated with the development of complete courses of study built from available learning objects?" As well, the research analysis will consider:

- How do instructors use learning objects?
- Are there sufficient learning objects available?
- Can an instructor create an effective post-secondary course by reusing learning objects?

Method

The research generally follows a development research design (Van Den Akker, 1999) in which complex learning content, created to function in complex real-world contexts, require research designs that assess the process as well as the outcome of the intervention. Development research is particularly applicable to learning objects as it "is often initiated for complex, innovative tasks for which only very few validated principles are available to structure and support the design and development activities. … The aim is not to elaborate and implement complete interventions, but to come to (successive) prototypes that increasingly meet the innovative aspirations and requirements" (Ibid., p. 9). The research design entails preliminary investigation, theoretical articulation, empirical testing of the intervention followed by analysis and documentation of the research findings (Ibid.).

In this study, we used a *laissez faire* development methodology in which we asked three experienced distance education faculty members and course designers to create (or do a major revision) of one of their courses with the objective of reusing as many publicly available learning objects as possible. The three courses developers are subject matter experts in their discipline. The courses are all in different subject areas at the undergraduate post-secondary level. These include business writing, nursing studies and professional writing.

The business team course developers sought to revise an entry-level undergraduate course. The goal envisioned by the developers was a course structure that would help students plan, write and edit simple informative texts (e.g., memos, e-mails, faxes, etc.) and more complex informative and argumentative texts (e.g., letters, reports, etc.). The student enrollment is forecast at 600 students annually. The skills-based course includes very little issues-based content. The developer states "students need to acquire conceptual knowledge (rule-based) about writing and practical knowledge as well." The focus on skill development will remain following revision, but the developers are seeking to increase the component of system-led student assessment (automated quizzes) following revision. The developers were originally optimistic that the learning object approach would provide a means for student evaluation.

The nursing team course developers sought to develop an entry-level course and revise an advanced-level course. The entry-level course offers an introductory survey-based learning for students with assessment led by an instructor. The advanced-level course deals with analysis of current nursing trends and issues with assessment led by student peers. The forecast number of student enrollment is relatively low at approximately 25 students annually for the entry-level course and 50-75 students annually for the advanced-level course.

The literature team course developers sought to develop a professional writing course. "Writing for Performance" is an advanced-level undergraduate course focusing on creative writing. The course focuses on writing for film, radio, screen and theatre productions. The course is seen to draw from numerous examples for students to consider, critique and discuss. The goal of the course is to encourage the creation of material that is of high artistic merit, but also demonstrates awareness of current marketing environment.

The three teams of course developers participated in an initial training session. The session introduced the concept of learning objects and provided an introductory document (Bartz, Paille, & Norman, 2003). The document includes various repository sources and discusses methods of evaluation for learning objects.

Following the initial group session, the individuals and their research assistants proceeded to creating or revising a course by using as many freely available learning objects as possible. Monthly surveys were conducted by email and telephone to discuss the following questions:

1. What sources and methods are being utilized for the selection of learning objects?
2. What assessment activities are being undertaken and tools utilized (website ratings etc.)?
3. What issues have been encountered (e.g., copyright)?
4. What benefits have been derived (ease of access, relevance, quality, costs, time, etc.)?
5. What barriers have been encountered (ease of access, relevance, quality, cost, time, etc.)?
6. What is your perception of the feasibility of assembling learning objects into a viable course package?

As well, telephone and in person interviews were conducted with the course designers to conclude the research process.

This *laissez faire* development methodology differs significantly from the methodology followed by other instructional designers. For example, Muzio, Heins and Mundell (2001) use a more traditional approach to course development with a team being led by instructional designers. In our study, we wanted to see how AU faculty members could use learning objects. We purposely did not impose any new instructional designs on the course developers, but rather used the study to investigate how the new paradigm of learning objects could fit within their existing practice. From Rogers' (1995) classic theory of innovation adoption, we know that innovations must be compatible, offer relative advantage, be trialable and also compatible. Both the academic and the training trade presses are replete with articles expounding upon the benefits of developing learning activities by reusing learning objects, resulting in cost effective reuse of expensive content. This research project sought to determine if this utopian vision is the reality for three course developers at AU.

Results

Learning Objects - Availability and Selection

The availability of learning objects is a crucial consideration in determining the feasibility of using this approach in course design. The course developers were asked "what sources and methods are being utilized for the selection of learning objects?"

The lead individual in the business team initially browsed learning object repositories, but focused efforts on searching for 'boxes' rather than learning objects. He sought to construct a structure which would be filled in with learning objects that demonstrated the process under study, such as writing a memo. The research assistant focused on searching for learning objects, examining existing learning object classification systems and developing a unique classification system. However, it soon became apparent that the classification system being developed would transform the Internet search task into an endless and time-consuming cataloguing task. The team switched from classifying to selecting learning objects based on a sequence of course units and lessons. A system of folders was devised for collecting material relevant to each lesson.

The course developers in the nursing team set out with a goal of finding learning objects relevant to the variety of content included in their issues-based course. The nursing team used the MERLOT repository and general search engines (notably Google) as sources for finding and selecting learning objects. The web site provided the team with general information to consider purpose, authority, accuracy, objectivity and suggestions for further reading. The search method entailed determining search terms and critically evaluating sources for bias.

The course developers in the literature team sought to find learning objects which illustrated various approaches to writing scripts for public performance. Efforts were focused on finding model scripts and discourse at a suitable level. An abundance of web sites were found with learning objects of possible value. The team's search method entailed visiting various drama, film, television, and radio web sites. The web sites included personal sites of individual writers, broadcasters' sites and educational sites.

Learning Objects - Assessment

The course developers responded to the question "What assessment activities are being undertaken and tools utilized (website ratings etc.)?"

The selection of learning objects by the business team was based on their instructional merit and applicability to a lesson. The goal was to find enough learning objects to plan a typical lesson around predictable instructional/learning features such as examples, readings, writing rules, instructions and practical exercises. Various commercial software applications were considered such as Adapweb and the Electric Learning Kit.

The nursing team undertook a continuous assessment process to select appropriate learning objects. The process entailed describing the web site in a word-processing document under the heading of the issue concept under study. The descriptive statement described the fit, acceptability and ideas of how the web site might be best utilized.

The literature team also undertook evaluation on a continuous basis in combination with the selection process. Each course developer evaluated the various web sites according to their professional writing education and experience. Model scripts were evaluated to determine the degree to which they would meet the objectives of the course. Each model script was evaluated using personal judgment of the course developers as writers, directors, critics and teachers.

Learning Objects - Contextual Issues

The three course development teams were questioned as to how they contextualized learning objects. AU makes extensive use of study guides to assist students in the course learning process. The three teams were questioned as to the role of textbooks, reading lists and study guides.

The business team found the issue of context as critical. The weakness of an incompatible context, when following a learning object approach, proved to be an insurmountable barrier. The team concluded that "students need learning objects designed in a highly cohesive and effective learning environment." Their frustration with the wide variety, level and approach of various publicly available objects caused them to look at available commercial products that were designed as an integrated whole. They found an online and interactive textbook consisting of a printed text with a supporting web site containing various interactive exercises directly linked to the text. They believed this approach was better able to "provide a rich environment that enables students to learn via a variety of 'learning paths'."

Both the nursing and literature teams wrote a context narrative to envelope the learning objects. The nursing team drew on past experience of extensive reading file materials to support course learning. The reading file of 20 to 30 print articles has now changed to a web site resource with five links. The literature team also determined that they would continue to use a reading file of published articles and also incorporate interactive learning objects.

Learning Objects - Issues Encountered

The course developers responded to the question "What issues have been encountered through this process?" The issues of search strategy and copyright were discussed with the course developers.

The business team found the search for learning objects to be difficult with inconsistent results. The team perceived online learning material as more suitable for designing a preparatory on-line writing course, than for a specialized second-year writing course. Learning object repositories and Internet web sites provided the team with very few learning objects. Those found were deemed to be of questionable relevance. The goal for the skill-based course being developed was to find high quality learning objects with strong content. Context emerged as a major issue as the writing style between web sites and learning objects varies greatly, as does the interface environments in which the learning material is located. Context emerged as a major issue with a "patchwork result" in the course development process a cause for concern. The issue of copyright was seriously considered and served as a deterrent to employing learning objects. The team considered contacting publishers to negotiate copyright. However, only a portion of the publisher's web site or online material was needed for inserting as the learning object into the course. The onerous copyright process was not considered time or cost effective and thus not pursued.

The main issue encountered by the nursing team was determining when to conclude the search process. The abundance of learning objects, they found, required administrative discipline to maintain an order to the search and selection process. While searching, the team undertook assessment of the material, therefore requiring a record to be kept of web sites visited and which may also work well in other courses. Copyright did not emerge as a major issue. The nursing team sought to revise the course without having to seek copyright. Free use web sites, such as the Canadian Nursing Association (CNA) and Health Canada, allow for free use with acknowledgement. Copyright clearance was not sought as the team believed the fair dealing exemption would be applicable. The web site sources were not hosted, but rather merely linked to. All sources were referenced appropriately and web site information regarding copyright was abided by.

The literature team was more concerned with copyright than the nursing team. The nature of the learning objects required special attention to copyright clearance. An email was sent to several web sites to seek copyright clearance for possible learning material. The literature team focused on permission to transfer learning objects to Athabasca University's server. The team wanted to host learning objects on the server at Athabasca University to ensure the availability of online resources for students. Partial access to core material is unacceptable, resulting in the team pursuing system requirements for hosting.

Learning Objects - Benefits

The question "what benefits have been derived (ease of access, relevance, quality, costs, time, etc.)?" was posed to each of the three course development teams.

The business team considered the learning object approach as pioneering instructional design. The approach "permitted designers to respond to students' learning needs and learning styles not addressed in a 'book-based' learning experience." The use of readings and instructions from on-line journals (cleared for copyright) through the AU library's subscription to e-journals and various journal syndication services was seen to enhance the course lessons. The learning object approach diminished instructor control, but improved graphics content, interactive capabilities and the opportunity to institute online student assessment with automated quizzes.

The nursing team considered the learning object approach as timely. Web sites provide timely content, which is likely to be revised sooner and more easily than comparable print resources. As well, the nursing team favoured the use of interactive media available through learning objects.

The literature team, like the nursing team, considered the learning object approach as timely. Timeliness of online content is preferred to textbooks which are considered to be quickly out of date. They believed a likely benefit will be relevance, as very current discussions and writing models can be found online. The learning object approach is perceived to allow for spontaneity, creativity, diversity and variety in learning resources.

Learning Objects - Barriers

The question "what barriers have been encountered (ease of access, relevance, quality, costs, time, etc.)?" was posed to each of the three course development teams.

The business team struggled with four barriers. The first barrier was difficult deadlines attached to the six month course development project. The deadline was perceived as short and resulting in the need to seek rapid solutions when faced with obstacles. The second barrier was the perceived scarcity of course-relevant learning objects. Learning objects collected were found difficult to incorporate into a course structure. The lead developer states "gathering and assessing objects is tedious and very time consuming – it must be guided by a clear vision of what objects are required to form a lesson rather than a lesson being designed around objects." The scarcity of lesson content requires that course material be created by the team. The third barrier was the perceived lack of quality in learning objects available. While some web sites were considered to contain excellent content many were considered inappropriate for use in the course due to web-based formatting problems, differences in presentation style and a generally "low-quality look." The fourth and critical barrier to the use of learning objects is the issue of context. Lesson content and writing style varies greatly from website to website. A lack of coherence in website content is of particular concern for students studying writing. The team was faced with having to "patch together" lesson material from a variety of web sites. The lead developer strived to achieve a solid concept to envelope the learning objects in order to draw in students. The team decided to use an interactive textbook supplemented with additional learning objects linked to on a course web site.

The nursing team struggled with a perceived abundance of web sites. The developers tended to visit a large number of web sites of questionable relevance. The quality of the web sites was extremely varied, requiring continual assessment and tracking. Some difficulty was encountered in finding content geared specifically to nursing. The issue of context emerged for this team as well with resolution through a written narrative.

The literature team struggled with technology issues. Information system difficulties were encountered while downloading learning objects to the AU server. The team was concerned with the cost implications in providing a supporting platform. As well, the cost for the learning object itself may serve as a barrier when copyright permission or royalty fees are accounted for. The size of learning objects also presented a barrier. Learning objects are seen as effective for reading short pieces, but more difficult with larger components (such as a book).

Learning Objects - Feasibility

The question "what is your perception of the feasibility of assembling learning objects into a viable course package?" was posed to each of the three course development teams.

The business team struggled with finding relevant learning and freely available learning objects. The outcome of the learning object approach is perceived to be incomplete, very poor in content, and not academically sound. Rather than focusing on freely available learning objects, the team turned their attention to commercial learning resources and on-line journals.

The nursing team perceived that assembling learning objects into a viable course package as quite feasible. Question arose relating to the level of academic rigour, which is a critical driver in developing any university level course, but was resolved by the creation of commentaries, exercise and discussions forums around the objects.

The literature team perceived assembling learning objects into a viable course package as highly feasible. The content, level of study and student-base of their course makes the learning objects approach appealing. Regarding the student-base, the computer literacy of the students must be considered in determining feasibility of a learning objects' course design. The student-base for the course is believed to be orientated to using the computer, online resources and asynchronous communications. A dialogue forum will form a portion of the students' course requirements with students being required to review and critique the work of others online.

Course Development - Instructional Design

The influence of instructional design was discussed with the developers. The teams were queried as to how they would describe the instructional design of the course being developed and if an instructional designer or specialist was consulted. We attempted to determine if an initial template or model was followed and revised during the development process.

The business team determined that finding high quality learning objects required too much effort and was not time efficient. The result of this search and course development process was a "patchwork learning environment" which was considered "not learning effective." The lead developer states "given available learning objects, the design of lessons, learning activities, and ultimately, the design of a course were severely restricted."

The nursing and literature teams fared better in their course development. The nursing team sought to incorporate reflective and critical thinking components into the course design. The design process followed was deemed successful and relevant to the learning object approach. The design process followed entails: preparing (determining the level of knowledge), practice (exercises) and reflecting (critical thinking). The literature team also considered their design process successful. The learning object approach allowed for interactive design supporting student dialogue via asynchronous communications.

Course Development - Production Process

The three teams used various approaches to the course production process. A course designer was not drawn into the production process. The three groups set out to develop the course based on their subject matter and teaching expertise.

The business team conducted a skills-based needs assessment as well as a pedagogical needs assessment. The skills-based needs analysis determined that students require more practical writing skills. The pedagogical needs analysis determined that students require more feedback during the course. The team stated they would value students' assessment of the learning object approach, particularly to address the instructional design issues such as a lack of context that they encountered.

Both the nursing and literature teams provided an enveloping context through a written narrative for the learning objects. Both teams also found that learning objects inspired course content. The nursing team determined an overall course design and then set out on a search for learning objects. The required readings are supplemented with numerous web sites located and referenced. The literature team searched for learning objects after the course design was determined. The course structure entailed four large areas for development. The team envisioned five or six learning objects for each of the four instructional areas resulting in 20 to 25 learning objects in total for the course.

Course Development - Production Issues

The three teams were questioned as to the tools and techniques used to incorporate learning objects into the course. During the interview, the possibility of modifying existing learning objects and creating new learning objects for contribution to a repository was discussed.

The business team was concerned about the large size of learning objects. The lack of success in finding suitable learning objects led the team to prefer a website that includes learning objects as a supplement to the course content. The perceived contextual weakness of the learning object approach resulted in an interactive text being selected. “The interactive text concept allowed us to co-opt technical help to design “small” learning objects rather than large ones that our team could not have produced.”

The nursing and literature teams found an abundance of learning objects. Both teams did not consider creating learning objects, as ample supply was considered to exist. The nursing team found it difficult to stop searching for a “better” learning object. The literature team anticipates creating learning objects to enhance the course content.

Course Development - Production Time and Cost Efficiencies

The course development teams were asked if the focus on learning objects altered the speed and/or cost of producing the course.

The business team was concerned with tight deadlines and the perceived heavy time commitment required for creating learning objects. They concluded that the learning object approach “was too costly and time consuming.” As well, they concluded that “gathering and assembling objects to create a course on one’s own was not cost effective…it was cheaper to design a course around an existing online learning environment and curriculum designed by a publisher than to create one’s own course.”

The nursing team considered past experience with traditional (print format) course development with extensive time being required for editing and printing. The learning object approach is believed to be considerably faster, if the course production process is kept in the online format and not taken to paper format and then back to online format. They concluded that online courses following the learning object approach eases course editing and speed for revision.

The literature team did not perceive a fundamental change attributable to the learning object approach. Cost efficiencies are seen with the lack of a textbook being required, however web site administration will add to the course cost. Course cost was not considered a driving factor for this team.

Discussion

The course developers were challenged to use learning objects in their course design process. As discussed, selection of appropriate learning objects was challenging with accessibility, context and quality emerging as issues. The abundance of available material is helpful in selecting learning objects. However, great care must be taken in planning the search strategy and method of compiling results. A unified system of repositories and classification methods would assist course developers in their search, selection and retrieval of learning objects. Use of a general search engine may thwart the search process by rendering information overload. In the business course, the divergence and incompatibility of freely available objects was judged to be so severe that a commercial solution (a paper text book, supplemented with a variety of related and web-based customized multimedia objects) was deemed to be a more effective way to use networked resources.

All developers spent considerable time searching for relevant objects using tools that were not optimized for educational use. The development of more effective learning object repositories would have assisted all of the teams in focusing their search strategy and narrowing their search results. Repositories, with their classification and evaluation processes, may have provided improved search results by providing higher-quality learning objects. For instance, MERLOT offers learning objects which have undergone a peer review process. In addition to peer reviews, MERLOT offers quality ratings, assignments and access to discipline communities.

The issue of creating new learning objects (especially those incorporating multi-media) was dismissed by the course developers as being too difficult and expensive. However, it is important to consider the possibility of modifying existing learning objects. The adaptive nature of autonomous learning objects provides a foundation to build upon. The learning object approach depends on interoperability and adaptation. This adaptation process is termed "content repurposing" and "allows learning objects to become customizable and thereby promotes their reuse. Designing and developing educational material in a manner that allows the customization, editing and adaptability to learner needs is the key to providing cost effective, sustainable, and high quality educational materials" (Belle Project at http://belle.netera.ca).

Information technologies provide an enhanced ability to tailor content to meet particular needs. This is evident in the use of "cookies" in e-retailing where individual preferences are stored for later customization of the user interface. E-learning can also benefit from this ability of information systems to customize content to personalize content to meet an individual's unique learning needs. Facilitating variety in study patterns is an important benefit of the learning object approach. Students can choose to engage in particular learning experiences to a greater or lesser extent. Their active participation in the learning process is a distinct advantage of the learning object approach. Learners can be provided with an active environment with autonomy in choosing to follow various learning paths. "Each of the pieces of evidence contributes to an overall argument they are constructing, and thus the wider the pool of evidence they have to draw upon, then the richer their final assessment will be" (Weller, Pegler & Mason, 2003). The role of course developers also changes as the learning object approach "means that there is far less requirement on the course team to write all of the material and to occupy student study time solely in reading course-authored text. The emphasis is instead on writing good introductory and framing material, structuring activities and locating engaging resources" (Ibid.).

The issue of context emerged as an insurmountable barrier for the business team. As a result of their dismay with the "patchwork result" derived from the learning object approach, the team decided to incorporate a preformatted interactive textbook. The value of context raises a multitude of pedagogical issues and debates. The decision of reverting to a textbook can be debated; it should not be assumed that the provision of a main learning resource for students is a superior means of learning. The ability to personalize the learning approach and customize learning materials to a particular learning style must be considered. Courses developed according to the learning objects approach do have a different contextual environment. Though:

> *it remains to be seen whether the removal of explicit connections may render the material more meaningful for students, since it places the responsibility for making such connections with the student. The integration between materials is thus an activity the student must engage with, rather than simply being spoon-fed. It is also in keeping with more constructivist sympathies, that there is not one set of connections to be made between concepts, i.e. those of the educator, but rather a multitude and every individual will create their own meaningful overarching narrative. (Weller, Pegler & Mason, 2003)*

Course developers must balance the value of a variety of learning resources, with different approaches to a subject and viewpoint being offered for consideration, against the need to provide coherence in the course materials. Variety may be beneficial to the learning process, but it does require students to alter their learning process as they approach the various materials. Weller, Pegler & Mason (Ibid.) state "a course that continually seems to shift dramatically in pedagogy, level or style would carry an overhead for students as they make the cognitive shift between objects and styles."

The variety of learning materials can be contextualized by the writing of narrative elements which provide cohesiveness in the course. Another approach is to include online dialogue such as in a computer conferencing system. The dialogue can provide a narrative thread through the provision of tutor and peer support. Students can be encouraged to make cognitive and contextual connections between the learning objects provided (Ibid.).

It is obvious from the different approaches adopted in these three case studies that there is no single best method for implementing learning objects in course design at the current time. Continuing changes in the storage, search and retrieval capacity; the ease and cost of acquiring rights for use; and the increasing capacity and ease of use of content creation tools will individually, and in aggregate continue to change the factors that inhibit and support course construction based on learning objects. In Figure 1 below, we illustrate the generic process of course creation based on objects as practiced in these case studies.

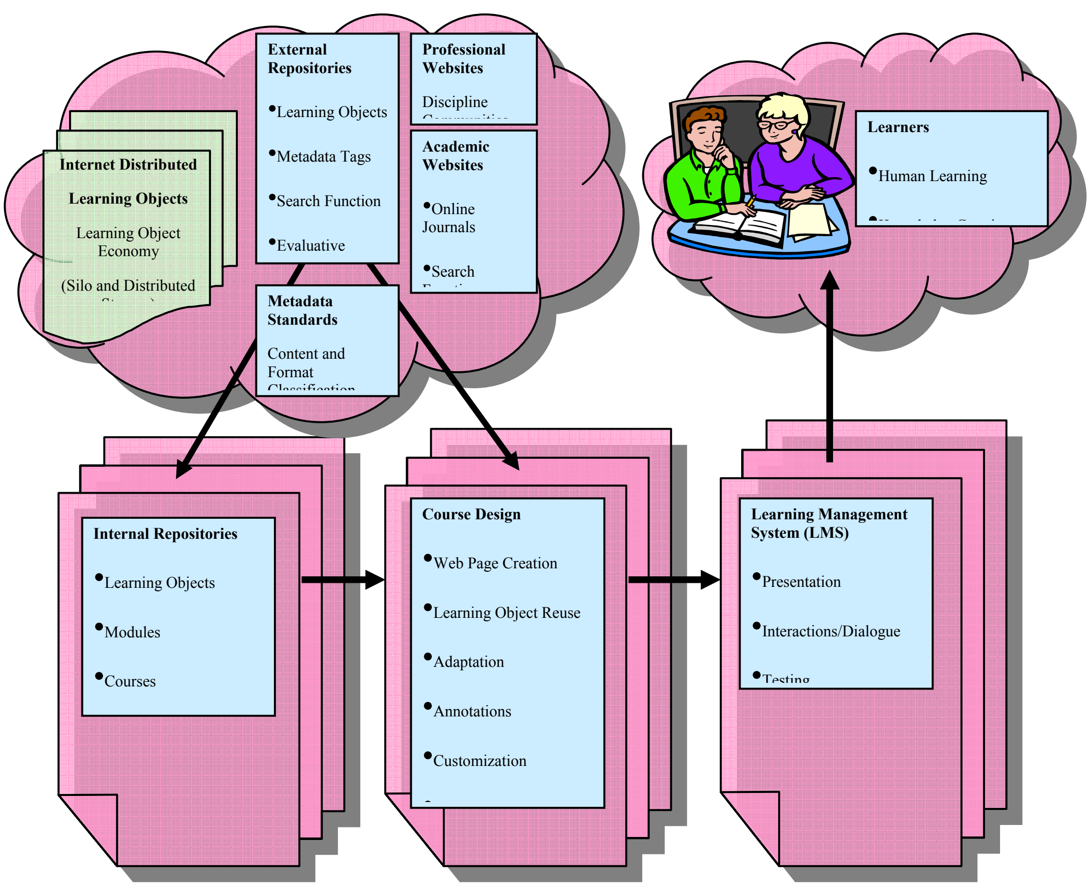

***Figure 1*. A generic model of course creation and delivery using learning objects.**

In this model developers begin the course development process in the learning design phase. Here they design the course through formal and informal needs analysis, articulation of learning outcomes, design of experiences, assessments and learning activities. Unlike in times past, this process is from beginning to end enriched by excursions into both internal and external networks. Here developers extract knowledge and content related to similar courses offered internally and by competitors, addressing learner needs, aspirations and expectations, searching and retrieving content formatted in a variety of media. This content is annotated, customized for local learner needs, personalized by the developers own experiences and incorporated into a variety of learning activities and assessments. Finally, the course content is ported to a Learning Management System (LMS) where it is presented to learners – again in a variety of formats and structures. The LMS also provides interaction environments (conferencing, chats and audio/video conferencing), testing tools, and a variety of scheduling and tracking tools.

Conclusion

Athabasca University, Canada's Open University, has been developing course materials for independent study through a variety of course designs since 1974. The university is now committing to the development of learning objects as the principal methodology in the design, development and deployment of course materials across all subject areas. Learning objects present challenges to course developers, such as finding and contextualizing the resources. The playfulness of merely plugging Lego blocks together to form a structure is misleading when applied to the course development process. Instructional design using learning objects demands skillful construction by course designers. The issues encountered by the course developers in this research project have proven to be formidable. However, the barriers can be countered and the results arguably warrant the effort.

The results of this case study analysis shows promise for future course design with learning objects. The nursing and literature course developers were pleased with the learning object approach. The business team's difficulties demonstrate the weaknesses in learning object availability and context. The distributed model envisioned by Downes (2003) is not yet a reality. Issues relating to repository silos constrain the learning object economy and the free sharing of resources. The barriers to the learning object approach may also be cognitive barriers by faculty members in falling back into well trodden paths. The learning object approach is innovative and demanding to implement with search and retrieval issues being followed by a need for contextualization. These costs must be evaluated against the benefits of interoperability, multi-media learning resources, personalization in learning style, ease of course revisions and diversity in content. This case study seems to align with the conclusions reached by Acker, Pearl and Rissing (2003) who state

> *The promise remains too tenuous, the risk-reward ratio too high, and the sense of urgency too low for the majority of faculty to change their current practices. Nonetheless, learning objects – right-sized content that may be re-used, recontextualized, and re-purposed – bring with them small seeds of change that likely will grow vigorously in the future. (Ibid., p. 83)*

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About the Authors

Jo-An Christiansen is a part-time research assistant with Athabasca University and a full-time research officer with Alberta Agriculture, Food and Rural Development. She has completed five credentials: Library Technician Diploma, University Certificate in Public Administration, Bachelor's Degree in Administration, University Certificate in Computers and Management Information Systems, and a Master's Degree in Integrated Studies (Adult Education specialization). The interdisciplinary studies focused on adult education, distance education, research methodologies and information technology applications. Currently, she is completing a Bachelor's Degree in Computing and Information Systems through Athabasca University.

Contact her via email at: jo-an.christiansen@gov.ab.ca

Terry Anderson, Ph.D. is a professor and Canada Research Chair in Distance Education at Athabasca University, Canada's Open University. He is coauthor of: Anderson and Kanuka, (2002), eResearch: Methods, Issues, and Strategies; Garrison and Anderson, (2002), Online Learning in the 21st Century: A Framework for Research and Practice. He is co-editor of an online book: Terry Anderson and Fathi Elloumi, (2002) Theory and Practice of Online Learning cde.athabascau.ca/online book. Contact him at Terrya@athabascau.ca.

Editor's Note: This is a detailed and technical study. It discusses design issues in depth as they relate to the subject matter, learning objects, and best practices in instructional design, teaching, and learning.

Design Issues Involved in Using Learning Objects for Teaching a Programming Language within a Collaborative eLearning Environment

Jinan Fiaidhi and Sabah Mohammed

Introduction:

Collaboration and sharing are well-established traditions in higher education. Recently the open source model based on XML let academics build their collaborations upon the concept of *learning objects*. With learning objects one can develop reusable high quality educational learning contents. Learning objects are increasingly seen as key to a technology-based revolution in education and training — even to an emerging global knowledge economy.

An international effort is underway to formulate standards that will enable their exchange, and the topic is popular in many journals and at conferences, e.g.

eduSource Project http://www.edusource.ca/

MERLOT (www.merlot.org)

NSERC Task force on Virtual Universities and eLearning (http://www.nserc.ca/programs/taskforce_e.htm)

POOL Learning Portal (www.canarie.ca)

IEEE Learning Technology Journal (http://lttf.ieee.org/learn_tech/issues/january2003/index.html)

BlueJ utilities (http://java.sun.com/features/2002/07/bluej.html)

CAREO http://www.careo.org/

ED-MEDIA 03 Conference (http://www.aace.org/conf/edmedia/symposium2003.htm).

The major advantage of the learning objects is that it has an open source/reusable format that enables both facilitators and students actively construct/modify knowledge rather than are being taught centrally by a static core material. Unfortunately, this advantage is greatly limited by the current available system for locating learning object or what is known as the "silo model" (Downs, 2003). On the silo model, resources are not designed or intended for wide distribution. Rather, they are located in a particular location, or a particular format, are intended for one sort of use only. The original vision of learning object should encompasses beside the reuse and exchange of learning contents the ability to search, collaborate and distribute these contents among multiple educational settings, instructors, courses, and institutions. Certainly, the issue of reusability and personalization of learning objects allows learners with different requirements to learn what they need, in the style, format and speed, which they prefer.

However, sharing such learning objects is another important issue. If we accept the premise that institutions will share learning materials, then we need to ask, what will they share? The answer that intuitively offers itself is: courses. Why, then, would institutions not share these courses? To a certain degree, they already do so. Most colleges and universities define course articulation policies, whereby a course completed at one institution is accepted for credit at another institution. The assumption is this: that there are thousands of colleges and universities, each of which teaches popular programming languages such as “Java Programming”. And each Java course in each of these institutions describes the same concepts (e.g. polymorphism, inheritance, class, object, etc). Moreover – because the properties of these concepts remain constant from institution to institution – we can assume that each institution’s description of such concepts is more or less the same as each other institution. What we have, then, are thousands of similar descriptions of identical Java concepts.

The aim of this article is to investigate the possibility of adopting the notion of Learning Objects for constructing a collaborative eLearning system for teaching and learning Java programming as well as for providing an environment for collaborative programming (e.g. extreme programming). Actually one of the major problems of bringing students to the same level of understanding in a short period of time is the lack of an effective communication mechanism between instructor-student and student-student to share crucial knowledge at the right time.

Students often misunderstand concepts and thus apply them incorrectly; which leads to hours of wasted time spent on debugging logically incorrect code. By the time students get help it is either too late or there is little opportunity for the instructor or TA to intervene. According to Anderson (Anderson, Kanuka, 1997) the facilitators of any professional development activities have a responsibility not only to provide information but also to assist professionals in developing a critical and analytical way of considering knowledge, to provide opportunities for professionals to practice using their judgment skills, and to assist professionals in developing new knowledge based on practice. The best way to facilitate this kind of learning is through the rich resources of practical knowledge acquired by other professionals in a collaborative environment (Cervero, 1988).

This article describes an approach to a content creation and delivery mechanism for a Java programming course. This approach is based on the concept of creating a large repository of Java learning objects, each of which consists of the core material, code examples, supplementary notes, and review questions. A learning object will be uniquely described by a XML document and presents an interface for future search, retrieval and updating, as well as for potential connection to external assessment tools.

This article is a description about an ongoing development project at Lakehead University to create a collaborative eLearning environment for teaching and learning Java programming using the notion of learning objects. Various design issues been investigated for this purpose including the structure of Java Learning Objects and the Learning Objects Messanger Engine. Particular attention has paid for techniques required for searching for relevant learning objects from the various learning objects repositories on the Web. Three techniques have been found necessary for effective searching of learning objects based on *collaborative ontology*, *query expansion* and *relaxation*.

Learning Objects Realization and Standardization:

Learning objects (or RLO - reusable learning object) have been the hype of the elearning industry since 2000 (Hodgins, 2000). They have been hailed as the future reality of learning...and as idealistic, but unattainable view for education. Separating the hype from reality is still an ongoing activity. There are massive research efforts for describing, cataloging and tagging such learning objects. These tags provide descriptive summaries intended to convey the semantics of the object. Together, these tags (or data elements) usually comprise what is called a metadata structure.

Although learning objects are conceptually appealing, exactly what constitutes a learning object in practice has been unclear. In the past, different vendors have had different ways of instantiating the notion of a learning object and different ways of enabling learning objects to communicate information about the learner. For many researchers (Darlagiannis, et. al. , 2000), learning objects can be viewed based on the notions of Object Oriented Programming (OOP) - a programming term referring to the creation of segments of code that can be incorporated and reused in different areas. The view is that if learning is designed properly, each object will be a self-contained "piece" of learning. In this particular view, Java programming environment and many of its supporting tools can be considered as the basic infrastructure for any collaborative eLearning system.

The popularity of the Web is another encouraging factor which has greatly increased the availability of high bandwidth networking, making real-time collaboration feasible. In addition to network bandwidth, collaborators must also have compatible software. Java facilitates this by allowing software to be delivered over the web and executed on a variety of platforms without modification. Java also includes component support in the form of the JavaBeans component architecture (EJB). BeanBox, Sun's reference JavaBeans builder tool, provides an example of a simple standard environment for editing and connecting beans. Indeed using the EJB architecture we can build collaborative environments such as Sieve (http://linc.cs.ut.edu/Sieve).

Also we can use many Java APIs that can help in allowing the control and synchronization of distributed data such as Java Shared Data Toolkit(JSTD), Collaborative AWT (C-AWT), and Java Multimedia Framework(JMF) to build collaborative systems such as Habanero (Chabert, et al, 1998) and JAMM (Kuhmünch, et al, 1998). But such architectures prove to be restrictive, depends a lot on the APIs or EJB vendor implementation and utilities (Mahapatra, 2000) (Shirmohammadi, et. al., 2001). However, there are many notable attempts for solving these restrictions such as AdventNet SNMP API (http://www.adventnet.com/products/snmpapi4/) and CollabNet (http://www.collab.net) which is based on the extensible Java integrated development environment (IDE) as well as the JETS/JASMINE system which presents a more sophisticated transparent Java collaborative environment (Shirmohammadi, et. al., 2001) (Shirmohammadi, et. al., 2003). Moreover, a variety of educational tools help in constructing a successful collaborative environment (See http://www.edutools.info/course/productinfo/index.jsp).

As the eLearning landscape develops and matures, universal learning standards will become the conduit to connect global knowledge assets. Indeed searching the Web cannot the work of finding required educational objects. Simply because multimedia contents excluded, simplistic character matching mechanisms, and there is no way to search for educational aspects according to whatsoever category(age appropriate, user appropriate, or learning style appropriate).

Fortunately, and thanks to the efforts and cooperation of many standards organizations and the vendor community, there are now widely adopted standards that allow learning objects to be described, assembled, delivered, and tracked in a standardized way, regardless of their shape, size, or intended purpose. These organizations forms specialized groups to write specifications and to clarify issues such as: How should eLearning content be tagged? What fields should be required? And how can this information be communicated?

Once the specifications group compiles its work, it submits the proposed protocols to an official sanctioning body for standardization. A specifications group is an organization with common interests and purposes, and works to develop protocols - agreements - that the community can support. The most important groups which are writing specification models for Learning Objects are (E-com Inc, 2003):

- Advanced Distributed Learning (ADL)
- Aviation Industry CBT Committee (AICC)

- Canadian Core Learning Resource Metadata Application Profile Initiative (CanCore)
- Dublin Core Metadata Initiative (DCMI)
- Institute of Electrical and Electronic Engineers (IEEE)
- Instructional Management System (IMS) Global Learning Consortium
- World Wide Web Consortium (W3C)

All these groups are developing standards for the new wave of eLearning systems and they agree that such new systems must fulfill the following requirements:

- It should allow interoperability of content from multiple sources
- It should allow interchangeability of content for transfer between sources
- It should allow reusability of content within the same source
- It should allow accessibility of content to search object repositories
- It should have a separate communication Interface—how resources communicate with other systems,
- It should have meta-data—how to describe eLearning resources in a consistent manner,
- It should allow packaging—how to gather resources into useful bundles

Unfortunately, there is no universally agreed *standard* (FIAIDHI, MOHAMMED, 2003) (FIAIDHI, and MOHAMMED, 2003) among the above mentioned list. Instead, there are some universally agreed de facto, as opposed to formal, standards. De facto means that the specifications have been adopted widely, even before they are officially standardized. In this direction CanCore take the lead as the de facto standard (Friesen et al, 2002).

CanCore is a Canadian implementation of an emerging IEEE standard for educational metadata - the cataloguing and indexing information for digital learning resources. CanCore interprets and simplifies existing educational standards and protocols. CanCore allow educators, researchers and students in Canada and around the world to more easily search and locate material from any online repository of educational objects. These educational or learning objects can be as simple as individual web pages, video clips, or interactive presentations, or as comprehensive as full lessons, courses or training programs.

CanCore provides guidelines and interpretations that will reduce ambiguities and facilitate implementation and extension of metadata to meet the needs of a particular collection of resources while remaining searchable by users from afar. The CanCore Metadata Protocol is a streamlined subset of elements from IMS Global and is intended for the efficient and uniform description of digital learning resources. CanCore was developed by researchers in the CAREO and POOL projects sponsored by the Canarie Inc. eLearning Program. Since its initial introduction in 2000, it gains wide international followers.

The CanCore Learning Object Metadata Application Profile takes as its starting point the explicit recognition of the human intervention and interpretation that separates raw data management from the information or knowledge that can actually be "about" something. The Canadian Core Metadata Application Profile, in short, is a streamlined and thoroughly explicated version of a sub-set of the LOM metadata elements. The CanCore element set is explicitly based on the elements and the hierarchical structure of the LOM standard, but it greatly reduces the complexity and ambiguity of this specification. The CanCore specification includes many essential elements for all the essential educational categories.

Table 1 illustrates the basic CanCore elements. The general CanCore Schema provides 54 Elements in Total:

- 36 active elements
- 15 placeholder elements
- 3 reserved elements

Each element within the CanCore Schema can be described with 4 pieces of information:

1. **Name:** How the meta-data element should be spelled.
2. **Explanation:** The definition of the element.
3. **Multiplicity:** How many elements are allowed and whether their order is significant.
4. **Type:** Whether the element's value is textual, numerical or a date; and any constraints on its size and format.

Table 1: The CanCore Schema Elements

1 general 1.1 identifier 1.2 title 1.3 catalogentry 1.3.1 catalog 1.3.2 entry 1.4 language 1.5 description 1.7 coverage **2 lifecycle** 2.1 version 2.3 contribute 2.3.1 role 2.3.2 entity 2.3.3 date	**3 metametadata** 3.1 identifier 3.2 catalogentry 3.2.1 catalog 3.2.2 entry 3.3 contribute 3.3.1 role 3.3.2 entity 3.3.3 date 3.4 metadatascheme 3.5 language **4 technical** 4.1 format 4.2 size 4.3 location	4.6 otherplatform-requirements 4.7 duration **5 educational** 5.2 learning-resourcetype 5.5 intendedenduser-role 5.6 context 5.7 typicalagerange 5.11 language **6 rights** 6.1 cost 6.2 copyrightand otherrestrictions	6.3 description **7 relation** 7.1 kind 7.2 resource 7.2.1 identifier 7.2.3 catalogentry 7.2.3.1 catalog 7.2.3.2 entry **9 classification** 9.1 purpose 9.2 taxonpath 9.2.1 source 9.2.2 taxon 9.2.2.2 entry 9.4 keyword

By using the CanCore elements and protocols, one can search for learning objects in the various repositories. CanCore as well as the other standards uses XML for describing both the learning objects as well as their metadata. XML offers a disciplined language for describing the various resources and provides a common set of elements that can be exchanged between multiple systems and products. There is one more magic reason behind agreeing on XML as an industry de facto which can be addressed as *Data binding (*Mahapatra, 2000), which allows a mapping of data from an XML document to a Java object, and then back again. Data binding starts with the assumption that your priority is business-driven, not XML-driven. Instead of elements and attributes, you want to work with people, names, addresses, and phone numbers. You want to dispense with XML and get to the data in the XML document, but you also don't want to have to wade through XML semantics to do it. For this reason, data binding allows a mapping from XML data (not structure) to business-driven Java classes.

These classes are user-defined, so they could be things like a Person class, an Address class, or a string field named city. Data binding APIs take care of converting elements' and attributes' data into these custom, business-driven types. There are numerous APIs that already allow some variant of this conversion: Jato, SAX, DOM, JDOM, dom4j, JAXP, etc. The list goes on and on;

however, data binding has something unique that makes it worth delving into. The plus side of data binding is that XML data will look like Java objects which makes it easier for the Java programmer to manipulate and interact with that data. Such mappings are usually a two-way street in that they can also take a Java object and serialize it into XML. The negative side would be performance (by introducing some overhead) and the inherent incompatibility that exists among the different binding mechanism.

In this article, we are proposing a method that reduces the overhead of data binding and let Java source to be coded in XML. By capturing the mapping in a single place and then allowing JXML to handle the parsing, conversion, and generation, you save many lines of code and gain performance. Also we are proposing a browsing technique for learning objects based on their metadata as well as using some internal specific attributes of the required learning objects.

Using XML for Describing Structure of Java Learning Objects:

In this section we describe our initial thoughts arising from our intension to deliver a Java programming module to BSc students who are being taught through the medium of the Internet and among the various smart classrooms and labs at our Lakehead University Advanced Technology and Academic Centre(ATAC). According to the IEEE workshop on the “Practice and Experience with Java Programming in Education AICCSA’03” (Workshop on Practice, 2003) the educational use of Java, however, is still in its infancy at many educational institutions around the world, and therefore many of the pitfalls have yet to be discovered. The mode of teaching such proposed course is essentially seminar-based, with a heavy emphasis on the moderated discussion of module topics and coursework/assignments in a Virtual Classroom. This approach leads to a high degree of interaction between instructor and students, and, especially between students in the class, who collaborate to create a mutually supportive learning environment.

Previous eLearning systems represents merely communication tools and do not allow students to discuss a programming question in its own context. For example, a student cannot highlight or annotate specific passages in the course materials or the supplementary materials and cannot initiate a discussion thread around it. Another issue which can be identified with the core materials is that there is no easy and effective ways to interconnect major components of the course such as code examples, and review questions to the core content. Students in such courses are generally not capable of sorting out all information and figuring out what makes sense to them. Clearly the current use of core materials in programming courses is not effective because their static contents do not allow any kind of content personalization, enhancement or interaction. We believe that we can address some of these problems by creating a better knowledge transfer mechanism between the teacher and the student or the students among themselves. We will focus in this section on presenting the key Java programming concepts by utilizing learning objects (referred to us as Java Learning Objects). Addressing this aspect, we need to make sure that all course related material is organized into a basic repository of the information objects. The key components of the basic repository are core Java course content, Java code examples and review questions. Then instructors can create learning objects using the basic repository of information objects; and share them with colleagues and students. Also we need to be certain that all knowledge components are assembled under one unified and interactive environment.

However and as have been described in the last section, XML should be used for representing the Java learning objects. Surely XML can represent any datatype including the bytecode (**Pentakalos, 2001**) which will let us represent any Java .class module in XML. This can be done automatically by using Byteml API (http://byteml.sourceforge.net/main.html) or by using Jato API which converts XML documents into Java objects and back again (**Krumel, 2001)**. This way of representation is quite restrictive for two reasons:

1. Projects needs to be represented using several XML files, and
2. Java source code and other textual materials can not be represented.

For this reason we believe that the facilitator need to assemble any Java project that he/she needs to explain its practical use in his/her course as a Java bean which can be converted to XML later using simple classes like BeanXMLMapping (**Caroli, 2003**) which have two methods. The "toXML():" generates the respective XML document String for the bean instance and the fromXML(): creates a bean instance for the XML document String. Generally, we assume that every Java Learning Object should include other essential programming elements. Figure 1 illustrates our imagination to the general architecture of the Java Learning Object.

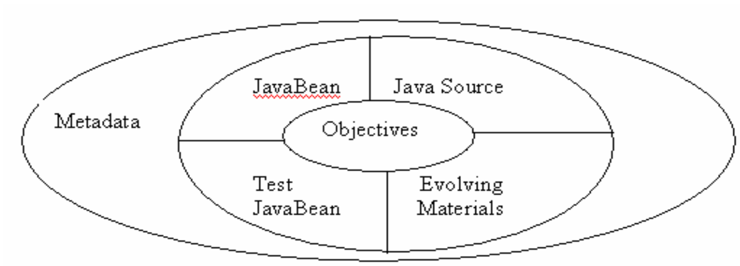

Figure 1: The architecture of Java Learning Object.

The issue of writing *Java source* code into XML can be treated effectively in two ways, either by using a very simplistic authoring language like srcML (Michael, Collard, and Marcus, 2002) or developing a syntax directed editor which according to Java Syntax schema the facilitator can insert the Java source within the XML code of the Java learning object (Simic, and Topolnik, 2003). The *evolving materials* module initially includes the facilitator description of a Java concept and it allow students to create personalized learning profiles and share them with others as well as creating an environment where students and facilitators can discuss course-related material. The facilitator and thereafter the students can use simple authoring toolkits like the LOM editor (*Kassanke, and Steinacker,* 2001**)** to edit any learning object evolving material. The *Beans testing* module is an environment which enables students to test the facilitator JavaBean by incorporating linkage to the Sun's Java BeanBox http://java.sun.com/products/javabeans/software/bdk_download.html or by using the Bean-test API(http://www.rswsoftware.com). The *meta data* module provides all the external references and relations to the other learning objects and databases as well as the learning constraints and the internal structure of the learning object. The meta data must conform to one of the international standards. For the purposes of our discussion here, a Learning Object (LO) will be defined as a unit of instructionally sound content centred on a learning objective or outcome intended to teach a focused Java concept and it should follow the CanCore standard (www.cancore.org/schema.html). This will enable the resulted learning object to be used widely through the eduSource educational network (http://www.edusource.ca/) or the POOL learning portal (www.canarie.ca) (Richards, McGreal, and Friesen, 2002) (Hatala, and Richards, 2002). The *objective* module should be designed by the facilitator by setting guiding rules on the role of the learning object and its relations to the other learning objects.

Learning Objects Messenger for discussions and exchange of learning objects:

As you might expect for any web-based application, XML can provide a standard, agreed upon format to transfer data over the Internet. In this respect XML is similar to a data format such as Comma Delimited or SDF file in the past. However, as a data representation format XML is also much more flexible than these old formats, because it can carry just about *any kind* of data. Most other text formats have been hampered by their limited ability to transport complex data like memo fields or binary data. XML is very flexible in what kind data it can carry.

However, establishing a communication and discussion platform within such environment is a different issue. In the past, such distributed applications have been treated using Java technology system with RMI. Or, perhaps some COM or CORBA objects resided on the server. The use of such technologies will not provide an open-source communication paradigm.

Alternatively, XML Web services are open and platform-independent. It is not important how the service is implemented underneath. With UDDI (Universal Description, Discovery and Integration), a system can publish all its services for all potential clients to discover. For this reason many XML-based messaging utilities have been introduced during the last few years which ranges between a Lightweight API (e.g. JML toolkit (http://java.sun.com/products/jms/) and a sophisticated XML messaging platform (e.g. ebXML (www.ebxml.org)). Most of these utilities comply with the standard XML Messaging specification of the W3C (http://www.w3.org/TR/xmsg/).

The Primary goals of the W3C XML Messaging specification are: to provide the ability to transport multiple documents and references to associated data objects within a single document (a message) and preserve their identity, to provide the ability to associate metadata with both the documents and the message without modifying the original document or schemas for those documents, and to provide the ability to transport non-XML data as a document within the message.

For our collaborative environment we are proposing the use of SOAP (Simple Object Access Protocol) which can implements all the required functionalities of discussion and message exchange (http://www.w3.org/TR/SOAP/). SOAP uses a standard lightweight JAXM API (http://java.sun.com/xml/jaxm/). This is useful because your application can then communicate across different platforms (since SOAP is XML-based, and therefore plaintext), and communicate with XML Web services. By utilizing SOAP, any system can use a Web service from any other system by communicating with XML-based messages. On either end, these XML messages can be converted to whatever format is necessary for the system to understand. SOAP message has the following general structure:

- The SOAP envelope, represented by a <soap-env:Envelope> element.
- The SOAP header (optional), represented by a <soap-env:Header> element.
- The SOAP body, represented by a <soap-env:Body> element.
- One or more body elements. This is the actual content of the message.
- A SOAP Fault (if an error occurred), represented by a <soap-env:Fault> element.

Based on SOAP the sequences of communication events can be summarized as follows (see Figure 2):

The student creates and sends a SOAP message containing requests for one or more Java-based concepts.

The LOMBE receives the SOAP message containing the requests and processes it, extracting the names of the requested concepts. Errors are handled by the use of a SOAP Fault element.

The LOMBE searches for the requested concepts from the main LO repository or from the students collaborative LO repository. Again, if an error occurs, it will be trapped with a SOAP Fault.

The LOMBE creates and sends a SOAP message, containing the requested LO, back to the waiting student.

The student receives and processes the response message, extracting the required concept information. If the student would like to comment on the LO, then s/he can save a new copy of LO at his/her personal LO repository.

If no matching LOs been found a SOAP message is sent to the CanCore/eduSource registry service to search for external learning objects.

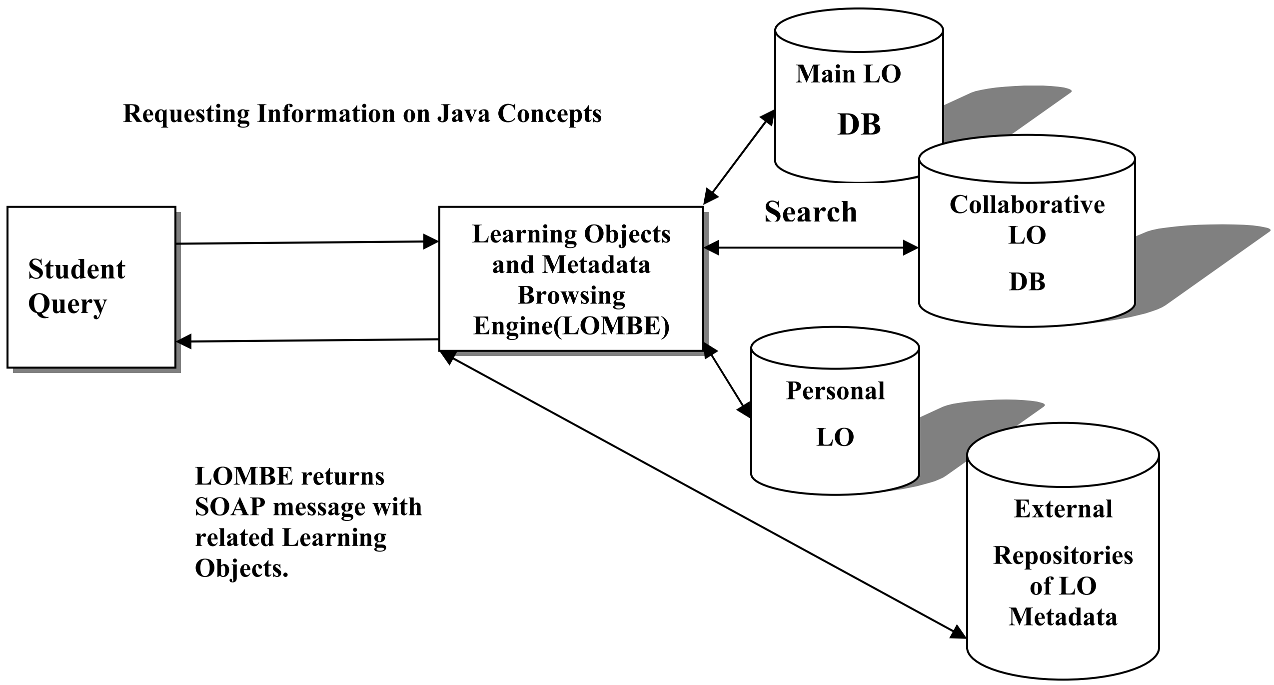

Figure 2: SOAP-Based Communication Infrastructure: The LOs Messenger.

Browsing and Searching for Learning Objects: Problems and Proposal

Many researchers believe that searching for learning objects should be straightforward via searching for a matching metadata (i.e. an XML document). This believe came from the fact that XML is a form of a database (Rizzolo, Mendelzon, 2001) and hence searching for an XML metadata should be as easy as querying a database. According to such believe, many organizations developed various searching engines for the XML databases of documents(e.g. Amberfish, IXIASOFT, Infonyte Query, XML Query Engine, Tamino, MLE, Ultraseek, SIM, X-Hive, Xdirect, Xset, fxgrep, Xtenint, and Lore).

As a "database" format, XML has some advantages. For example, it is self-describing (the markup describes the structure and type names of the data, although not the semantics), it is portable (Unicode), and it can describe data in tree or graph structures. It also has some disadvantages. For example, it is verbose and access to the data is slow due to parsing and text conversion. Actually an XML document is a database only in the strictest sense of the term.

On the plus side, XML technology provides many of the things found in databases: storage, query languages, programming interfaces, and so on. On the minus side, it lacks many of the things found in real databases: efficient storage, indexes, security, transactions and data integrity, collaborative access, triggers, queries across multiple documents, and so on. For this purpose, many surrounding technologies have been developed for treating XML documents as a database management system DBMS (e.g. DTD, XML schema, XQuery, XPath, XQL, XML-QL, QUILT).

However, we don't think that XML technology will solve "the search problem" alone at any time soon, although in the long run, XML will provide many of the benefits of database searching while still retaining the simplicity of plain text searching (FIAIDHI, MOHAMMED, and YANG, 2004). There are many programming and standardization issues involved and need to be addressed first. We are listing some of such issues that affect searching and browsing learning objects and their metadata:

XML Search Requires Collaborative Ontology: The roadmap to build the future *Semantic Web* is built around the universal XML communication model. The semantic web represents technologies for enabling machines to make more sense of the Web, with the result of making the Web more useful for humans. The hope is that the semantic web can alleviate some of the problems with the current web, and let computers process the interchanged data in a more intelligent way. In an open system like the Internet, which is a network of heterogeneous and distributed information systems (IS), mechanisms have to be developed in order to enable systems to share information and cooperate. This is commonly referred to as the problem of interoperability.

The essential requirement for the semantic web is interoperability of IS. If machines want to take advantage of the web resources, they must be able to access and use them. Ontology is a key factor for enabling interoperability in the semantic web (Berners-Lee, Hendler, Lassila, 2001). An ontology is an explicit specification of a conceptualization (Uschold, and Gruninger*,* 1996). It includes an explicit description of the assumptions regarding both the domain structure and the terms used = to describe the domain. Ontologies are central to the semantic web because they allow applications to agree on the terms that they use when communicating. Shared ontologies and ontology extension allow a certain degree of interoperability between IS in different organizations and domains. However there are often cases where there are multiple ways to model the same information and the problem of anomalies in interpreting similar models leads to a greater complexity of the semantic interoperability problem. In an open environment, ontologies are developed and maintained independently of each other in a distributed environment. Therefore two systems may use different ontologies to represent their view of the domain.

Differences in ontologies are referred to as ontology mismatch (Klein, 2001). The problem of ontology mismatch arises because a universe of discourse, UoD, can be specified in many different ways, using different modeling formalisms. In such a situation, interoperability between systems is based on the reconciliation of their heterogeneous views. How to tackle ontology mismatch is still a question under intensive research. A solution to the ontology mismatch problem should yield a collaborative ontology.

XML Search Requires Query Relaxation: As the Web becomes a major means of disseminating and sharing information and as the amount of XML data increases substantially, there are increased needs to manage and query such XML data in a novel yet efficient way. Unlike relational databases where the schema is relatively small and fixed, XML model allows missing structures and values, which make it difficult for users to ask questions precisely and completely. To address such problems techniques like *query relaxation (*Gaaster, 1997) can be used to enable systems to automatically weaken, when not satisfactory, the given user query to a less restricted form to permit approximate answers as well.

XML Search Requires Query Expansion: One of the strengths of XML is that it can be used to represent *structured data* (i.e., records) as well as *unstructured data* (i.e., text). For example, XML can be used in a hospital to represent (structured) information about patients (e.g., name, address, birth date) and (unstructured) observations from doctors. To take advantage of this strength, however, it is important to have tools and techniques that can work effectively with both kinds of data; it is in particular important to have XML query languages which *select* records from the structured part of an XML document and *search* for information in text. For instance, it should be possible to pose one query that finds all patients that are older than 45 years and have some specific symptoms. Hence, searching text-rich XML documents on the web or in a collaborative environment can be both rewarding and frustrating.

While valuable information can be found, typically many irrelevant XML documents are also retrieved and many relevant ones are missed. Terminology (e.g. tags, keywords) mismatches between the user's query and document contents are a main cause of retrieval failures. As a solution one can use query expansion *(Cai, Rijsbergen,* **2002)**. Expanding a user's query with related words can improve search performance, but finding and using related words is an open problem. One solution used for finding related terminologies is that each term is expanded to a disjunctive set of terms on the basis of term relationships pointed out by the collaborative ontology. If expansion to broader concepts is requested, only the immediate broader concepts are added, because that would probably expand the meaning of the query too far. If expansion to narrower concepts is requested, the terms are expanded to all immediate or indirect narrower terms. If associative expansion is requested, expansion is by one link in the association relationship. If expansion to instance terms is requested, the instance terms of all expanded concepts are included.

Currently the above problems have not been solved and there is no query language for XML which is fully standardized by WWW Consortium (W3C). However, there are several query languages for XML documents available from various vendors. For example *XQL*, *XML-QL* and *Quilt* (all accessible via http://www.w3c.org). For simplicity we recommend XQL to be the driving engine within our proposed Learning Objects and Metadata Browsing Engine (LOMBE). The reasons for choosing XQL can be summarized as follows: a) its grammar has already been standardized by W3C, and b) Application Programming Interfaces (API) for XQL are available in Java. It is important to note first, that XQL is used to query an individual XML page, and to return results from that page. It does not query *many* XML pages, and return combined results from them. In this direction, we are proposing the SAX API directly over a database, enabling XML tools to treat databases with a JDBC driver. That way, we can obviate the need of converting a database.

The proposed LOMBE can be viewed as integral search engine which generates/updates the collaborative learning objects metadata index by searching through the new learning objects created by each individual student/facilitator and also by using similar concepts suggested through the selected ontology similarity and merging algorithm. The LOMBE starts by allowing each student to enter the query using the traditional SQL format. The original query, then, will be reformulated using both query expansion and relaxation algorithms and the search will start by fetching the relevant concepts within the inverted index of the facilitator main LO database.

Also the LOMBE crawls through the repository of each individual student, and runs the XQL query off each LO which been referred by the collaborative index. At the end the LOS displays matched LO to the requester student. The LOMBE can upload the facilitator metadata and/or the collaborative metadata to the CanCore/eduSource registry for the wide use. Finally the LOMBE can be used to search and browse for external learning objects through the CanCore/edu registry panel. Figure 3 illustrates the architecture of such general collaborative XML search engine.

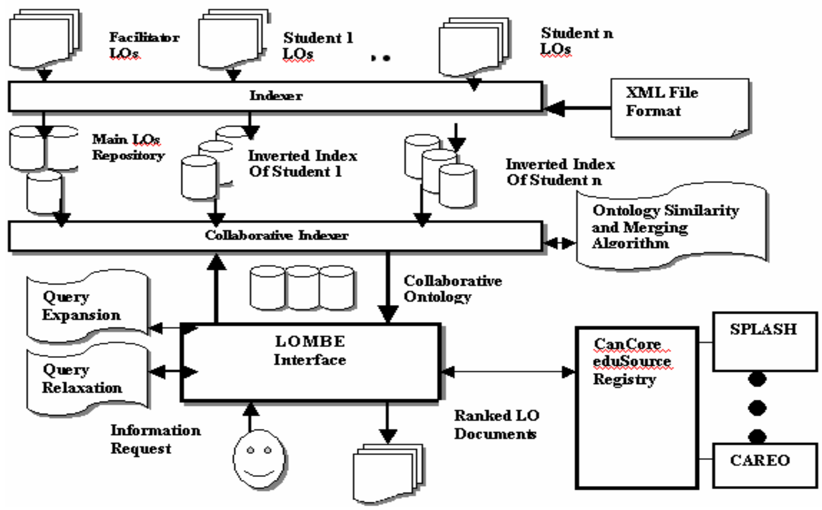

Figure 3: General structure of the LOMBE Searching and Browsing Engine.

The proposed components of the proposed Learning Objects Services modules can be summarized as follows:

The *Indexer* indexes and searches well-formed XML-based LOs, not necessarily be verified ones. This means that the system ignores DTD, even if it is provided.

Finite number of Java concepts, which we like to make searchable, must be identified well in advance to the indexing time. In addition and more importantly, the associations within LO's structure from tag-paths to search fields must be defined in a setting file called *XML File Format*.

The indexer first interprets the Format file, then creates a set of necessary files, such as an inverted index, for each defined tag and textual tokens.

The *collaborative indexer* retrieves all the inverted indexes outputted by the indexer and produces a collaborative ontology metadata index through the use of suitable *similarity and merging algorithm*.

The *LOMBE Interface* enables peers to formulate a query, acceptable by the query engine, from the user's information request. The interface tunes the query to the common interest of the peer's community via query expansion and also by using the collaborative ontologies as well as by finding the related tags via query relaxation. The interface searches both the facilitator and the collaborative repositories for matching learning objects. In case there is no direct searching outcome available within the collaborative environment, the search is put to the CanCore/eduSource registry to look for possible matching through the various available learning objects metadata repositories(e.g. SPLASH, CAREO, ALOHA). The output of the interface is a set of ranked LO documents. The interface also enables users to browse the Java course syllabus and click linkages to any learning object of interest.

Conclusions:

This article introduces some design principles needed to adopt and implements the notion of Learning Objects for teaching Java programming within a collaborative eLearning environment. It also shed the light on how to search for such learning objects at the collaborative environment and beyond.

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About the Authors

Jinan A. W. Fiaidhi is Associate Professor position of Computer Science at Lakehead University. She received her B.Sc. in Applied Statistics from AlMustansriyah University (1976), and her graduate degrees in Computer Science from Essex University (1983), and Ph.D. from Brunel University (1986). From 1986-1996, Dr. Fiaidhi was Assistant/Associate Professor of Computer Science at the University of Technology. In 1993 she became Chairperson. In 1996-1997 she was Associate Professor of Computer Science at Philadelphia University. In 1997 she was Associate Professor at Applied Science University and in 1999 became Full Professor. In 2000-2001 she was Professor of Computer Science at Sultan Qaboos University.

Dr. Fiaidhi co-authored four text books in Compilers, Artificial Intelligence, Java Programming and Applied Image Processing and published in 65 refereed publications. In 1997 and 1998 she chaired scientific committees international conferences on Computers and their Applications.

Dr. Fiaidhi's research interests include Learning Objects, XML Search Engine. Software Forensics, Java watermarking, and collaborative eLearning systems, Software Complexity. Dr. Fiaidhi is on the editorial boards of the International Journal of Computers and Information Sciences, Jordanian Journal of Applied Sciences, International Arab Journal of Information Technology, Asian Journal of information Technology, and Pakistan Journal of Information and Technology. Dr. Fiaidhi is a member of the British Computer Society, member of the ACM SIG Computer Science Education, Information Society Professional of the Canadian Information Processing Society and member of the International Forum of Educational Technology

She can be contacted at the Department of Computer Science, Lakehead University, Ontario P7B 5E1, Canada or by email at jinan.fiaidhi@lakeheadu.ca.

Sabah M.A. Mohammed is Associate Professor, Department of Computer Science, Lakehead University, Ontario P7B 5E1, CANADA. Dr. Mohammed received his B.Sc. in Applied Mathematics from Baghdad University in 1977, his MSc degrees in Computer Science from Glasgow University in 1981, and Ph.D. from Brunel University in 1986.

Since late 2001, Dr. Mohammed is an Associate Professor of Computer Science at Lakehead University. Formerly, from 1986-1995, Dr. Mohammed was an Assistant/Associate Professor of Computer Science at Baghdad University. In 1996-2001, he served as Chair of Computer Science at four different universities: Amman University (1995-1996), Philadelphia University (1996-1997), Applied Science University (1997-2000), and Higher College of Technology(2000-2001).

Dr. Mohammed has co-authored four text books in Compilers, Artificial Intelligence, Java Programming and Applied Image Processing, published over 70 refereed publications, was the MSc advisor for 14 students and 1 PhD student, and has received research support from a variety of governmental and industrial organizations. Dr. Mohammed has consulted for a variety of organizations. Dr. Mohammed organized two international conferences on Computers and their Applications during 1997 (Philadelphia University) and 1998 (Applied Science University) as well as a Regional Symposium on eEducation during 2001 (Higher College of Technology).

Dr. Mohammed's research interests include image processing, artificial intelligence and fuzzy logic. Dr. Mohammed is also on the editorial boards of the Jordanian Journal of Applied Sciences, Pakistan Journal of Information and Technology, International Arab Journal of Information Technology and the Asian Journal of Information Technology. Dr. Mohammed is a member of the British Computer Society, voting member of the ACM, and Member of IEE.

Contact him at: sabah.mohammed@lakeheadu.ca, Tel: 1 807 343-8777 Fax: 1 807 343-8023

Editor's Note: Evaluation can server a variety of purposes. Evaluation of instruction allows comparison of methods against a benchmark, in this case distance learning compared to traditional instruction. It also provides valuable data for improvement of the teaching-learning process.

EVALUATING DISTANCE EDUCATION

Comparison of Student Ratings of Instruction in Distance Education and Traditional Courses

Claudia Flowers, LuAnn Jordan, Robert Algozzine, Fred Spooner, Ashlee Fisher

Abstract

The fundamental concept of distance education is simple enough: Students and teachers are separated by distance and sometime by time. From correspondence and independent study to computer networks and multimedia distribution, learning away from the traditional classroom has evolved to the extent that almost every university or college in the United States participates in it in some way. Research illustrates that learning at a distance is effective when measured by student achievement and attitudes. In this study, we added to that literature by evaluating differences in student perceptions of course and instructor effectiveness in distance education and traditional courses.

The type of distance education examined was two-way interactive TV. Three different modes of course delivery were studied: (1) distance education off-campus, (2) distance education on-campus, and (3) traditional on-campus. Eight instructors taught a course using each method of delivery. On-campus students in traditional courses perceived the course and the instructor as being more effective than their off-campus peers in distance education courses. The magnitude of difference between the means was significant and large. The results are discussed with regard to their implications for new and ongoing distance education programs.

Comparison of Student Ratings of Instruction in Distance Education and Traditional Courses

The term "distance learning" describes any instructional arrangement where the teacher and learner are geographically separated (Moore & Thompson 1997). Distance learning, sometimes described as distance education (DE), home study, correspondence study, independent study, or external studies, has been an alternative method for delivering university-level courses for almost 300 years. Correspondence education was invented in the late 19th century to enable learners to receive instruction when they could not attend traditional classes (Moore & Thompson 1997). Today, the more popular term for this type of learning at a distance is distance education or "…planned learning that normally occurs in a different place from teaching and as a result requires special techniques of course design, special instructional techniques, special methods of communication by electronic and other technology, as well as special organizational and administrative arrangements" (Moore & Kearsley, 1996, p. 2). From correspondence and independent study to computer networks and multimedia distribution, learning away from the traditional classroom has evolved to the extent that large numbers of universities and colleges in the United States are involved in it in some way. For example, according to data compiled by the

National Center on Education Statistics (1997), 79 percent of public four-year institutions and 72 percent of public two-year institutions offered distance-education courses; further, more than 1,600 institutions offered a total of about 54,000 online-education courses with 1.6 million students enrolled. The widespread availability of high-speed Internet services has brought modern, electronic forms of distance education to new high levels of interest and use (Carnevale, 2000).

Keegan (1988) suggests that there are six defining characteristics of learning at a distance. First, there is separation of the teacher and the student (i.e., separation vs. face-to-face in the same classroom). Next, there is a component not typically found in most on-campus courses, the influence of an educational organization (e.g., department or college) in the planning, preparation or delivery of material (vs. a stand alone instructor responsible for content generation and delivery of course information). Third, there is the use of technical media. Historically, this technical media has been print, but as technology advances, electronic media (computers, TV studio delivery, computer software presentation packages) will be added to a list of technical options. The fourth defining characteristic is the provision for two-way communication. This could be via a telephone conference with a single student, or a group of students at a central location at a prescribed time. Another defining characteristic is the possibility of an occasional seminar. This would be the opportunity for students working independently, to assemble as a group in the presence of the instructor. The last defining characteristic as illustrated by Keegan is participation of the most industrialized form of education. Simply said, the industrialized form of education means a division of labor.

Moore and Kearsley (1996) describe the components of a general systems model for distance education. There must be sources of knowledge or skills that will be taught, systematic design of instructional experiences, at least one form of alternative instructional delivery (e.g., print, audio recordings, television, videoconferencing, computer networks), instructors who interact with students to facilitate the learning process, and alternative learning environments (e.g., homes, centers, workplaces). Typically, a team of individuals would be involved in the preparation and delivery of course content. Members of the team might include a content expert (e.g., a faculty member in elementary education, for a course offered from that program), graphic illustrators, who for all practical purposes, have no knowledge of the content, but take the content and bring it to life with related illustrations, and a “TV personality,” an individual trained to work in the presence of the camera and a TV or radio announcer’s voice to deliver the content.

Although distance education has been seen as promising by some, in the eyes of others it has been seen as something less than education typically received on a university or college campus: “They are the stepchildren of college courses, good for community relations but not considered part of mainstream higher education” (Turner, 1989). In evaluations of various types of distance education, comfort and convenience were repeatedly cited as positive elements of the distance experience (Moore & Thompson 1997). Essentially, students in these studies like the ease of taking distance education courses, but if given the choice to be in the same room with the instructor, most students will choose the personal contact.

Although a comprehensive historical review of technology research in special education (Woodward & Reith 1997) did not mention distance learning, researchers have examined the effectiveness of distance education. For example, Moore and Thompson (1997) reviewed research on learning outcomes and attitudes for students in participating in distance education experiences in higher education. The studies included in their review reflected no significant differences in cognitive factors (amount of learning, academic performance, achievement, and exam and assignment grades) between the distance classes and traditional classes. Other factors (e.g., student satisfaction with the course, comfort, convenience, communication with instructor, interaction and collaboration between students, independence, and perceptions of effectiveness) had more mixed results. In the majority of the studies where interaction was studied, the distance condition seemed to negatively affect opportunities for interaction between students and with the instructor. In contrast, distance condition was found to positively affect collaboration and interdependence among students, in addition to support for independent learning activities. Earlier, Moore and Kearsley (1996, p. 65) reached the following conclusions with regard to research on the effectiveness of distance education courses:

> *[T]here is insufficient evidence to support the idea that classroom instruction is the optimum delivery method; (2) instruction at a distance can be as effective in bringing about learning as classroom instruction; (3) the absence of face-to-face contact is not in itself detrimental to the learning process; and (4) what makes any course good or poor is a consequence of how well it is designed, delivered, and conducted, not whether the students are face-to-face or at a distance.*

Do students believe distance education is better or worse than traditional classroom instruction? Neither, according to Thomas L. Russell, who tracks studies of distance education methods, since "most studies show no difference in the effectiveness of the two media" (Young, 2000, p. A55). Additional support for the "no difference phenomenon" in higher education was provided by Spooner, Jordan, Algozzine, and Spooner (1999) who compared student ratings in two special education courses in a masters-level curriculum sequence for students in the area of severe disabilities when each was offered on campus and off campus. Additionally, student ratings were compared when distance classes via two-way interactive TV were taught at local and remote facilities. Student evaluations suggested no differences for overall course means. Organizational ratings were similar for a methods course taught on campus and at a distance, but were different for a curriculum course. When outcome measures for on-campus students vs. off-campus students were examined no differences were found in the overall ratings. Ratings for course, instructor, and communication were similar across settings and courses. Ratings for organization were similar for a curriculum course taught on campus, but were different for a methods course.

This research was completed to evaluate the effectiveness of a university distance education graduate program in special education in learning disabilities in terms students' evaluations of teaching rather than how much they learned. We empirically compared students' perceptions of (a) course effectiveness, (b) instructor effectiveness, and (c) overall effectiveness of the instruction in distance education (DE) courses, both off- and on-campus locations, and traditional on-campus courses.

Method

A quasi-experimental program evaluation was conducted to examine differences between DE courses, both off- and on-campus, and traditional on-campus courses. The independent variable was mode of course delivery – DE off-campus, DE on-campus, and traditional on-campus. To control for the effects of instructor and course topic, the same instructor and same class were taught under all 3 conditions; that is, each instructor taught the same course under the DE off-campus, DE on-campus, and traditional on-campus conditions. Students self selected into the type of class they would attend. A questionnaire was administered to students at the end of the course to evaluate their perception concerning course effectiveness, instructor effectiveness, and overall effectiveness of instruction. The instructor was not present when the questionnaires were administered and all responses were anonymous.

Participants

All participants were graduate students enrolled at a large university in the southeast United States. Most students were white (89%) females (91%) and worked full-time (83%). All participants were enrolled in required courses as part of a graduate program in special education.

Intervention

This study examined three modes of course delivery – DE off-campus, DE on-campus, and traditional on-campus. All the DE courses were delivered using a two-way interactive TV that allowed for real-time interaction between the instructor and students. The only difference between the DE off-campus and DE on-campus was the setting in which the instructor presented the content of the course. Typically the instructor taught the class from the on-campus location. Students in the DE off-campus viewed the lesson from the two-way interactive TV screen. Students enrolled in DE off-campus classes met in a community college classroom fully equipped with video and audio communication equipment. The traditional on-campus classes were taught with the instructor and students in the same classroom.

Instrumentation

The questionnaire consisted of 23 items that examined course effectiveness (e.g., This course had clearly stated objectives), instructor effectiveness (e.g., Instructor was able to simplify difficult materials), and overall satisfaction with the course. Each item was answered on a 5-point scale ranging from *strongly disagree* (1) to *strongly agree* (5). The questionnaire consisted of three domains, (1) course effectiveness (items 1-11), (2) instructor effectiveness (items 12-18), and (3) overall course effectiveness (items 19-23). The domain scores were calculated by averaging all the items within the domain with scores ranging from 1 to 5. Coefficient alpha internal consistency reliability estimates were 0.98 for all 23 items, 0.95 for the scale that evaluated the course effectiveness (items 1 to 11), 0.95 for the scale that evaluated the instructor's effectiveness (items 12 to 18), and 0.94 for the overall course evaluation (items 19-23).

Results

Eight instructors teaching eight different courses that were required in a graduate degree program were examined in this study. A total of 261 DE off-campus, 106 DE on-campus, and 176 traditional on-campus students completed and returned the questionnaires. Student results were aggregated to the class level and used in the analyses; that is, the mean class scores were used in the analyses.

A series of repeated measures ANOVAs was conducted with one within factor (i.e., mode of course delivery) to determine differences between the three modes of instruction. The means, standard deviations, F-values, and effect sizes (*partial* η^2) for each domain (course effectiveness, instructor effectiveness, and overall course effectiveness) are reported in Table 1. The means for the DE off-campus were lower than those of the on-campus courses in all the domains. The DE on-campus courses had lower means than the traditional on-campus courses. In addition, there was greater variability in scores for the DE off-campus courses.

TABLE 1

Descriptive Statistics, Repeated Measures ANOVAs, and Effect Sizes for the Three Domains

	Distance Education				***Traditional***			
	Off-Campus		***On-Campus***		***On-Campus***			
Domain	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*	η^2
Course Effectiveness Rating	4.13	.50	4.36	.33	4.56	.15	5.61*	.33
Instructor Rating	4.13	.59	4.47	.30	4.63	.20	4.77*	.40
Overall Course Rating	3.85	.69	4.28	.39	4.43	.29	4.79*	.41

* $p<.05$

There was a statistically significant difference between the mode of course delivery for all three domains. The mode of course delivery accounted for a large part of the explained variance *(η^2)*, ranging from .33 to .41. Follow-up analysis (dependent *t*-tests) indicated that there were statistically significant differences between the DE off-campus courses and the traditional on-campus courses for course effectiveness (t=3.00, p<.05), instructor effectiveness (t=3.03, p<.05), and overall effectiveness (t=3.38, p<.05); large effect sizes (Hedges, 1981) were found for (a) course effectiveness (g=1.16), (b) instructor rating (g=1.14), and (c) overall course effectiveness (g=1.10). There were no statistically significant differences between the DE off-campus courses and the DE on-campus. In addition, there were no differences detected between the DE on-campus and traditional on-campus domain scores.

To better understand the differences between the method of delivery, responses to each of the 23 items on the course evaluation questionnaire were examined. Comparing the 11 course rating items (see Table 2), there were statistically significant differences for items 3, 4, 5, 8, and 9. Follow-up analyses indicated that the mean differences were between the DE off-campus and the traditional on-campus courses. The magnitude of differences between the means was large, ranging from .97 to 1.34. There were no differences between the DE off-campus and DE on-campus or the DE on-campus and the traditional on-campus course means. Examining the 7 instructor effectiveness items (Table 3), there were statistically significant differences for all items except item 13. Follow-up analyses indicated that the differences were between the DE off-campus and the traditional on-campus courses. The magnitudes of differences for all items were large, ranging from .83 to 1.42. Examining the overall course effectiveness items (Table 4), there were statistically significant differences for all 5 items. Again, follow-up analyses indicated that the differences were between the DE off-campus and the traditional on-campus courses. The differences were large, ranging from .83 to 1.20.

TABLE 2

Descriptive Statistics, Repeated Measures ANOVAs, and Effect Sizes for Course Ratings

Item	Distance Education Off-Campus M	SD	Distance Education On-Campus M	SD	Traditional On-Campus M	SD	F	Partial η^2
1. This course had clearly stated objectives.	4.34	.52	4.54	.24	4.68	.11	2.02	.22
2. The stated goals of this course were consistently pursued.	4.25	.45	4.41	.31	4.60	.15	2.92	.30
3. I always felt challenged and motivated to learn.	3.90	.60	4.32	.39	4.49	.16	4.37*	.38
4. The class meetings helped me see other points of view.	4.15	.40	4.37	.37	4.56	.27	4.12*	.37
5. This course built understanding of concepts and principles.	4.17	.51	4.45	.32	4.62	.17	4.20*	.38
6. The practical application of subject matter was apparent.	4.13	.62	4.43	.43	4.60	.22	2.46	.26
7. The climate of this class was conductive to learning.	4.12	.59	4.15	.39	4.55	.22	2.71	.28
8. When I had a question/comment I knew it would be respected.	4.20	.59	4.62	.24	4.69	.13	4.48*	.39
9. This course contributes significantly to my professional growth.	4.00	.58	4.27	.44	4.53	.15	3.93*	.36
10. Assignments were of definite instructional value.	4.08	.52	4.26	.44	4.54	.16	3.03	.30
11. Assigned readings significantly contributed to this course.	4.03	.45	4.20	.47	4.34	.25	1.32	.16

* p<.05

TABLE 3

Descriptive Statistics, Repeated Measures ANOVAs, and Effect Sizes for Instructor Ratings

	Distance Education				Traditional			
	Off-Campus		On-Campus		On-Campus			Partial
Item	M	SD	M	SD	M	SD	F	η^2
12. Instructor displayed clear understanding of course topics.	4.45	.49	4.75	.26	4.76	.19	3.73*	.35
13. Instructor was able to simplify difficulty materials.	4.06	.72	4.44	.42	4.59	.29	3.00	.30
14. Instructor seemed well-prepared for class.	4.33	.58	4.63	.36	4.69	.19	4.57*	.39
15. Instructor stimulated interest in the course.	4.09	.66	4.46	.38	4.59	.30	5.16*	.42
16. Instructor helped me apply theory to solve problems.	3.95	.56	4.36	.39	4.52	.24	4.77*	.41
17. Instructor evaluated often and provided help when needed.	4.02	.60	4.31	.37	4.65	.18	5.29*	.43
18. Instructor adjusted to fit individual abilities and interests.	4.04	.62	4.36	.32	4.58	.26	4.28*	.38

* $p<.05$

TABLE 4

Descriptive Statistics, Repeated Measures ANOVAs, and Effect Sizes for Overall Course Ratings

	Distance Education				Traditional			
	Off-Campus		On-Campus		On-Campus			Partial
Item	M	SD	M	SD	M	SD	F	η^2
19. Instructor had an effective presentation style.	4.06	.66	4.50	.35	4.54	.33	5.07*	.42
20. Instructional methods used in this course were effective.	3.97	.65	4.34	.39	4.52	.28	3.96*	.36
21. Evaluation methods were fair and effective.	4.09	.56	4.50	.26	4.56	.25	4.22*	.38
22. This course is among the best I have ever taken.	3.40	.81	3.79	.64	4.18	.43	4.61*	.40
23. This instructor is among the best teachers I have known.	3.70	.80	4.25	.47	4.36	.30	5.14*	.42

$p<.05$

Discussion and Conclusions

Comfort and convenience have been repeatedly cited as positive elements of the distance condition. Additionally, students have reported that the more experience that they have had with distance education technology and conditions, the more comfortable they have become with the course and mode of interaction (Jones 1992). Moore and Kearsley (1996) identified the following “variables that determine the effectiveness of distance education courses:”

- Number of students at learning site (individuals, small groups, large groups)
- Length of class/course (hours, days, weeks, months)
- Reasons for student taking class/course (required, personal development, certification)
- Prior educational background of student (especially experience with self-study or distance education)

- Nature of instructional strategies used (lecture, discussion/debate, problem-solving activities)
- Kind of learning involved (concepts, skills, attitudes)
- Type of pacing (student determined, teacher defined, completion dates)
- Amount and type of interaction/learner feedback provided
- Role of tutors/site facilitators (low to high course involvement)
- Preparation and experience of instructors and administrators (minimal to extensive)
- Extent of learner support provided (minimal to extensive). (p. 76)

Spooner, Spooner, Algozzine, and Jordan (1998) assert that learning, attending classes, and obtaining information should be enhanced via distance learning.

In this research, on-campus students in a graduate preparation program for teachers of students with learning disabilities perceived their courses and instructors as being more effective than the off-campus DE students. Students in the off-campus sections consistently rated the course and instructor lower than both on-campus groups. The students in the DE off-campus courses reported (a) less challenge and motivation to learn, (b) lower opinions about the extent to which the class meetings helped them see other points of view, (c) lower opinions about the course building understanding of concepts and principles, (d) less feeling of respect, and (e) lower opinions of the contribution of the course to their professional growth. In addition, the DE off-campus students rated the instructor lower in (a) displaying clear understanding of topics, (b) being prepared for class, (c) stimulating interest in the course, (d) applying theory to solve problems, (e) evaluating often and providing help when needed, and (f) adjusting to fit individuals' abilities and interests.

This research addresses important concerns identified in recent reports questioning the effectiveness of distance education and arguing that much of the literature is not as useful as it could be because very little of it involves original research or is based on studies of questionable quality that render many of the findings inconclusive (cf. Blumenstyk & McCollum, 1999; Carnevale, 2000; The Institute for Higher Education, 1999). Further, the outcomes are different than the "no significant difference phenomenon" observed in many other studies of attitudes (Young, 2000, p. A55). Of course, there are a number of reasons why these program courses were viewed less favorably and each should be considered in future efforts to evaluate distance education programs. First, class sizes were different on and off campus and the characteristics of students enrolled in different sections of the same course might have influenced the outcomes. While this is difficult to control, it should be considered when comparing courses taught using different methods. The effect of vagaries of method is also a possible explanation for the findings. Organization, instructional strategies, and other methodological differences may have impacted a distance education course differently than an on-campus course. Similarly, placement of the course within the program (e.g., beginning *vs*. end) and its content (e.g., introduction *vs*. advanced, theory *vs*. methods) may create conditions to consider in evaluating instruction provided on and off campus. The novelty of taking courses at a distance should also be considered when evaluating programs (i.e., outcomes for earlier courses may be very different than those for courses taken later). Finally, the complex interaction of learner characteristics and learning style with instructional method and content should not be underestimated:

The primary assumption, which is flawed, is that the instructional effectiveness of each medium studied is constant across all content and all students. You're lumping all the students together, and you're ignoring their qualities and attributes as well as the qualities and attributes of the content. So by treating students, content, and instructional content as homogenous, we are ignoring some very important variables that we know for a fact do impact learning. (Barbara B. Lockee in interview with Dan Carnevale, February 21, 2001).

Faculty members and administrators at many universities and colleges remain skeptical about the quality and effectiveness of online research and teaching (Kiernan, 2000). Their skepticism, as well as other factors (e.g., time required for preparing and delivering distance education courses), can discourage young faculty members from embracing distance education. Institutions of higher education that base instructors' performance on student evaluations should be aware that teaching DE courses might present important issue to overcome. What can be done to address the potential hazards? Spooner, Algozzine, Flowers, Gretes, and Jordan (1998) suggest seven strategies that can be used to facilitate faculty/student interaction at a distance, so that the students at the remote sites believe that they are connected to their peers and the instructor in the studio classroom on campus. These techniques include: (a) establishing weekly agenda that goes beyond the syllabus, (b) facilitating a weekly student share to encourage class participation, (c) establishing off-line small group discussion with reporting, (d) tapping sites and individuals at remote sites for questions, (e) encouraging across site questioning by students, (f) traveling to remote sites for broadcast (each site one per semester), and (g) playing off of your local audience.

Other variables which will likely impact on the instructor's ability to reach students at remote sites, in addition to altering presentation style might be the overall size of the class. The instructor will likely have to work harder at making ALL students feel included as part of the group when the collective numbers approach 50, as opposed to as smaller number of students. A second important variable, and one that could potentially affect the evaluation outcomes is the number of times that the instructor delivers a course at a distance. The more practice the instructor has and the more times that s/he is "on the air" will also likely impact that individual's ability to be effective at reaching those students at remote sites. The type of presentation equipment (e.g., white board "on the fly" writing, or prepared overhead material, or material developed with electronic presentation software with appropriate images to illustrate content) that the instructor uses to deliver the content is another variable that could likely affect the outcome of student evaluation of instruction as well. Regardless of the approach taken to address potential problems and difficulties when teaching at a distance, there is a clear need for additional research evaluating implementations of improvement strategies and their effects in distance education courses.

Although the intended purpose of this research was to evaluate a distance education program, the results support the position that technology (or method) is only one factor that contributed to opinions about the quality of the course (cf. Carnevale, 2001). For example, although learning tasks and instructors were the same for the courses evaluated in this study, learner characteristics (e.g., motivation, experience) were potentially very different and, most certainly, contributed to the outcomes. Similarly, the results point to the value of a few good practices as supporting the art of good teaching. In 1996, the American Association of Higher Education (AAHE) proposed the following "Seven Principles for Good Practice in Undergraduate Education" to assist those using new communication and information technologies to improve teaching and learning processes (The Institute For Higher Education Policy, 1999, p. 32):

- encourage contact between students and faculty;
- develop reciprocity and cooperation among students;
- use active learning techniques;
- give prompt feedback;
- emphasize time-on-task;
- communicate high expectations; and
- respect diverse talents and ways of learning.

The principles have been included in a variety of publications on best practice and represent potential explanations for differences that result when distance education courses are compared to traditional on-campus courses (Carnevale, 2001; Chickering & Ehrmann, 1996). They also form the foundation for factors to be considered in future research focused on improving ways to teach students in higher education using distance as well as traditional methods.

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About the Authors

LuAnn Jordan (Ph. D., University of Florida) is an Assistant Professor in the Department of Counseling and Special Education at the University of North Carolina at Charlotte. Her current research interests include learning disabilities, attention deficit disorders, and improving distance education programs.

Claudia Flowers (Ph. D., Georgia State University) is an Associate Professor in the Department of Educational Leadership. Her current research interests include assessment issues, alternative assessment, applied statistics and technology in education.

Bob Algozzine (Ph. D., Penn State University) is a Professor in the Department of Educational Leadership and Co-Director of the Behavior and Reading Improvement Center at the University of North Carolina at Charlotte. His current research interests include school-wide discipline, effective teaching, block scheduling, self-determination, alternative assessment, and improving distance education programs.

Fred Spooner (Ph.D., University of Florida) is a Professor in the Department of Counseling, Special Education, and Child Development and Principal Investigator on a Personnel Preparation Project involving distance delivery technologies at the University of North Carolina at Charlotte. His research interests include instructional procedures for students with severe disabilities, alternate assessment, and improving distance education programs.

Ashlee Fisher (M.A., University of North Carolina at Charlotte) is a Mental Health Therapist at Expeditions Day treatment program. Her responsibilities include providing mental health services that target emotional and behavioral problems with adolescents and their families through individual, group, and family therapy.

Editor's Note: Distance learning requires feedback and interactivity to compensate for lack of face-to-face contact. This paper discusses student expectations, value of timely instructor feedback, instructional strategies, and ways to increase interaction through instructional design, peer-learning, and interactive multimedia.

Research Insights into Interactivity

Brent Muirhead

Introduction

Interactivity research studies involving online classes reveal that students value their opportunities to communicate with their peers and instructors. The author will briefly highlight student expectations for their online classes, discuss important findings from interaction studies and recommend several instructional ideas to enhance the quality of interaction in today's distance education classes.

Student Expectations

The literature on distance education reveals that students can experience problems which have a negative impact on their online education. Hara and Kling's (2000) study describes some of the frustrations that online graduate students have due to the absence of technical support and timely instructor feedback. In fact, distance educators are developing a new set of terms to describe the learning problems in virtual classes. The word *cyberia* refers to "a place to which online students feel they have been regulated when they receive no feedback from their instructor" (Jargon Monitor*,* 2000, p. A51).

Contemporary course designers, administrators and instructors must pay close attention to the learning needs of students. As Palloff & Pratt (2003) relate "what the virtual student wants and needs is very clear: communication and feedback, interactivity and a sense of community, and adequate direction and empowerment to carry out the tasks required for the course" (pp. 129-130). Today's online students need appropriate guidance for their assignments and relevant class discussions and activities. Instructors can diminish student motivation by assigning an excessive number of assignments and having numerous discussion questions in their weekly dialogs. Shearer (2003) observes that "while the students probably do not shy away from courses with extensive workloads, they do not want busy work to usurp the time they could be spending more productively on other tasks" (p. 13).

It should be recognized that distance education degree programs are not for all students. The author has observed that some students at the University of Phoenix (UOP) have related stories of being frustrated in their online classes. The students decided to switch to conventional face-to-face classes because they missed the physical presence of teachers and students. This naturally raises the question, what are the characteristics of a successful online student? The literature points to three key characteristics: good work ethic, ability to work collaboratively and the ability to think reflectively. Enrollment officials and administrators must work together to insure that they help prospective students assess whether they can effectively participate in online classes. Palloff & Pratt (2003) describe students who do not correctly assess their readiness "…they are not only minimizing their own chances for success but also limiting the ability of their classmates to get the greatest benefit from the course" (p. 7).

Student Interactions

Student-to-student interaction involves students communicating online with each other as individuals or as a group. In constructivist based learning, educators stress the value of learners interacting with other students by utilizing small group instructional activities that can enhance their skills in knowledge building and social cognition. This places a strong emphasis on collaborative and cooperative learning (Anderson, 2003).

Student-to-student interaction in group work fosters inter- and intra-peer collaboration.

Peer to peer learning is an interactive and dynamic process that involves learners in discourse, assessment, critique and value judgment as to the quality and standard of the work of their classmates. This process also involves providing feedback to their peers enabling them to enhance their academic performance (Juwah, 2003).

The instructional goals for small group activities can be used for a variety of learning objectives. Educators should utilize learning teams to foster community relationships, promote reflective thinking and enhance understanding of the subject matter (Palloff & Pratt, 2001). Contemporary educators often favor learning teams due to an assortment of learning benefits:

- encourages multiple perspective on issues
- facilitates higher developmental learning skills
- reduces learner uncertainty during complex activities
- increases learner participation in the educational process
- promotes cognitive processes such as verbalization (Harasim, 2003).

Harasim's (2003) model of conceptual change focused on collaboration as a key element in the mutual construction of knowledge by stressing three phases: idea generating, idea linking and intellectual convergence. Collaboration and discourse has played a vital role in making innovative contributions to new schools of thought and practice in the business and academic communities. Mark (2001) highlights the potential positive benefits to a social web:

- enhance social life through knowledge and mutual participation in new types of cultural and leisure activities
- encourage a shared community of knowledge that is international in scope
- provide opportunities to meet others who have similar interests, goals and needs which can foster.

Garrison & Anderson (2003) relates, "a problem with many forms of student to student interaction theory is that they nearly always assume that individuals share a content interest within a shared time space" (p. 44). Students will select certain distance education programs and institutions because they enjoy the freedom to pursue independent studies. Group discussions can be counter productive at times due to misinformation, group think mentality, dominating learners who undermine dialog and conflicts with individual learning styles. Hopper (2003) raises concerns that an excessive emphasis on consensus in learning teams can foster mediocrity and fail to affirm the creative contributions of independent thinkers. Hopper's graduate online group experiences were very frustrating. "I expected graduate work to put me in close contact with more learned minds, accomplished and respected in the discipline, who would challenge and guide me. I felt disappointed and frustrated to feel so often awash in the bland discourse of novices like myself" (p. 27).

Instructional Insights to Enhance Interactivity

Students have legitimate concerns about working in distance education classes such as isolationism and working with students who are less motivated about doing their assignments. Hannafin, Hill and Land (1997) believe that most students lack the substantial self-monitoring skills that are necessary for working in online classes. They suggested student academic success would need more academic support from their peers and teachers and empowerment through thoughtful interaction to acquire the necessary skills to work effectively in an open-ended setting.

Thurmond (2003) and Burge's (1994) studies affirmed the presence of specific peer behaviors that are essential for effective computer-mediated classes. The four major types of peer behavior are:

- **Participation**-share different perspectives demonstrate application of knowledge, risk sharing tentative ideas, and show interest in the educational experiences of other learners.
- **Response**-provide constructive feedback, respond to questions without being repetitive, be a dependable small group member, share positive remarks with others, and actively participate in relevant dialog.
- **Affective feedback**-use learner's names during course work, provide a sense of community or belonging to others, show patience, offer compliments, and encourage a learning atmosphere that is affirming and supporting.
- **Focused messaging**-use concise statements and avoid excessive messages that fail to contribute to group learning (Burge, 1994).

Online interaction has brought attention to the affective benefits found in distance education. Research studies on the affective dimension of learning indicate that it can have positive impact on academic achievement but it is area that needs more study (Brophy, 1999). Affective benefits represent important social and emotional aspects to the online experiences. Learners enjoy sharing personal stories that bring a human element to their classes where they can freely share their ideas and frustrations (Spitzer, 2001). In most online learning programs, learners are required to share a personal biography at the beginning of each class. The biographies provide an informational reference point for learners to share during the course. It helps learners create personal online identities which encourage more in-depth dialog (Muirhead, 2001).

Distance educators promote a philosophy of teaching and learning that integrates social interaction into a learner-centered environment. Teachers are encouraged to become facilitators who guide their students into instructional experiences that foster interaction with other learners. The online setting can create some communication anxiety among people who miss the social cues such as facial expressions. The act of posting comments in a class discussion forum involves a certain amount of personal risk. Students who send messages wonder how others will receive their written thoughts. Individuals who possess fewer cognitive and computer skills can feel even more anxious in their first online class. Seaton (1993) states that "students who are cognitively immature are not as likely to be active participants in CMC [Computer Mediated Communication] learning situations. They are likely to want faculty to provide the 'right answer' viewing knowledge not as critical thinking but as a collection of information" (p. 51).

Affective responses have a major impact on the quality of communication and interaction within an online class. Garrison & Anderson (2003) argues for classifying interactions under a broader category called social presence which includes three categories: affective, open communication and cohesive communication. What is social presence? According to Meyer (2002), it refers to "the degree to which a person is perceived as real in an on-line conversation" (p. 59). Therefore, social presence is part of a larger and complex set of interactions involving learner control and communication factors (Mortera-Gutierrez, 2002).

Student-teacher interaction is a multidimensional relationship that contains several variables such as the teacher's level of social presence, quality of feedback (i.e. accurate and timely) and intellectual depth of dialog (Berge, 2002, Gunawardena, 1995; Swan, 2001). As many learners may be new to distance and online education, teachers need to develop strategies that validate student's current academic development while helping them pursue their professional and personal goals. Teachers must create a class structure that stimulates social interaction and promotes independent learning skills (Jaffee, 1999). Obviously, the amount of teacher involvement varies from one educational context to the other because the learning process is a dynamic entity that transcends any exact formula. Collis (1998) believes communication patterns should be flexible for both students and teachers. Students should be able to ask the teacher questions when they have definite needs and expect a response in a reasonable amount of time.

Conclusion

A major challenge for today's online instructors involves creating a consistent level of interaction that fosters academic learning and cultivates a community atmosphere. This will require developing strategies that provide appropriate guidance and instruction for individuals and student groups. Roblyer & Wiencke (2003) note that "the more comfortable the students become with distance formats, the more likely they are to participate both spontaneously and when required" (p. 89). The literature affirms the importance of training new online instructors to equip them with the skills and professional knowledge to foster dynamic interaction in their classes (Muirhead 2002; Muirhead & Betz, 2002).

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About the Author

Brent Muirhead has a BA in social work, master's degrees in religious education, history, administration and e-learning and doctoral degrees in Education (D.Min. and Ph.D.).

Dr. Muirhead is the area chair for the MAED program in curriculum and technology for the University of Phoenix Online (UOP) and teaches a variety of master level courses. Also, he mentors faculty candidates in their graduate education programs. He is an Associate Editor for Educational Technology & Society and recently was a visiting research fellow to Robert Gordon University, Aberdeen, Scotland. He may be reached via email: bmuirhead@email.uophx.edu