

Digital Libraries in Education: Big Changes are Coming

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Abstract

This paper follows several large programs started abroad to clarify changes that can result from the development of Digital Libraries for Education (DLE) - such as NEEDS, IMS, SMETE, DLESE, SCHOLNET, CYCLADES. Intensive developments in DLE area will eventually lead to serious changes in educational environments, pedagogical methods, educator/learner communications, will lead to faster curricula acceptance, development and keeping up-to-date. These changes will lead to serious improvements of the learning efficiency and making life-long learning and learning anywhere and anytime a reality. The situation requires serious analysis by educators in Russia.

1. Introduction

Surprisingly, many areas of human activity traditionally remain unchanged or are changing slowly in the rapidly changing world. During many years education remained to be considered as traditionally conservative area. Now under the pressure of many trends situation becomes changing quickly. This paper follows several large programs started abroad to clarify changes that can result from the development of Digital Libraries for Education.

Now as never before the investment in lifestyle and money which individuals are willing to make in acquiring education and information increases [HESD00]. In such an environment, the market for high quality and innovative services for the personal acquisition of information expands. With an expanding market comes a corresponding competition for market share among suppliers. Any organization that undertakes an educational mission in the society is now and will increasingly be surrounded by alternative information service suppliers.

In this "competitive space," the role of the traditional library as the primary aggregator and purveyor of content to its community is less and less unique. Local collections and staff are no longer the only source for information services to serious learners and support for faculty in their research and teaching. Users (students) are beginning to perceive the library as something used at the end, or at best the middle, of their information search. This has important implications for the education programs, as well as for understanding library users behavior. Users want control of their own information environment. It is important to them to have some items owned for convenient personal consultation. The user's impression is that the information available free on the Web is the information that gets used. If students do need to ask a person for information help, they go to a friend or co-worker because that person already has an understanding of that person's context for either the problem or their level of understanding.

Another change in learning environments is that the quality of someone's teaching is no longer a personal matter or departmental matter. Faculty behavior in the classroom is brought out of the dimension of a personal contribution, to a service that is evaluated for its quality, just like other services.

University administrators start trying to assert university ownership over the development of courses designed to be offered over the web. There is great concern on many campuses about faculty being allowed to teach courses they have designed for online delivery (including other universities).

Important trends are characterized by the new requirements imposed on the knowledge industry in partnership with librarians and educators to provide adequate changes in information infrastructures and education methods to support learning as a *lifetime activity, learning anytime and anywhere*.

One of the natural responses to the above challenges consists in introducing the digital library for education (DLE) as a *learning environments and resources network* [SLRM01]:

- designed to meet the needs of learners, in both individual and collaborative settings;
- constructed to enable dynamic use of a broad array of materials for learning primarily in digital format;
- managed actively to promote reliable anytime, anywhere access to quality collections and services, available both within and without the network.

The paper compiles brief information on large programs in the DLE area that are being developed now in USA and Europe (such as NEEDS, IMS, SMETE, DLESE, SCHOLNET, CYCLADES). General DLE requirements are analyzed first.

2. Requirements for Digital Libraries in Education

Introducing Digital Libraries into the education process was well prepared by distance education [DELO00] that is being developed by years. With the Internet and the web distance education programs can mount sets of materials on web servers to support each course. One of the basic ideas [DELI97] is to join learning materials on various topics and written by many teachers in a *digital library of courseware*. Applying Digital Libraries in education has the potential to drastically change fundamental aspects of the classroom [WTSM99] in ways that could have an enormous impact on teaching and learning. New pedagogical methods should accompany DLE as an emerging technology for education to reach the compelling vision of the education expressed in [ACRA98]:

“Any individual can participate in on-line education programs regardless of geographic location, age, physical limitation, or personal schedule. Everyone can access repositories of educational materials, easily recalling past lessons, updating skills, or selecting from among different teaching methods in order to discover the most effective style for that individual. Educational programs can be customized to each individual’s needs, so that our information revolution reaches everyone and no one gets left behind”.

The digital library must not be seen as merely a digitised collection of information objects plus related management tools, but as an environment bringing together collections, services, and people to support the full cycle of creation, dissemination, use and preservation of data, information, and knowledge. A number of intermediate goals are formulated for Digital Libraries in Education (DLE) [SLRM01], among them:

1. Improve student performance
2. Get more students excited about science
3. Increase the quantity, quality and comprehensiveness of Internet-based science educational resources
4. Make these resources easy to discover and retrieve for students, parents, and teachers
5. Ensure that these resources are available over time

DLE is considered as a *federation of library services and collections* that function together to create a digital learning community. The range of supported materials includes curricula and courseware materials, lectures, lesson plans, computer programs, modeling and simulation, intelligent tutoring systems, access to remote scientific instruments, project-based learning, tools, the results of educational research, scientific research reported both formally in journals and informally in web sites, raw data for student activities, and multimedia image banks. DLE should provide services for authors and instructors such as annotation, evaluation, and peer review of donated materials. For students and faculty, it will offer the capability to search for desired information by subject area, to have access to scientific data sets, to interact with peers, to provide archiving, location-independent naming, recommender systems, selective dissemination of information, copyright management. Faculty, students, and other clients such as independent learners will be able to participate in forums. Interdisciplinary activities, lifelong learning, and the process of education will all benefit. In this way, the DLE will be much more than the sum of its parts, and will promote change and innovation in scientific and technical education at all levels.

3. Large programs for DLE development

National Engineering Education Delivery System Project (NEEDS)

NEEDS [NEEA99] is the distributed architecture developed by Synthesis: A National Engineering Education Coalition to enable *new pedagogical models* based on Internet-mediated learning environments. NEEDS catalogs courseware and other instructional software developed nationally and internationally to provide a resource where *both instructors and learners can search, access, and download* educational materials over the Web.

Materials indexed and searchable through NEEDS are diverse — content ranges from single topics that can be covered in a few minutes to fully integrated, term-long courses. One of the most powerful concepts supported by NEEDS is *courseware modularity*, in some cases NEEDS catalogs courseware as well as the individual elements (e.g., images, videos, and text) that comprise the courseware. Courseware elements provide a vehicle for continued re-use of content material beyond the lifespan of any particular courseware module. These elements can be used as is, or distilled from multiple sources and joined together to create new, customized courseware. The modularity supported within NEEDS is seen as a major enabling technology for fostering educational material adaptation and re-use. NEEDS solicits courseware from engineering educators via the website, conference and workshop presentations. Even limited to engineering education, the volume is enormous. NEEDS is developing a new vision of a digital library to serve the engineering education "community."

A National Digital Library for Science, Mathematics, Engineering, and Technology Education (NSDL)

To stimulate and sustain continual improvements in the quality of science, mathematics, engineering, and technology (SMET) education, the National Science Foundation (NSF) has launched the National Science,

Mathematics, Engineering, and Technology Education Digital Library (NSDL) program [SLRO00] The resulting digital library is intended to serve the needs of learners belonging to a broad user audience – K-12 to undergraduate, graduate, and life-long learning -- in both formal and informal settings. The NSDL program [SLRM01] is an unusual program for NSF in that its projects are engaged in building an enterprise much larger than the object of any one grant. The SMETE Library is not a research project, but it will be greatly strengthened by a parallel program of research [SLWSJ98]. The following areas for establishing guidelines are identified [SLWSJ98]: *Quality, Discovery, Customization, Interoperability, Ease of use, Reusability, Collaboration, Archiving and stability.*

The SMETE Library should be *sustainable, reflect current best practices regarding standards, and be a cost-effective mechanism* for enhancing quality education in science, mathematics, engineering and technology for undergraduates on the national scale (*reaching all students*) [SLWSJ98].

NSDL is considered as the aggregated capabilities of numerous, more specialized digital libraries, focused collections, and other digital resources, referred to as NSDL Member Libraries/Collections. A small but diverse collection of Collaborators have been chosen to serve as the initial Member Libraries/Collections:

- *The Digital Library for Earth System Education* – DLESE is a community-owned and governed digital library for Earth system science.
- *The Alexandria Digital Earth Project* – ADEPT is built on the research and development experiences with sophisticated spatial metadata and will provide services to support undergraduate education.
- *Windows to the Universe* – Windows is a K-12 interdisciplinary Web site uniting the Earth and space sciences with related arts and humanities content.
- *Unidata* – The Unidata Program is a community-based program that enables scientists and educators to acquire and use real-time data. Unidata brings to this project experience in very large real-time data flows, end-user tools for visualizing large data sets, and an established user base of nearly 200 university departments.
- *The National Engineering Education Delivery System* – The NEEDS project operates a digital library of courseware for engineering education.
- *Chemistry Education Digital Library Learning Environment* –this project seeks to build an innovative architecture of chemistry knowledge, with pilot collection for General Chemistry.
- *The National Engineering Education Delivery System* – The NEEDS project operates a digital library of courseware for engineering education.
- *Project Kaleidoscope* – PKAL is an informal national alliance of individuals, institutions, and organizations committed to strengthening undergraduate SMET education.

NSDL Services [SLMO98] are the key to serving the user community effectively. Some services will serve users directly; others will serve collections; and still others will serve other services.

The Digital Library for Earth System Education (DLESE)

DLESE has been conceived, and is being constructed, to meet these multiple needs in support of Earth system education [ESECOM]. DLESE can have a major impact in implementing the National Science Education Standards in the K-12 system; enhancing undergraduate science education for future scientists, future teachers, and all students; and increasing the resources available for all citizens and policy makers to learn about the Earth.

DLESE Goals are shortly expressed as follows [ESEREQ]:

1. Foster change toward discovery based earth system learning
2. Provide student friendly access to Earth data sets
3. Provide rapid access to effective teaching materials (reviewed, pedagogically effective, linking general to specific)
4. Provide a community center for discussing and working on geoscience education at all levels in all venues

DLESE will be a distributed network built as a community effort. Collections, services, and tools will be developed and maintained by numerous partners rather than being housed in a single centralized facility. Fundamental to the design and construction effort is a commitment to building a library that responds to the needs of the Earth system education community.

Scholnet and Cyclades: Extending the Role of Digital Libraries

Scholnet (IST-1000-20664) and Cyclades (IST-2000-25456) are two digital library projects funded by the EU 5th Framework Programme and coordinated scientifically by the IEI – CNR [SCCA01]. Both projects aim at extending the role of a digital library by providing services that support *remote communication and collaboration among*

scholars. In particular, the goal of Scholnet is to develop a digital library providing an enhanced set of specialised services, while Cyclades is focussed on the need to develop a service environment on top of large heterogeneous and multidisciplinary interoperable archives.

Instructional management systems project (IMS)

Designers and developers of online learning materials have an enormous variety of software tools at their disposal for creating learning resources. These tools range from simple presentation software packages to more complex authoring environments. Unfortunately, the wide variety of software tools available from a wide variety of vendors produce instructional materials that do not share a common mechanism for finding and using these resources.

In 1997, The IMS Project, part of the non-profit EDUCOM consortium (now EDUCAUSE) of U.S. institutions of higher education and their vendor partners established an effort to develop open, market-based standards for online learning, including specifications for learning content meta-data [LRBP11]. Also in 1997, groups within the National Institute for Standards and Technology (NIST) and the IEEE P.1484 study group (now the IEEE Learning Technology Standards Committee - LTSC) began similar efforts. These efforts lead to the current IEEE Learning Object Meta-data (LOM) base document [LOMN00] defining a set of metadata elements that can be used to describe learning resources. This standard specifies a conceptual data schema that defines the structure of a metadata instance for a learning object. For this standard, a learning object is defined as any entity, digital or non-digital, that may be used for learning, education or training.

Besides LOM, there is currently a variety of models for defining the nature and attributes of metadata entities ("elements"). One important model is the ISO 11179 set of standards for defining the attributes of data elements and the architecture of registries. Another is the somewhat simpler model being used by the Dublin Core Metadata Initiative in its prototype schema registry, which is based on RDF Schemas. Other terms are used in XML Schemas. An appropriate level of *harmonization between these various approaches* would help ensure a degree of interoperability as such initiatives deploy networked registries.

4. Summary

Intensive developments in DLE area will eventually lead to serious changes in educational environments, pedagogical methods, educator/learner communications, will lead to faster curricula acceptance, development and keeping up-to-date. These changes will lead to serious improvements of the learning efficiency and making life-long learning and learning anywhere and anytime a reality. The situation requires serious analysis by educators in Russia. Several scenarios of adequate development in Russia are possible. E.g., borrowing DLE technologies and providing own content, using own content and technologies, borrowing technologies and mixing own content with the courseware developed abroad. The last alternative looks most promising.

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