

SUSTAINING THE NATIONAL SCIENCE DIGITAL LIBRARY

Introduction

This essay describes the challenges and opportunities to sustain a national digital library of science, technology, engineering and mathematics (STEM) education. Currently, this national science digital library (NSDL) is being supported by the National Science Foundation with vision that requires entrepreneurial innovations, diverse partnerships and meaningful applications that extend throughout our society. Inspired by creative input from the NSDL Sustainability Standing Committee (<http://sustain.comm.nsdl.org/>), objectives of this essay are to stimulate discussions and proactive solutions that facilitate the long-term implementation and evolution of a National Science Digital Library that will benefit future generations.

Digital technologies and our 'world information society' are awakening a renaissance in education. We are poised at an education threshold with creative opportunities to learn from information resources in directions that go far beyond those of any previous era. At the beginning of the 20th century, in an entire lifetime, many individuals would have learned less about events across the planet than we can gather any morning just by tuning into radio, television and the internet. Imagine the next quantum leap in learning with tools to immediately synthesize digital information that today would take a lifetime to assimilate.

Part of this future knowledge discovery involves digital libraries with distributed collections and services that foster inquiry as well as the integration of information based on individual objectives. STEM perspectives have always reached into the architecture of our civilization with impacts on art and culture as well as government and business. Building a digital library for STEM education is relevant to our children, decision-makers and each of us who must create integrated solutions to solve the complex economic, environmental and social issues that are emerging from global to local levels.

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How should STEM researchers, educators and administrators build, apply and sustain the NSDL over the long-term for the benefit and progress of society at global to local scales?

Sustainability of the NSDL involves four interacting and complementary elements: program, project, user-community and technical sustainability (Table 1). For the National Science Foundation and other agencies, recognition that exemplary projects need to be sustained beyond the period of federal support is not new.

On one hand, sustaining valuable projects is good business. There also is the reality of increasingly tight budgets and competition for limited government funding - as reflected by the statistics that inflation-adjusted federal support for STEM research and development has less than doubled since 1993 while the community of Ph.D.s in the United States has been growing by more than 25,000 each year during the same period (<http://www.nsf.gov/sbe/srs/stats.htm>). Consequently, it is necessary and timely to identify, implement and embrace strategies to support education and research in

non-traditional directions that go beyond government funding.

What legal, accounting and administrative procedures in the NSDL program have been or should be established to implement partnerships with corporations, other government agencies or universities in a responsible and timely manner?

As noted in the White House memorandum by John H. Marburger, III and Mitchell E. Daniels, Jr. (full text of the 5 June 2003 memorandum can be found on the Sustainability Standing Committee website, see above) - regarding [FY 2005 Interagency Research and Development Priorities](#), *"the Administration will favor investments in federal R&D that:*

- ♦ *strengthen science, mathematics, and engineering education by enhancing access and broad availability of excellent educational programs, establishing and encouraging best educational practices, and integrating research and education;*
- ♦ *promote collaborations among agencies, industry, academia and states to advance common S&T goals; and*
- ♦ *strengthen international partnerships that foster advancement of scientific frontiers and accelerate the progress of science across borders."*

Table 1: Sustainability Characteristics of the National Science Digital Library

SUSTAINABILITY ELEMENTS	SUSTAINABILITY CHARACTERISTICS
Program Sustainability	This sustainability element involves strategies to facilitate long-term collaborations among projects, users, sponsors, federal agencies and other stakeholders that share in the progress of the NSDL.
Project Sustainability	This sustainability element involves the public-private-university-government strategies to support the creation, maintenance and evolution of collections and services in the NSDL.
User-Community Sustainability	This sustainability element involves the networking, outreach and engagement strategies that are necessary to grow the community of users, members and sponsors who will support the NSDL into the future.
Technical Sustainability	This sustainability element involves coordination among technology developers and the overall program to develop the NSDL in a persistent, functional, and visionary manner.

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To "promote collaborations" for the NSDL program, in part, will require clear and compelling articulation of the benefits that can be shared among potential partners. For example - there are large corporations that have broad strategies to distribute their computer brands into kindergarten through university (K-16) classrooms on an international level. However, these computer corporations are challenged to bring creative content into educational environments. Conversely, NSDL is rich in creative content and services from educators, researchers and other experts. However, NSDL currently lacks broad branding and distribution into K-16 classrooms. Together, there may be an ideal marriage between NSDL and computer corporations that would increase the competitive advantages of the corporations while enhancing the outreach and application of the NSDL.

How should the revenues be allocated to best facilitate the ongoing development, maintenance and evolution of individual projects (collections and services) so that they can be sustained over the long-term as part of the NSDL program?

NSDL projects include digital collections and services that have practical value in diverse educational environments from K-16 outward to society. These projects currently are being seeded with federal funds, but their ongoing maintenance and evolution will require entrepreneurial activities that involve additional sources of revenue.

Such sources of revenue could involve licensing agreements for protected intellectual properties as well as e-commerce solutions that could be implemented over the internet. The NSDL program could facilitate these revenue-generating activities by providing the appropriate infrastructure, which could include:

- ♦ integrated access to information regarding the needs and requirements of the intended educational audiences (such as the current educational standards on national and state levels);
- ♦ enhanced networking and distributional opportunities for individual projects to be integrated into and advertised as part of a premier educational brand; or
- ♦ financial procedures for receiving, accounting for and budgeting funds collected over the internet.

What user-community assessment, outreach and engagement strategies will best promote the evolution of the NSDL in a sustainable manner?

The value of the NSDL program and all of its projects ultimately will be determined by the user-community. Currently, the NSDL program has the challenge of introducing the power and utility of its collections and services to a broad and diverse user community, which includes formal academic environments from K-16 as well as decision-makers and other individuals who have interdisciplinary needs for STEM information.

With emerging success in outreach and dissemination, it will become increasingly critical to retain these diverse users by soliciting and responding to their feedback - in effect, empowering users as vital contributors to the evolution of the NSDL. Among the types of information that could be collected on an ongoing basis, case studies that reveal model applications of the collections and services may be particularly fertile to facilitate the growth and sustainability of the NSDL user-community (as noted in the PKAL essay by John Moore see: http://www.pkal.org/template2.cfm?c_id=1373). Consequently, the user community and the NSDL must build innovative avenues to collaborate for their mutual benefit.

What are the strategies that will enable the NSDL to provide sustained leadership in developing and implementing visionary technologies that open doors for integrated access to information and user-defined knowledge discovery?

The NSDL program, along with its collections and services, must stay ahead of the technology curve to be sustainable. Such innovation is a huge challenge given the rapid rise and dynamic nature of information technologies that have been emerging over the last three decades.



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The NSDL has been referred to as 'one library with many portals.' This federated architecture provides flexibility to include outstanding collections and services without the overhead of storing all the information. The NSDL also facilitates interoperability with standardized metadata that reflect the contents of the collections and services, which then can be queried to generate lists of relevant information resources.

Complementing the challenges, there also are huge opportunities given our recent transition from a paper-driven information society into world connected by digital media with the internet effectively providing infinite and instantaneous information access. The promise of the future is convenience and control to integrate, analyze and discover knowledge from digital information based on user-defined criteria.

At the end of the day - to succeed, the NSDL must be sustainable and sustainability requires the generation of revenue to support the maintenance and evolution of this visionary education initiative.

The NSDL is more than a research experiment that will incrementally advance STEM education. The NSDL is an opportunity for the STEM community to create innovations that will lead into a new generation of education with digital tools that integrate natural and social sciences with global-local relevance.

As noted in the Marburger and Daniels memorandum (see above) - federal investments in research and development will be considered in terms of the programs':

- ◆ relevance;
- ◆ quality;
- ◆ performance; and,
- ◆ industry issues.

The National Science Foundation already applies review criteria to demonstrate societal relevance in terms of "broader impacts" as well as the "intellectual merit and quality of the proposed activity." However, federal investments are only part of the equation to sustain programs like the NSDL. Ultimately, to be sustainable, these exemplar programs need to leverage government support in directions that will bring in non-traditional sources of funding. As observed by the 2002 Nobel laureate in economics, Vernon L. Smith: in the Wall Street Journal on 19 August 2004:

Those who argue that the university should be a haven of intellectual purity uncontaminated by the world of practice are promoting a diminished and restricted climate for education. The vast majority of students have to find their way in the world of commerce, industry or government. Their most important lesson is to learn how to learn, and to be creatively useful in that world.

With the "spirit of inquiry" (as stated by Howard Burrows in his PKAL essay see: http://www.pkal.org/template2.cfm?c_id=1374) - the NSDL program with its collections and services is awakening a landscape change in interdisciplinary education. The value of the NSDL rests with the dreams and creativity of its researchers, teachers and other experts who are building collections and services for the long-term benefit of diverse user-communities. It is our collective challenge to identify strategies for sustaining the NSDL (Table 1) to realize our dreams for knowledge discovery as we journey into a new age rich with digital information. ■