Growing a national learning environments and resources network for science, mathematics, engineering, and technology education

Current Issues and Opportunities for the NSDL Program

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The National Science Foundation’s (NSF) National Science, Mathematics, Engineering, and Technology Education Digital Library (NSDL) program seeks to create, develop, and sustain a national digital library supporting science, mathematics, engineering, and technology (SMET) education at all levels – preK-12, undergraduate, graduate, and life-long learning. The resulting virtual institution is expected to catalyze and support continual improvements in the quality of science, mathematics, engineering, and technology (SMET) education in both formal and informal settings. The vision for this program has been explored through a series of workshops over the past several years and documented in accompanying reports and monographs. These efforts have led to a characterization of the digital library as a learning environments and resources network for science, mathematics, engineering, and technology education, that is:

- 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; and
- managed actively to promote reliable anytime, anywhere access to quality collections and services, available both within and without the network.

Underlying the NSDL program are several working assumptions. First, while there is currently no lack of “great piles of content” on the Web, there is an urgent need for “piles of great content”. The difficulties in discovering and verifying the authority of appropriate Web-based material are certainly well known, yet there are many examples of learning resources of great promise available (particularly those exploiting the power of multiple media), with more added every day. The breadth and interconnectedness of the Web are simultaneously a great strength and shortcoming. Second, the “unit” or granularity of educational content can and will shrink, affording the opportunity for users to become creators and vice versa, as learning objects are reused, repackaged, and repurposed. To be sure, this scenario cannot take place without serious attention to intellectual property and digital rights management concerns. But new models and technologies are being explored (see a number of recent articles in the January issue of D-Lib Magazine). Third, there is a need for an “organizational infrastructure” that facilitates connections between distributed users and distributed content, as alluded to in the third bullet above. Finally, while much of the ongoing use of the library is envisioned to be “free” in the sense of the public good, there is an opportunity and a need to consider multiple alternative models of sustainability, particularly in the area of services offered by the digital library.

More details about the NSDL program including information about proposal deadlines and current awards may be found at <http://www.ehr.nsf.gov/ehr/due/programs/nsdl>.

"The network is the library"

In a library, be it digital or analog, the essential transaction is the same: a user interacts with content. But richer interaction is possible within the digital environment not only as more content is put within reach of the user, but also as more tools and services are put directly in the hands of the user. These include the ability to search, refer, validate, integrate, create, customize, publish, share, notify, and collaborate, to name but a few. Students, teachers, faculty, and those pursuing continuing education will "connect to learn"; but they will also "learn to connect", as they leverage their participation with other users of the library and its resources.

By networking users and content with tools the digital library enables three chains of support. First, users supported by profiles enable the formation of learning communities. These can be communities of one or they may be communities of thousands; and they may be short-lived communities born of immediate needs, or they may grow into persistent communities. However, an important concern to users supported by profiles enable the formation of learning communities. These can be communities of one or they may be communities of thousands; and they may be short-lived communities born of immediate needs, or they may grow into persistent communities. However, an important concern to...
immediate needs, or they may grow into persistent communities. However, an important concern to acknowledge is the potential loss of privacy, which must be balanced against the potential gain in personalization of a user's experience. A second chain of support closely related to the first is that content supported by metadata enables the formation of customizable collections of educational objects and learning material. These collections may target an individual or they may target a community; and they may learn and adapt to the behavior of their users. Finally, tools supported by common protocols or standards enable opportunity for the development of varied application services that enhance the value of the library's content for the learner. This latter area is a particularly interesting one to the NSDL program's Services track for proposals and bears on sustainability issues.

An organizational infrastructure

The NSDL program 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. Indeed, the success of the program rests squarely on the extent to which the many projects can embrace this collective sense of identity and mission. Towards that end, an initial grantees meeting was convened at NSF in late September 2000 for the purpose of introducing all projects to one another with an eye towards identifying potential areas of collaboration and partnership. The meeting was characterized by a great sense of passion and responsibility on the part of the attendees, and working groups self-organized around various topics and issues of joint concern. Threaded discussions continue at <http://www.smete.org/nsdl/forum>, and the broader SMET educational community is encouraged to join these.

But active coordination of the various resource collections and services comprising the national digital library for SMET education requires the support of an organizational infrastructure that is both proactive and responsive. This is the goal of the Core Integration track of the NSDL program (see http://www.nsf.gov/od/oiep/getpub/nsd0155). While there are certainly technical aspects to the development and implementation of such an integrating capacity, there are equally vital social aspects to how this coordination and management is to be accomplished. It is perhaps useful to liken the core integrating functionality to an "operational system" for the library network, analogous to the operating system for a computer. For example, issues of interoperability of components (collections and services) and coordination of protocols and standards across the user and provider base must be addressed. From this perspective the analogy permits examination of the vibrant open source software development movements such as Linux, the Free Software Foundation, Perl, Apache, and more recently Jabber, as models for self-organization and governance. The Nobel laureate Amo Peruzzas (formerly of Bell Labs) has observed that in the future, "There is going to be intelligence everywhere in the network, but there will be considerably more control at the edge." While this remark refers to the hardware network, it has applicability to the learning environments and resources network as well. Collections and services may have a high degree of operational autonomy, but their interoperability will have to be facilitated throughout by coordinated protocols and standards.

Sustainability

There are many arguments for the national digital library for SMET education to be a "national treasure" supported as a public good; indeed the frequent calls for open, free access to content are rooted in this view. An attractive scenario for the long-term management of the digital library is to place responsibility in the hands of a non-profit organization. In mind that one person's fees are another's taxes, here is a hypothetical calculation: approximately 4,000 institutions of higher education and 16,000 local K-12 school districts multiplied by an average contribution of $10,000/year would generate $200M annually in operating funds. Unfortunately, this begs the question of how creators will be compensated for their efforts. For contributions of "fine-grained" content (e.g., short applet tutorials or simulators) the digital library can offer recognition from peers which would be suitable and important "compensation". Digital rights management technologies also hold promise for identifying usage of and then appropriately providing compensation for content. This would allow the creators and purveyors of content to differentially price and/or repackage portions of "coarse-grained" material that has been disaggregated. (Some publishers have begun to offer custom runs of selected textbook chapters to professors - a practice somewhat analogous to that employed by the airlines, which long ago figured out that a filled seat is better than an empty seat.) Dyson and more recently Shapiro and Varian have observed that reconceptualizing information as a service rather than a good offers the opportunity for new revenue streams that can be directed back towards content creators. This view suggests interesting possibilities for the development of new services for users -- available, for example, individually or through affiliation with existing organizations such as professional societies. Degrees of access based on levels of service may also be viable. Sponsorship opportunities following the public broadcasting model are yet another possibility. While it remains a central premise of the NSDL program that there should be long-term support and open access to core components of the digital library, the program does encourage proposals which explore alternative (and multiple) models of sustainability. Ultimately, open and restricted access can co-exist (see relevant articles from the January issue of D-Lib Magazine).

Changing roles and future directions

The evolution of the NSDL program and development of the national digital library for SMET education are likely to produce several trends. First, the traditional roles and relationships to one another of faculty and librarians are changing on campuses. Faculty, as producers of scholarship that is increasingly "born digital", will need to develop awareness of, if not base level expertise in issues of library management; e.g., cataloging, metadata tagging, and preservation. Library staff are likely to find that their conversion to the campus of externally produced resources will be balanced by a need to convey to the external world the products of faculty efforts on campus. There may be similar implications for teachers and librarians in the preK-12 sector. If these trends do emerge, then they have important implications for graduate programs, which will provide the next generation of faculty and library and information specialists. Similar issues bear on the future of museums and other informal learning venues. Finally, two additional opportunities merit the attention of the NSDL program. One is in the area of international collaboration and the other is in the area of promoting collections and services development in content domains outside of science, mathematics, engineering, and technology education.
Notes

[Note 1] The views expressed in this article are entirely those of the author and do not reflect official NSF statements or positions.

[Note 2] Indeed, as users interact both synchronously and asynchronously with the same content, the digital library allows one to be loud!


[Note 4] It is unclear if these are appropriate figures, or even the right order of magnitude. But it is an issue that should be explored.

References


