



NSDL Technical Network Services 2010 Workplan

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NSDL Technical Network Services

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Overview

The NSDL Technical Network Services (TNS) team is responsible for operating NSDL infrastructure and NSDL.org; providing technical support for NSDL tools, services, and collections accessioning; supporting Pathways and other NSDL projects to contribute to NSDL; engaging the NSDL community in identifying priorities for services developments; and developing models for sustainability. TNS is also charged with assisting the STEM education community in deploying and evaluating NSDL technologies, services, and content in learning environments.

TNS is a collaborative effort led by PI, Carl Lagoze at Cornell University, co-PI Tamara Sumner at the University of Colorado at Boulder, and co-PI Michael Wright at the University Corporation for Atmospheric Research (UCAR). TNS also works closely with the NSDL Resource Center (RC) in carrying out shared goals.

Progress to Date

Since the inception of TNS in October 2008, the combined Cornell, UCAR, and University of Colorado team has made significant progress in several areas.

Establish new TNS organization. Although TNS is built on the technical legacy created by the NSDL Core Integration team, TNS is composed of entirely new senior management and includes new organizational partners. Over the past year, we have established new management processes, staffed the organization, developed shared strategic priorities with the NSDL Resource Center, and systematically analyzed the technical components and collections development processes created and maintained by the former NSDL Core Integration team.

Analyze existing infrastructure and processes. We completed a technical infrastructure audit and a collections audit. The technical audit produced a 100+ page document describing each hardware and software component being operated by NSDL at the start of the performance period. The collections audit described each collection being ingested into the NSDL Data Repository at the start of the same period. The results of these audits fed into our short-term project management and our long-term strategic planning. We also organized and conducted a two day, all-hands retreat involving TNS and Resource Center staff in November 2008. The purpose of this retreat was to review the results of the Technical Audit and to develop mechanisms for coordinating activities across the two groups. This latter activity informed the development of the TNS/RC Coordination Plan required by NSF and submitted in January 2009.

Strategic Planning and Sustainability Planning. Collaborating with the NSDL Resource Center, we have started the sustainability planning process and completed an initial round of joint strategic planning. The result of this round was an articulation of six shared goals to organize and coordinate the TNS and Resource Center efforts on behalf of NSDL. These goals were presented and discussed with NSF Program Officers at the reverse site visit on April 17th 2009. The six shared strategic goals are (1) Maintain and operate the technical infrastructure, (2) Mobilize the community, (3) Improve the NSDL.org user experience, (4) Support educational exemplars, (5) Evaluation, and (6) Extend strategic partnerships.

Completed NSF Reverse Site Visit. Collaborating with the Resource Center, we planned and conducted our first NSF reverse site visit on April 17th 2009. In a series of presentations, we reviewed lessons learned to date from NSDL, our progress for the first 6 months, our six shared strategic goals and plans for the coming year.

Maintain and operate the technical infrastructure (Strategic Goal 1). In addition to operating and maintaining NSDL.org and the underlying infrastructure, we focused our initial efforts on streamlining and simplifying the existing NSDL technical infrastructure. Our goal is to reduce the overall operating costs of the NSDL infrastructure while improving its maintainability and scalability. The technical audit identified inefficiencies in the existing hardware/software stack. We have started the process of decommissioning components that are either no longer used or are significantly underutilized. Examples of decommissioned components include GForge (no longer used), Shibboleth (underutilized), and 10 community wikis (no longer used). We have also installed new hardware at Cornell to support virtualization, a critical step towards reducing the overall number of servers that TNS needs to support while making hosting of community-developed services more efficient.

Mobilize the community (Strategic Goal 2). For TNS, this goal translates into establishing and ramping up an open source-style community engagement process. We have completed several activities in this area. First, we have packaged up, documented, and released EduPak 1.0¹, a bundling of key components of the NSDL technical infrastructure under a single open source license. These components – the collection system, discovery system, and data repository – provide the key capabilities necessary for creating cyberlearning applications using NSDL tools and collections.

Second, we established Roadmap priorities for 2009 based on discussions with NSDL partners and grantees that are guiding TNS core grant activities this year. We started the process to identify 2010 priorities and this process informs the objectives outlined later in this plan. Third, we have developed a preliminary training program to assist NSDL, CCLI, and other NSF grantees to use NSDL technical products. Portions of this training program are already underway, notably in the area of collections development where we have instituted monthly web-based training seminars. Fourth, we are providing technical support to several NSDL grantees who are using EduPak (as deployed at nsdl.org or locally) to construct and underpin their library and cyberlearning applications, including SMILE (the informal learning Pathway), MSP2 (the middle school Pathway), and the CCS (the Curriculum Customization Service with Denver Public Schools).

Third, we are currently soliciting community feedback on three documents outlining proposed TNS plans for 2010 and changes to the NSDL collections policy. Comments are formally being gathered at the NSDL 2009 Annual Meeting and through the NSDL Community Site through December 18, 2009. The two roadmaps below will remain posted for ongoing comments after that period:

- The EduPak Roadmap, available at <https://www.nsdlnetwork.org/edupak>, outlines plans to add a collections API to the NDR, and to add annotations to the data model.
- The Strand Map Service Roadmap, available at <https://www.nsdlnetwork.org/sms>, outlines a variety of possible changes and additions to both the Strand Map Service and the NSDL Science Literacy Maps, and to the “surrounding” services that help to connect NSDL content to the AAAS Benchmarks and Maps and to connect NSDL with end-users.
- The revised collection policy and resource quality criteria, available at <https://www.nsdlnetwork.org/collections-policy>, were developed by the NSDL Collection Taskforce, which is recommending these policy revisions to the Pathways who will approve them for review by the NSDL community at the Annual Meeting.

¹ <http://ncore.nsdlnetwork.org/index.php?menu=services&submenu=services!EduPak>

Improve the NSDL.org User Experience (Strategic Goal 3). Our efforts have focused on streamlining collections in the NSDL Data Repository that are made available through NSDL.org. The collections audit identified legacy collections that were no longer being maintained by their contributors and collections that do not conform to NSDL's current collections policies. We recommended that these collections be de-accessioned (removed) from the library and worked with the Resource Center and the Pathways to ensure this took place with minimal disruption to library partners and users. We completed an evaluation that indicates that the quality and relevance of the search results in NSDL.org will be significantly enhanced as a result of this collection streamlining activity. This evaluation protocol examines the interaction between collection scope and search behaviors from a user experience perspective. We created a suite of queries derived from our query logs; for each query in the suite, we analyzed the top ten search results to assess the target audience of each item, the resource type (e.g. journal article, image, teaching resource, etc.), and the metadata quality. This evaluation shows that the streamlined repository will be better aligned with NSDL.org's target users and will provide increased access to teaching and learning materials with higher quality item-level metadata. Using the previous repository, searches from our query suite were mainly returning journal articles and university research department pages targeted at graduate students and researchers; using the streamlined repository, results from the same searches are returning mostly teaching and learning resources aimed at high school and early undergraduate educators and students.

Support Educational Exemplars (Strategic Goal 4). To ensure that the evolving NSDL infrastructure meets the needs of application developers, we are collecting and analyzing use cases of cyberlearning applications. We organized and led a mini-technical summit where TNS staff and NSDL community members systematically analyzed use cases arising from several NSDL-funded applications. We focused this mini-summit on applications developed to support educators and students in formal K-12 classroom settings, specifically the NSDL Science Literacy Maps,² a tool for teachers and students to help them find resources that relate to specific science and math concepts, the Curriculum Customization Service being developed with Denver Public Schools, the Instructional Architect³ which is widely used and evaluated in teacher professional development, the Digital IdeaKeeper⁴ which is designed to support middle school students to engage in personal, inquiry-oriented research, and DLESE Teaching Boxes which provide classroom-ready, middle and high school Earth science curriculum composed from NSDL resources. In this workshop, we analyzed application features and capabilities, evaluation results on the applications' utility, and underlying data models. In a separate activity, we also analyzed services and tools being developed by the Pathways projects, such as the textbook table-of-content model⁵ pioneered by ChemEd DL for large introductory undergraduate courses, and the various approaches being used to support users to collect and manage personal resources (see Teachers' Domain and AMSER for examples).

² <http://strandmaps.nsdl.org/>

³ <http://ia.usu.edu/>

⁴ <http://hi-ce.org/digitalideakeeper/index.html>

⁵ http://wiki.chemeddl.org/index.php/Development:TToC_v._ChemEd_Content

Work Objectives for 2010

This work plan is organized around the six strategic goals articulated above and reflects input and feedback from numerous sources, including the Roadmap process involving discussions with Pathways and other NSDL grantees, experiences and lessons learned from working with grantees using EduPak, analyses of cyberlearning use cases, and discussions and feedback from NSF at our recent reverse site visit. This plan will continue to be informed and revised based on feedback from the NSDL community and NSF. In addition to the mini-summits described below, opportunities for feedback and discussion on this work plan include numerous formal and informal venues, such as a fall NSDL Brown Bag session (a monthly seminar series organized by the Resource Center) and sessions at the NSDL Annual Meeting. Additionally, we will have one-on-one discussions with newly funded NSDL projects to ensure that our activities are both leveraging and supporting these new ideas, talent, and energy.

The overarching goal of our work is to operate and support sustainable infrastructure and to develop and pilot next generation NSDL technical services that are tightly focused on increasing NSDL usage, demonstrating impact, and supporting cyberlearning. This work responds to requests from the NSDL community and NSF funders for library services that have a direct connection to learning activities, for which evaluation metrics are developed and learning outcomes documented. We will leverage and extend the successful efforts to date of the TNS team and the NSDL Resource Center to organize an active cyberlearning-focused community, to develop advanced infrastructure, and to accumulate quality collections of educational resources that facilitate the development of cyberlearning applications that have impact on STEM education.

Strategic Goal 1: Maintain and Operate the Technical Infrastructure

The primary work objectives to support core NSDL technical operations include:

- Operating, maintaining, and upgrading the NSDL “data center”; i.e., running the hardware and software stack underpinning NSDL.org and several community-led services
- Operating, maintaining, and upgrading NSDL.org in collaboration with the Resource Center
- Performing the technical activities of collections accessioning, harvesting and maintenance that are necessary for managing the NSDL Data Repository

TNS will continue to focus significant effort on streamlining, automating, and hardening the NSDL data center operations to continue to lower operating costs structure and to improve the reliability, maintainability, and scalability of the NSDL infrastructure, including the hardware/software stack underpinning NSDL.org and hosted community services.

These activities were initiated last year following the audit of TNS technical systems and were described at the April reverse site visit to NSF. Priority activities include:

- Streamlining infrastructure and NSDL.org operations as well as collections management and ingest to reach goals for sustainable levels of support.
- Completion of the conversion from Shibboleth to LDAP for user authentication and revamp of the login page design.
- Working with community-led service providers to harden service components

Strategic Goal 2: Mobilize the Community

TNS is responsible for engaging the NSDL and broader STEM education developer community in using and contributing to the NSDL cyberlearning platform. TNS also provides training opportunities, technical support and consulting. In 2009, we initiated a program of mini-summits as a way to incorporate NSDL developer input into our Roadmap planning and to ensure that the evolving NSDL infrastructure meets the needs of application developers. Through these mini-summits, we are collecting and analyzing use cases of cyberlearning applications. In 2010, we will continue these mini-summits as a part of the Roadmap planning process. TNS will convene and host web seminars and face-to-face mini-summits approximately twice a year to engage NSDL community members to develop education-specific technical requirements to guide our work and open source software development practices to contribute to this effort. Each summit will engage educational technology developers from the NSDL community on a focused topic integral to developing exemplar cyberlearning applications. Examples of potential topics for future mini-summits include personalization and collecting services, evaluation tools, data mining services, and end-user authoring tools. Participants will be asked to evaluate the summit process and subsequent progress towards collaborative improvement of TNS technical components.

In 2010, TNS will release a new version and improved documentation of EduPak to the NSDL and broader STEM community. We will also formulate plans for future releases as a part of the Roadmap process (described below). Initially we will focus on two Pathways which are currently key customers: SMILE (the informal learning Pathway), MSP2 (the middle school Pathway). Both are using EduPak to construct and underpin their library and cyberlearning applications. SMILE is using a local instance; MSP2 is using the components deployed at nsdl.org. We are also in discussions with several other NSDL grantees who are considering adopting EduPak.

We will continue to provide significant technical support and hosting services to NSDL grantees using EduPak and other NSDL infrastructure services, and we will continue to fold technical advances developed by grantees back into the NSDL infrastructure. For instance, improvements to the NSDL Collection System (NCS), which were collaboratively developed through our work with SMILE, have already been folded back into the NCS for general use. TNS Roadmaps, which are rough guides of present and future releases of TNS supported services for the NSDL community and the broader STEM education community, are based on formal and informal developer feedback.

Specific priorities for the coming year include:

- Connecting with each of the recently funded large projects. The primary goal is for us to listen and understand what these projects are trying to achieve, what they have in place, and to inform them about how we can work together.
- Developing schedules and topics for mini-summits
- Continuing to provide roadmaps about plans for public feedback on the NSDL Community site.
- Setting up collaborative tools and processes to enable community contributions to evolving Roadmap.
- Continuing to provide TNS updates at the monthly Pathways calls.
- Continuing regular collections development and NCS training.
- Developing and offering training for implementation and use of the SMS and DDS
- Working with RC to develop and offer training for NSF Rotators and other Program Officers.

Strategic Goal 3: Improve the NSDL.org User Experience

In collaboration with the RC and NSDL Pathways, we have engaged in refocusing NSDL collections to more closely align with NSDL's mission to support teaching and learning environments and to improve the user experience. We identified a significant number of collections for deaccessioning and to date have removed approximately 50 collections and approximately two million resources from the library.

We will continue to critically examine collection processes for further opportunities for automation and streamlining. We will work with the NSDL Collections Task Force to revise and update NSDL Collection policies to reflect changes in the NSDL organization, collection focus, and to harmonize with other policies such as Terms of Use and Privacy. We will also work with the Resource Center and Pathways to improve the quality and completeness of metadata characterizations of high utility for cyberlearning applications such as grade level and educational standards. To further improve collections and collections management processes, we will:

- Complete de-accessioning of collections no longer meeting collection scope and quality guidelines.
- Establish automated processes for collection assessment and reporting.
- Establish processes for basic vitality monitoring; i.e. link checking, to ensure resource availability.
- Streamline collections ingest and harvesting procedures.
- Create a demonstration using custom/native metadata in NDR for learning applications. The first trial of this capability has recently been successfully completed with the MSP2 Pathway.
- Complete work to allow NCS/DDS hosting and customization. SMILE and MSP2 Pathways provide first examples.

Strategic Goal 4: Support Educational Exemplars

The goal of this work objective is to develop and deploy educational exemplars in middle, high, and undergraduate classroom contexts. We will enhance a selected set of existing and in-development NSDL cyberlearning applications to support scalable deployment. In partnership with the Resource Center and other NSDL grantees, these cyberlearning applications will be deployed in mainstream educational settings. These applications will showcase high quality collections and services developed by NSDL Pathways and other grantees. In addition, we will extend the NSDL Data Repository (NDR) data model and NDR API to make constructing such cyberlearning applications simpler and more efficient as outlined in the EduPak roadmap. These capabilities and extensions will be folded back into EduPak for broader use by NSDL grantees and other developers, and to provide the foundation for future cyberlearning application deployment.

There are three tasks under this objective: enhancing existing NSDL-developed cyberlearning applications, extending the NSDL Data Repository (NDR) data model and API to make constructing such cyberlearning applications simpler and more efficient, and showcasing high quality collections developed by NSDL Pathways and other grantees.

Task 1: Enhance existing NSDL-developed cyberlearning applications. In a number of the cyberlearning use cases we have examined, there is a common theme of providing mechanisms for users to collect and manage personal collections of resources, and to share personal collections with a group. For instance, folders provided by Teachers' Domain enable teachers to save and organize resources. The Curriculum Customization Service extends this feature to enable teachers to also upload their supporting materials incorporating saved resources, such as lesson plans and presentations. The Instructional Architect allows

users to develop Projects which can be public, or shared with a group. Digital IdeaKeeper provides students with the means to manage a resource portfolio around a question of interest. NSDL community surveys conducted by Project 2061/AAAS in spring of this year documented significant community interest in extending the NSDL Science Literacy Maps (built on the Strand Map Service) to enable users to collect resources in the context of the maps and benchmarks.

As outlined in the Strand Map Service Roadmap, we are considering the possibility of enhancing and deploying components that could provide a personalization infrastructure for the core NSDL platform. We would build on the personalization capabilities already developed by NSDL projects and enhance these capabilities to support the broader needs emerging from our use case analysis. The initial phase would yield a personal portfolio service allowing users to collect references to library resources, add their own notes/tags/ratings, and share these with other users. This portfolio service would be deployed and evaluated in the NSDL Science Literacy Maps. This application is a logical choice for our first deployment case since several strategic partners (Georgia University System and the Departments of Education in Georgia, Massachusetts, and Indiana) are particularly interested in utilizing the Literacy Maps with their state standards. User profiles would be managed in the NSDL account management system (currently being changed from Shibboleth to an LDAP-based system). A second phase would enable resources in personal portfolios to be easily exported for use in external applications, such as Learning Management Systems (LMS). Improved integration with LMS' such as Moodle and Blackboard are a priority with many of the current Pathways projects.

Task 2: Extend the NDR Data Model and API. The NDR architecture, built on the open source Fedora repository software, manages digital objects such as resources, metadata and agents in accordance with an information model developed for NSDL. The NDR provides an API (Application Programming Interface) that exposes the repository contents in the context of the NSDL information model through a set of web-services. The current data model was developed for digital libraries in general in that it does not have any education-specific relationships at the object level – any education specific criteria are held within the metadata descriptions that are placed into the metadata object. While the data model as currently defined in the NDR has been sufficient for aggregating collections of normalized metadata from collection providers and providing search over these via the NSDL.org search interface, it is limited in providing the necessary models for the cyberlearning applications.

We have examined the data models collected from our cyberlearning use cases and developed an enhanced NDR model that will support these applications. We are now enhancing the NDR API such that it will provide operations on this model that applications can use.

Task 3: High Quality Collections. A key to success for cyberlearning applications such as the Curriculum Customization Service, Instructional Architect and Digital IdeaKeeper is the quality of resources, and descriptions of them, made available through the library. The collection analysis and de-accessioning task currently underway begins the process of increasing the integrity of the library. In addition, the revision of the collections policy will also contribute to a more focused library. We will work with the collection developers, particularly the Pathways, to ensure that educationally-specific metadata elements are being created and shared via library interoperability mechanisms.

An important part of a high integrity data source is ongoing availability of the content of the library. We will institute systems to monitor the vitality of the items in collections identifying those that become

unstable, or lost (from an access perspective), and providing notification to those users who have placed the items in their portfolio projects.

For work in 2011, we anticipate extending the notification to include suggestions to replace items that have been lost. Lost items can be a result of the owner of a resource no longer maintaining it, or losing their host environment. This poses both a short-term persistence problem and a long-term preservation issue. The issue of long-term preservation (having a copy for the indefinite future) is currently beyond our scope to address. However, the short-term persistence (5 years) may be tractable. In 2010, we will begin discussions with service providers that could help with a persistence solution based on an appropriate preservation and archiving model for the NSDL collection. Two examples are DuraSpace (the new organization from the merging of DSpace and Fedora) and Archive-It, a service of the Internet Archive.

Strategic Goal 5: Evaluation

Integrating evaluation activities into core technical services is critically important when developing and deploying educational applications. As noted in the NSF cyberlearning report, deriving information and outcomes from the deluge of behavioral data available from online learning applications is both a huge opportunity and a difficult technical challenge. We will develop reusable evaluation protocols and instruments, tightly coupled with extensive infrastructure instrumentation, to inform the development and refinement of educational exemplars, enabling more effective use of NSDL and better integration of NSDL into educational settings. These instruments and protocols will be informed by collaboration with NSDL grantees, used at selected deployment sites, and made available for broader use within the NSDL program. Educational exemplars and underlying technical components will be extensively instrumented, enabling us to collect high quality usage data which can be correlated with other data sources. We will also coordinate discussions across NSDL recommendation systems and educational data mining projects to ensure that NSDL instrumentation supports the needs of these projects and is informed by their advances.

The goals of this work objective are to gather evidence of the impact of NSDL on teaching practice, knowledge development, and student learning and to produce reusable, technology-enabled evaluation protocols and instruments. The TNS team will work closely with the Resource Center (particularly co-PI Marlino, charged with coordinating their evaluation efforts), Pathways, and other projects to ensure that the instruments and protocols are useful to the broader NSDL.

Task 1: Gather, revise, and validate instruments and protocols. We will develop and validate instruments and research protocols that will enable us to characterize and measure changes in practices, changes in teacher knowledge, and changes in student learning outcomes. These instruments will be constructed so that they are reusable across deployment sites. Rather than starting from scratch, we have begun to collect protocols and instruments used in prior NSDL evaluations and prior learning science research, such as the Effective Access survey (NSDL Award NSF-DUE 0226483). We will revise these instruments to have more focus and sensitivity to aspects of teacher practice and teacher knowledge that NSDL is trying to support: namely practices and knowledge about how to effectively use digital resources in order to help students with diverse knowledge and capabilities develop science content knowledge and science inquiry skills. In addition, we will extend the instruments to assess changes in teacher practice and knowledge that the NSDL Science Literacy Maps are trying to support: namely awareness of key science

concepts and their interconnectedness and the knowledge and skills necessary to develop lessons and activities that support student mastery of key science concepts.

We will recruit science educators from the strategic partner deployment sites to assist with validating and pilot testing our instruments and protocols. We are engaging Dr. Kirsten Butcher (Educational Psychology, University of Utah) to assist with these design and validation activities. Dr. Butcher has extensive experience in the use of mixed methods research and the coordinated analysis of qualitative and quantitative data sources to assess and characterize changes in cognition, learning, and meta-cognition resulting from multimedia learning environments. She also has prior experience with designing evaluation protocols for NSDL, including leading the effort to evaluate a very early prototype of the NSDL Strand Map Service⁶.

Task 2: Select deployment site(s) and configure instruments. We will work with the Resource Center and Pathways to identify and select a small number of specific deployment sites to be evaluated, ideally to include sites at the middle, high, and undergraduate levels. We will work with these partners to configure the instruments created in Task 1 for site deployment and data collection. We anticipate identifying sites during 2010 and being ready to configure instruments and begin evaluation studies in 2011, with primary data collection and data analyses taking place in 2011.

Strategic Goal 6: Strategic Partnerships

The goal of this work objective is to improve and enhance collaboration with existing NSDL awardees (i.e. the Pathways projects) and to systematically expand the NSDL community to include user-oriented deployment site partners that will enable us to simultaneously grow the user base of NSDL and establish sites for evaluation activities. The NSDL program is now mature enough in terms of technical infrastructure, collections, and operations, to put us in the position to shift our focus from library development to promoting usage. Towards that end, it is imperative that the NSDL community grow to include significant user sites, both in terms of numbers of users and their depth of engagement with NSDL applications and collections. We will work with the Resource Center and NSDL grantees to extend the NSDL community to include a network of deployment sites. The role of TNS will be less on establishing such strategic partnerships and more on providing the technical support to enable these partnerships to flourish.

The Resource Center has made significant progress in establishing strategic partnerships with state-based Departments of Education and educational consortia. These partners include the University System of Georgia Board of Regents and the Georgia Department of Education, the Indiana Department of Education, and the Massachusetts Department of Education. All three partner states wish to integrate NSDL collections and applications, particularly the Science Literacy Maps, into the services they provide to their constituencies. Such partnerships offer an excellent path towards increasing the usage and visibility of NSDL, embedding NSDL collections and tools into mainstream educational settings, and evaluating the impact of NSDL on teacher practice and student learning. To this end, we will also work with the Pathways, many of whom are developing deployment sites for specialized content and services. We will also work with the Resource Center to engage deployment site partners in discussions about

⁶ Butcher, K., S. Bhushan, and T. Sumner. (2006). Multimedia displays for conceptual discovery: Information seeking with strand maps. *Multimedia Systems Journal*, 11(3), 236-248.

sustainability and business models to support operations and service provision beyond the period of NSF funding.

Summary

The 2010 TNS work objectives address the recommendation of the recent report of the NSF task force on cyberlearning⁷ to “instill a platform perspective into NSF’s cyberlearning activities” (section 6.2 of the report). By enhancing and utilizing the NCore platform, this work will continue the “design and development of a common, open cyberlearning platform that supports a full range of learning and teaching activities, including assessment and analysis.” Furthermore, this work will leverage the “high-value resources” developed by our Pathways partners and other NSDL grantees. Finally, because these work objectives involve direct deployment in the classroom environment and support of the educators involved in that effort, it meets the recommendation to “design effective supports for those using these modules to incorporate them into a full curriculum, customize them for specific goals, author new materials that incorporate effective pedagogy, align assessment with instruction, and create professional development that takes advantage of the same technologies.”

Through these efforts, TNS will help NSDL shift its emphasis from supporting library building to supporting use and embedding of the results of the work of all NSDL grantees in mainstream educational settings.

⁷ <http://www.nsf.gov/pubs/2008/nsf08204/nsf08204.pdf>