TPC Proof-of-Concept Project: Digital Libraries go to School

GOALS & OUTCOMES

This proposal, **Digital Libraries go to School**, is submitted under *Category B. Professional Resources, Subcategory 1, Proof-of-Concept Projects* within the *Teacher Professional Continuum (TPC) program*. The proposed project unites institutions with strong credentials in developing and disseminating educational digital libraries and with long-term K-12 partnerships: Utah State University (USU), the National Science Digital Library (NSDL) Core Integration (CI) at the University Corporation for Atmospheric Research (UCAR), and the State University of New York (SUNY) at Cortland. Under the leadership of **Dr. Mimi Recker** (USU), the project brings together a team of senior researchers with extensive experience in digital libraries, science and mathematics education, teacher preparation and educational research and evaluation, including **Dr. Kaye Howe** (UCAR) and **Dr. Rena Janke** (SUNY Cortland).

The **primary goal** of this project is to help teachers learn to use NSDL resources in ways that meaningfully affect their practice in science, technology, engineering, and mathematics (STEM) content areas, while also increasing their skills as designers of learning activities. *Secondary goals* will examine the extent that this approach helps teachers effectively increase 1) technology integration and 2) STEM content knowledge by engaging in sustained use of NSDL resources (Davis & Krajcik, 2005). Table 1 summarizes the project objectives and anticipated outcomes.

The **target audience** for this project includes 1) in-service middle school and high school math and science teachers and 2) student-educators in pre-service math and science courses. The project will be piloted in Utah and New York, where we will especially target in-service teachers in **rural** areas, as these have a special need for high quality STEM resources (see Design & Work plan for site characteristics). *This project is expected to directly impact 120 educators*. After investigating options for wider dissemination (see Dissemination Plans describing alternate formats for workshop delivery and adaptable types of teacher support) and sustainability models, results of this project could impact pre- and in-service teachers nationwide.

Table 1: Objectives & Anticipated Outcomes

1. Design and implement a teacher development model:

- Pre-/in-service teachers increase their capacity for designing learning activities.

2. Design and implement a STEM content development model:

- Pre-/in-service teachers increase their capacity for using NSDL and other online resources as buildings blocks for teacher-created STEM content and assessments.

3. Contribute teacher-designed learning activities to NSDL:

- Rubrics developed for assessing teacher-created content
- Model developed for engaging cross-disciplinary review team (experts and teachers) to assess teacher-created content for inclusion in NSDL and elsewhere.
- Context around NSDL resources extended with metadata on pedagogy and quality

4. Use evaluation and research to measure impact on teaching:

- Research instruments adapted or developed for documenting impact on teacher practice, capacity for designing learning activities, use of online (particularly NSDL) resources, and increased STEM content knowledge.

Broader Impacts and Intellectual Merit

This proof-of-concept project will have the following broader impacts:

- *Teacher/content development model* supporting increased pre-/in-service teacher capacity for designing standards-aligned classroom materials and assessments using online STEM resources
- *Adaptable workshop curriculum* for different types of teachers (who vary in terms of experience, technology skills, and content knowledge) added to TE-MAT
- *Alternate formats* of the professional development program to support scalable delivery
- *Scalable structure* to support use of STEM materials in classrooms
- *Materials and assessments* added to the growing body of online STEM resources in NSDL available to teachers and learners

The proposed focus on cultivating and studying a strong community of users, and a strong evaluation plan will provide rich documentation of enablers and barriers of successful implementation of our design and content development models in educational contexts. In addition, project work will help contribute to design principles for learning resource designers regarding the usefulness of resource content, granularity, and educational metadata for different kinds of teachers. It will also provide critical data regarding the role and value of online learning resources in supporting increased content knowledge. Finally, it will contribute to the knowledge base on effective integration of educational technology in schools. The latter contributes directly to Title II D: Enhancing Education Through Technology (EETT) of the No Child Left Behind Act (NCLB). Finally, our approach will develop models for helping connect teachers to the emerging *CyberInfrastructure*, an important research and promising education focus of the National Science Foundation.

RATIONALE AND RELATED RESEARCH

Recent widespread availability of educational resources on the World-Wide Web holds great potential for transforming education. In science education, for example, students can access real-time images from space exploration. They can also download data and partner with other students and scientists to analyze simulations of complex weather events (Marlino, Sumner, Fulker, Manduca, & Mogk, 2001). In mathematics, students can interact with virtual tools and manipulatives that help make abstract concepts more concrete (Dorward & Heal, 1999). Teachers can effectively and efficiently tailor instructional activities to meet curriculum standards and the unique interests and educational needs of their students. In short, through interacting with Web content, students can now engage in highly personalized learning experiences, instead of relying on a one-size-fits-all textbook.

In recognition of this potential, several large-scale national initiatives have been developing *digital libraries* (or, repositories) containing catalogued collections of high-quality *online learning resources* (or, learning objects). The NSF-funded National Science Digital Library (http://nsdl.org) is a prominent example. Key objectives of such initiatives are to improve teacher and learner access to high-quality learning resources and to increase their use in order to improve education, and in the case of the NSDL, specifically to improve teaching and learning in STEM disciplines (Wattenberg, 1998; Zia, 2001).

Despite these efforts, little is known about how teachers view their roles in terms of adapting, designing, and reusing learning objects in diverse classroom situations, or how teachers'

knowledge and skills are changed as a result of their interactions with these technologies and resources. Even less is known about impact on students. Indeed, an implicit assumption of these initiatives seems to be that teachers and learners will access and use these technologies in unproblematic and seamless ways. Unfortunately, the history of educational technology suggests that this is seldom the case (Cuban, 1986). Instead, systems that must cross many institutional boundaries (such as school settings) rarely do so in transparent ways (Agre, 2003).

In this proposal, we take the view that teaching is a creative, constructive process in which online resources, such as those found in NSDL, can play a key role. From this perspective, teachers are designers who adapt and customize online resources to fit their local needs, contexts, and curricular standards (Brown & Edelson, 2003; Dede, 2003). Online resources from digital libraries then become catalysts for building locally relevant instructional approaches.

However, not all teachers naturally view elements of their practice as design. For example, teachers' beliefs and their pedagogical philosophies will impact their use of such resources (Becker & Reil, 2000; Remillard, 2005). Teachers with little teaching experience, including pre-service teachers, or in-service teachers who have a low comfort with STEM subject matter, may be less likely to adapt resources, and more likely to use them unchanged. In addition, the nature of the resource provides affordances and constraints on their adaptation and use. For example, the granularity (or size) of a resource impacts adaptation (Wiley, Recker, & Gibbons, 2000). Because of many internal dependencies, large resources should be used with little modification or additional effort, and the number of contexts in which they can be applied is small. Conversely, small, self-contained resources afford opportunities for improvisation and adaptation. For example, a simple graphing calculator applet can be used in a wide range of scientific contexts. In sum, resources, people, and situations shape capacity in dynamic ways.

This project will help pre-/in-service teachers expand their design capacity, take advantage of the availability of high-quality, online resources for learning, such as those provided by NSDL, and extend the research on the impact of technology on learning.

PROJECT DESIGN & WORK PLAN

Below we detail objectives that are part of the overall *project design*, provide a *timeline and work plan* (Table 2), and describe *characteristics of the pilot sites* in Utah and New York.

Project Design

Objectives 1 & 2: Design and implement teacher and STEM content development models

In recent years, a large body of research and literature documenting what constitutes effective technology-centered teacher professional development has been accruing (Goldenberg & Gallimore, 1991; Putnam & Borko, 2000)). Findings suggest that effective programs are:

- Sustained, rather than short in duration (Borko, 2004);
- Comprised of both workshop (or classroom) teaching and follow-up support (Sorge & Russell, 2000; Sparks & Loucks-Horsley, 1989);
- Complemented with teacher release time to allow for experimentation, implementation, and reflection (Pianfetti, 2001);
- Tied to incentives to participate (Richardson, 1992);

- Relevant and/or adaptable to teacher needs, and can be implemented in the teachers' context (Borko, 2004; Pianfetti, 2001);
- Hands-on with active participation;
- Encouraging of active shared expertise between teachers and peers, and teachers and pedagogy experts (Richardson, 1992);
- Collaborative (Borko, 2004; Hoffman & Thompson, 2000);
- Design-based (Marx, Blumenfeld, Krajcik, & Soloway, 1997; Putnam & Borko, 2000); and
- Linked to relevant educational standards.

Objectives 1 and 2 will be jointly addressed via teacher professional development programs that follow these best practices. *The first objective focuses on helping teachers increase their capacity for designing learning activities*. Working in tandem with the first, the *second objective focuses on helping teachers increase their capacity for using NSDL and other online STEM resources as buildings blocks for teacher-created content and assessments*. The proposed model includes **professional development workshops** and a **support network** for STEM resource use within in-service classrooms as well as pre-service instruction.

A. Professional development workshops. The *workshops* will be hands-on, collaborative, adaptable, and design-based (Borko, 2004).The focus will be on both the *mechanics* of using digital libraries (including developing basic information literacy, search and retrieval, and metadata use skills) to ensure that teachers are able to effectively find and use resources; and *strategies for designing* instructional activities, lessons, and assessments that integrate STEM digital resources with existing science and mathematics core curriculum standards.

As part of the workshop activities and to directly support the hands-on and design focus, participants will learn to use the **Instructional Architect** (IA.usu.edu; see Figure 1), a simple, end-user authoring service intended to support the design of instructional activities by using resources in NSDL and elsewhere on the web (Recker et al., 2005).

The workshop curriculum will follow a modified *problem-based approach* (Barrows, 1986; Barrows, 1996), in that participants will be asked to identify and design solutions to problems or issues they will be facing in their classes. With its strong focus on solving authentic problems using a self-directed approach that incorporates small group discussion as well as reflection, problem-based learning has been shown to be an effective instructional approach for adult learners (Doucet, Purdy, Kaufman, & Langille, 1998). It also has ancillary benefits such as promoting a desire to affiliate and collaborate with peers, and an enjoyment of the educational opportunity itself which may promote an increased desire for life-long learning (Albanese, 2000).

While the workshops will follow a problem-based learning model, the design and implementation methods employed by the teachers will be of their own choosing. Other projects have attempted to dictate too closely the integration of innovations only to realize, in hind-sight, that teachers still have ultimate control in the classroom (Putnam & Borko, 2000). Acknowledging this reality, along with encouraging teachers to "own" the processes *before* the program is finished will help project achieve lasting change in teacher practice (Richardson, 1992).

Finally, a key goal for in-service teachers will be to design materials and assessments in ways that are congruent with core curriculum objectives. The workshop will also be adapted to meet the curricular requirements for pre-service teachers including assessments and activities that contribute to course requirements, such as teaching portfolios.

Figure 1: The Instructional Architect (IA): An activity development tool

The IA enables teachers to discover, select, and design instruction (e.g., lesson plans, study aids, homework) using online learning resources. In this way, the IA is intended to increase the utility of online learning resources for the classroom educators (Recker, Dorward, & Reinke, 2003).

Teachers can use IA in several ways. In the '**My Resources'** area of the IA, teachers can search for and save resources from NSDL. Teachers can also select any Web resource, and add it to their list of saved resources. In the '**My Projects'** area, teachers can create web pages in which they select a look and feel for their project, input selected resources and provide accompanying text. Finally, teachers can '**Publish'** their projects and set permissions on who can view them. The viewing options include teacher-only, their students, or anyone browsing the IA site. Site visitors can also comment on any public projects.

Design, development and evaluation of IA has been ongoing since 2001. Results from early evaluation efforts involving over 100 educators indicated that participants were very positive about the value of NSDL, the quality of discovered learning resources, and the value of the IA. Participants also generally reported that they would recommend the IA to other teachers. As stated by one high school teacher on 2005: *"But now that I have been introduced to IA, I think that I will be able to show the teaching staff some practical, easy, and quick ways to incorporate the internet into their classrooms."* Complete evaluation findings are described elsewhere (Dorward, Reinke, & Recker, 2002; Recker et al., 2005).

B. Support Network. Evidence suggests that the general idea of the 'one-shot-workshop' for teacher development does not produce lasting change (Sorge & Russell, 2000; Sparks & Loucks-Horsley, 1989) and that without follow-up support, 90% of initial development in staff development is lost (Joyce & Showers, 1995). Therefore, to extend the workshop experience toward classroom change, follow-on support from experts and peers is needed to assist participants.

Literature from the field of developing online communities to support teacher professional development suggests that successful online communities share the following characteristics:

- Existence of shared interests among a group that is physically or temporally unable to interface for dialogue or sharing resources (Riel and Levin, 1990)
- Shared purpose, social norms, and multiple roles (Ackerman & Palen, 1996; Kollock & Smith, 1996)
- Overcoming isolation from and sharing experiences/resources with peers (Schlager & Schank, 1997)
- Ease of access to reliable computer network (Riel and Levin, 1990)
- Safe environment and shared tools for professional discourse (Schlager & Schank, 1997)
- Ongoing activity, critical mass of users with persistent identities (Ackerman & Palen, 1996; Kollock & Smith, 1996)

- Archive of prior interactions and contributions (Ackerman & Palen, 1996; Kollock & Smith, 1996)
- Support for peripheral participation or lurking (Ackerman & Palen, 1996; Kollock & Smith, 1996)
- Recognition and rewards for achievements (Schlager & Schank, 1997)

These characteristics, which complement the goals of problem-based learning, will be operationalized in a network to provide follow-up support after the workshops. While developing a centralized website is an obvious first step in creating an online presence for the support network, significant resources will not be devoted to re-inventing communications tools just for this project. Instead, we will draw on existing tools already in use at USU and UCAR while incorporating, where possible, the communications functionality used by pilot sites.

Centralized features of the network include: hosting materials, such as pedagogy tips and video clips modeling how to use online resources; links to teacher-created projects from other workshop participants; real-time chat functionality; and an annotation tool to provide feedback on teacher projects. Decentralized features include moderated, asynchronous discussion lists (archived centrally) that can be pushed out to teachers' email.

A key component to the support network is teacher communities of practice, which will set processes in place whereby in-service teachers take ownership, support one another, and act as mentors to pre-service teachers. Following best practices, the approach will entail building small teams local to schools to help promote a group-change effort (Goldenberg & Gallimore, 1991). Cross-subject teams (Borko, 1994; Putnam & Borko, 2000) can encourage greater understanding of in-service colleagues' methods and practices as well as provide a more integrated environment for pre-service students to learn the relationships between disciplines. Teams will be asked to review and comment on projects designed by others in their group. We will also leverage existing communities of practice with NSDL partners such as the Math Forum.

One of the biggest barriers to affecting a change in teachers' daily practice is their lack of time, though this can be mitigated through the use of incentives that are structured according to local practices and that fit within the context of peer group standards (Giersch et. al, 2004). We plan to offer a monetary incentive to participate, not just in the workshop but to continue participation throughout the year, along with other forms of local recognition linked to specific activities. Part of the evaluation plan, (see Table 4) involves monitoring participants' support needs and adapting the forms of support and incentives as required. We will use webmetrics to determine usage patterns of the centralized network features, but will also use more in-depth evaluation activities (e.g., interviews) to identify the overall impact of the support network.

Objective 3. Contribute teacher-created content to the NSDL.

As of summer 2005, NSDL was comprised of over 1 million resources from 480 collections (NSDL Whiteboard Report, 2005). Yet, teachers have created little of that content despite the fact that early evaluation studies suggest that teachers are interested in finding other teacher-created content (Recker, Dorward, & Nelson, 2004). Therefore, the resources created in the context of this project will help meet a need expressed by teachers already using NSDL.

As part of their professional development program, pre-/in-service teachers will create new learning resources and activities. These activities can be nominated (by the teacher or by others) for inclusion in NSDL To ensure that teacher-developed resources meet standards for content

quality, STEM accuracy, and pedagogical soundness, a Review Committee (RC) will first develop, then use a content review rubric to *assess the resources* and *identify how resources* could meet science and math state curriculum requirements. Teachers will be able to revise their resources in response to RC comments, and results of the content review will be included as part of the resources' metadata when they are contributed to NSDL. In recognition of their contribution, the content authors' will receive a certificate award and a letter of acknowledgement to local administrators (Pianfetti, 2001).

To seamlessly fit with the current NSDL architecture (Lagoze, 2002), the teacher-created resources and their metadata will be made available for harvesting, using the OAI protocol, for inclusion in NSDL's metadata repository. Once resources are included in the metadata repository, they will be will be correlated with state and local educational standards to further resource use in classrooms beyond the pilot sites. This service is provided via the Achievement Standards Network (ASN) which is being developed by the non-profit organization Jess & Co.

Work Plan

The work proposed for this proof-of-concept project builds on existing relationships established with teachers through the DLConnect Project (NSF DUE-0085855 in Utah) and the New York Project, a Core Integration (CI) initiative to promote the use of NSDL in New York classrooms. Over the past year, CI conducted a feasibility study and established contacts in preparation for beginning pilot tests. As such, the timeline for developing, implementing and adapting this model for scaling is projected at two years. **Table 2** contains a timeline of specific project activities, which are described below.

Table 2: Timeline of Project Activities

		Year 1				Year 2			
Task Set / Task	*Leads*	Q1*	Q2	Q2	Q4	Q1	Q2	Q3	Q4
Activity 1: Pilot teacher/ STEM content development workshops with in-service teachers		*2*	*0*	*0*	*6*	*2*	*0*	*0*	*7*
Develop STEM content and pedagogy curriculum components for f2f workshop delivery	MR, AW, GS, SG								
Identify pilot participants in NY and UT	GS, SG								
Conduct workshops (Year 1: 2 in NY, 2 in UT)	MR, GS, SG, SVG								
Conduct workshop delivered in alternate formats (e.g., online, CD-ROM) (Year 2)	SVG, GS								
Activity 2: Support in-service teachers' use of STEM content in classrooms									
Develop organizational and technical structure to support teachers at a distance	SG, AW, SVG, GS, MR								
Provide technical and personnel scaffolds to implement pilot communities of practice	SG, GS								
Activity 3: Adapt workshop curriculum									
Analyze teacher feedback and observation results about workshop implementation and curriculum	MR, AW, GS								
Adapt curriculum for use in pre-service teacher education classes	RJ, GS, SG								
Adapt curriculum for delivery in alternate formats (e.g., online, CD-ROM)	SVG, GS								
Activity 4: Pilot adapted curriculum with SUNY-Cortland and USU pre-service teachers									

Task Set / Task	*Leads*	Year 1 Q1*	Year 1 Q2	Year 1 Q2	Year 1 Q4	Year 2 Q1	Year 2 Q2	Year 2 Q3	Year 2 Q4
Identify pilot participants	RJ, GS								
Deliver adapted workshop curriculum to pre-service teachers	RJ, MR								
Incorporate pre-service teachers into community of practice support network	RJ, GS, SG								
Activity 5: Review teacher created resources									
Develop quality rubric and review resources	RC								
Contribute content to NSDL	GS								

Activity Level: Primary / initial
Activity Level: Secondary /follow-up

*Q=quarter; Q1=Jan-Mar, Q2=Apr-June, etc.

USU: Mimi Recker (MR), Andrew Walker (AW), Grad Student (GS); *CI*: Sarah Giersch-SG, Susan Van Gundy (SVG); *SUNY Cortland*: Rena Janke (RJ); Review Committee (RC)

Year 1 of the project will focus on designing and formatively testing a face-to-face version of the workshop and developing a follow-on support network with small, pilot groups of **middle and high school math and science teachers** in Utah and New York in rural areas. An outline of workshop activities is shown in *Figure 2*. Subsequent classroom visits to pilot sites will help define and refine the structure of the support network. As part of the evaluation plan (see Tables 3, 4), the Review Committee will examine nominated materials designed by teachers to develop rubrics for assessing the quality of teacher-created online learning resources.

Figure 2: In-Service Program Activities (1 semester in Y1)

Workshop 1 (1/2 day):
- Group activity to promote community; introduction to and guided practice of using digital libraries, NSDL, IA.
- Teacher orientation to designing activities. Examine and discuss examples of audience-appropriate learning activities using online resources. Following a PBL framework, teachers identify and design solutions (3-5 IA projects) to problems or issues from their classes.
- Form 3-5 person teams. Develop community structure in team. Give examples and read through a worked-out example of community relations. Demonstrate project commenting facilities in IA, website chat, and other Internet-based communication software (e.g., email).

- Teachers implement at least two of their activities in their class. Internet and phone support from project staff and from team formed during workshop is available.
- Teachers view and comment on projects created by other members of their team.

Workshop 2 (1/2 day):
- Teachers demonstrate and discuss designed activities and classroom implementation issues. Participants will 'simulate' students to model activities.
- Teachers finish by revisiting the initial problems to examine what they would have done differently (representing the closed-loop approach advocated by Barrows (1986)).
- Discussion of how to improve designs and implementations.

- Using online communication tools, continue to discuss team's problems, solutions, and experiences.
- Ongoing online support available from project experts and peer teachers using introduced communication tools.

Year 2 of the project will involve adapting the face-to-face version of the workshop component for use in **pre-service teacher education** courses at the pilot sites at SUNY Cortland and USU, the largest teacher preparation schools in their respective states. Working with content development experts and School of Education professors, the workshop curricula will be tied to teacher education outcomes and assessments (including teaching portfolios). An outline of the activities for pre-service educators is shown in *Figure 3*. Additionally, the face-to-face version of the workshop will be modified for online delivery within, and beyond the pilot sites from Year 1. The support structure for pre-service teachers will be implemented, and mechanisms for communities of practice and mentors will be established.

Figure 3: Pre-Service Program Activities (1 semester in Y2)

Class activity 1 (1 session):
- Group activity to promote community; introduction to and guided practice of using digital libraries, NSDL, IA.
- Participant orientation to designing activities. Examine and discuss examples of learning activities using online resources created by Y1 teachers. Following a PBL approach, participants design solutions to authentic problems or issues identified by the in-service teachers. Participants design 3-5 IA projects to be used in their student teaching practicum.
- Develop community structure in class. Give examples and read through a worked-out example of community relations. Demonstrate commenting facility in IA, and other Internet-based communication software available via project website.

- Participants implement at least one of their activities during their student teaching experience.
- Participants view and comment on projects created by other members of their class.

Class activity 2 (1 session)
- Demonstrate and discuss designed activities and classroom implementation issues. Participants will 'simulate' students to model activities.
- Participants finish by revisiting the initial problem to examine what they would have done differently, representing the closed-loop PBL approach advocated by Barrows (1986).

- Using online communication tools, continue to discuss class's problems and experiences.
- Ongoing online support from project experts, mentors and peers using communication tools.

Pilot Site Characteristics

In Year 1, the pilot sites in Utah and New York will target in-service middle and high school science and math teachers. In Year 2, the number of pilot sites with middle and high school teachers will be expanded and pilot sites (classes) at SUNY Cortland and USU will be added.

In ***New York***, schools districts are organized into regional groupings call BOCES - Board of Cooperative Educational Services. BOCES is a public organization that provides shared educational programs and services to school districts. Through the New York Project, relationships have been formed with two BOCES: Onondaga-Cortland-Madison (OCM) and Washington, Saratoga, Warren, Hamilton and Essex (WSWHE). These BOCES represent two distinct regions in New York (e.g., OCM: urban, economically advantaged; WSWHE: rural, high poverty). The BOCES provide a means of reaching schools at the district and building level, and they serve as a distribution mechanism for workshops and teacher support.

In Year 1, one face-to-face workshop will be conducted in the OCM and the WSWHE BOCES with up to ten people per workshop (two total workshops, twenty maximum in-service teachers). The small pilot size will make it easier for project staff to provide support and to conduct evaluations of effectiveness of workshop curricula, STEM materials and teacher STEM

content knowledge. The WSWHE and OCM BOCES staff will support the project (see letters of support) by providing training space at regional centers, by having BOCES science and math training coordinators participate in workshops, and by assisting in selecting participants. Participants will be selected by BOCES coordinators with assistance from district and building administrators based. Two criteria are especially important for New York pilot sites: availability of computers in the classroom (to maximize use of teacher-created learning resources); and relative new-ness to teaching STEM subjects (to help teachers meet recent New York professional development requirements – 150 hours within 5 years of completing a degree).

In Year 2, once the workshop curricula has been adapted for online delivery, a second cohort of ten pilot participants will be selected from the OCM and WSWHE BOCES to participate in the online workshop. Technology literacy and access to technology are key criteria for selecting participants. Based on Year 1 evaluation results, workshop curricula will be revised and tested during two more face-to-face workshops, conducted with ten teachers in OCM and WSWHE BOCES. Also, the workshop curricula will be adapted for use in teacher education courses at SUNY Cortland (see letter of support), which is home to the largest comprehensive teacher education program in New York and the 10th largest among public institutions in the U.S. Up to twenty pre-service teachers will participate with selection based on course requirements.

In ***Utah***, face-to-face workshops will be conducted with math and science teachers in rural school districts. The Southeast Educational Service Center, which serves Utah's most rural districts and a large Native American student population, has already agreed to participate (see attached letters of support from the coordinator and the Curriculum Director at the Utah State Office of Education). A district will be matched with a control group (from another rural school district) to form a quasi-experimental design (see evaluation section).

In Year 2, the adapted workshop will be used in teacher education courses at Utah State University. Up to twenty pre-service teachers will participate in their mathematics and technology pre-service courses (see attached letters of support from the instructor and Dean). Selection is based on course requirements.

PROJECT EVALUATION

Much of the prior focus of technology-centered professional development has been on training teachers in the mechanics of using technology; not enough attention has been given to strategies for integrating technology into classroom practice (Lancaster & Lancaster, 2002; Wallace, 2004; Wallace, Kupperman, Krajcik, & Soloway, 2000). Professional development research has also been slow to incorporate research on using technology in the service of teaching subject matter. Additional barriers to conducting research on professional development programs include curricula that typically consist of one-day activities, without follow-up, and programs that serve volunteer audiences. Since workshop participation is voluntary, there can be no random selection or assignment, and everyone who volunteers receives the same workshop experience. Evaluations of such workshops have mostly used within-group pre- and post-survey designs to measure satisfaction with the workshop. Distributed training and follow-up, along with comparisons to a matched or randomized group to assess workshop impact in terms of technology use, is sorely lacking (Lawless & Pellegrino, 2005).

To address these shortcomings, evaluation and data collection tasks are built into every activity of the project to meet *Objective 4: Use evaluation and research to measure impact on*

teaching. Project staff will conduct ongoing formative evaluations throughout the project, and the external evaluator (Dr. Lawless) will provide a review of project materials at the end of Year 1 and 2, and a summative report to NSF. The science education professor (Dr. Janke) and the external evaluator (Dr. Lawless) will perform an expert review of materials for the teacher development models in the early phases of the project and provide feedback. **Table 3** summarizes the broad evaluation questions and measures associated with each objective and **Table 4** is a timeline of evaluation activities linked to objectives.

Table 3: Project Evaluation Questions

Objectives / Evaluation Questions	*Measures*
1&2: Teacher and content development model	
What variables influence use and perceived utility of the program?	- Participant Pre/post surveys, interviews, and classroom observations. - Webmetrics. - Quasi-experimental study (Utah) - Document analysis
How are teachers using online resources?	
What kinds of artifacts are workshop participants creating?	
How are the teacher and content development models working (pedagogy and content)?	
3: Contribution of content to NSDL	
What is the quality of rubric?	- Interviews with RC - Measure number of projects contributed to NSDL
How easy is it to apply to the evaluation of teacher projects?	
Secondary objectives	
Does the program result in increased technology integration?	- Participant pre/post classroom observations and interviews.
Does the program have impact on content knowledge?	

Table 4: Timeline of Project Evaluation Activities

Objectives / Evaluation Activities	*Leads*	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1&2: Teacher and content development model		*2*	*0*	*0*	*6*	*2*	*0*	*0*	*7*
Evaluate in-service teacher technology and design-based pedagogy skills pre/post program	MR, GS, SG								
Evaluate teacher in-class use of STEM resources	MR, GS								
Evaluate pre-service teacher technology and design-based pedagogy skills pre/post curriculum	RJ, MR, GS								
Evaluate support structure	MR, SVG, GS								
Evaluate effectiveness of teacher/content development model	KL, RJ								
3: Contribution of content to NSDL									
Evaluate teacher-created content	RC								
Evaluate the content assessment rubric	KL								
Secondary Objectives									
Review project materials and communication	KL								
Write summative report	KL								
Identify scalable features of the pilot	USU, CI, SUNY								
*Q=quarter; Q1=Jan-Mar, Q2=Apr-June, etc.									

USU: Mimi Recker (MR), Grad Student (GS); *CI*: Sarah Giersch-SG, Susan Van Gundy (SVG); *SUNY Cortland*: Rena Janke (RJ); External evaluator, Kim Lawless (KL); Review Committee (RC)

Evaluation of activities, objectives and the project overall will use a mixed-method approach, involving both qualitative and quantitative measures (see Figure 4), as is increasingly the norm in education research (Johnson & Onwuegbuzie, 2005). In addition, a quasi-experimental study will be conducted with the Utah cohort of in-service teachers (described below), thereby supporting a more rigorous evaluation of the professional development program and objectives. The fundamental evaluation and research question this project will address is *whether a temporally distributed technology-focused teacher and content model that addresses mechanics, design capacity, integration, and support issues can have real impact in terms of teacher knowledge and practice in the classroom*. The hypothesis is that rigorous design can demonstrate impact, but that impact will be moderated by individual teacher characteristics as well as environmental factors at the school and district level.

Figure 4: Proposed Quantitative & Qualitative Evaluation Measures

Pre- and post- **online surveys** will be developed to assess:
- Demographic and professional experience data;
- Current technology infrastructure at the school where they teach (if applicable);
- Prior participation in professional development;
- Their use of technology in instruction on a daily basis (if applicable) and at home;
- Attitudes towards and knowledge of technology.

Open and lickert-scale items will be selected from previously developed and tested surveys (Becker, 2000; Recker et al., 2005). Surveys samples can be accessed at dlconnect.usu.edu.

A random sample of participants will be involved in pre- and post- **interviews and classroom observations**. Rubrics will be developed to assess:
- Teacher design of learning activities and use of online resources;
- Barriers and enablers;
- Use of and attitudes towards program support structures;
- Pre and post program general integration of technology in instructional activities;
- Self-reported impact on STEM content knowledge.

Webmetrics analyses will be conducted to assess:
- Creation and use of Instructional Architect projects;
- Use of online resources;
- Quality of resulting projects.

The **quasi-experimental study** in Utah will involve rural school districts. Using a phased approach, middle and high schools from this district will be randomly assigned to treatment and control groups, and math and science teachers in those schools will be the participants. Because teachers often design their courses and identify the types of materials they will use in advance of the semester, the study will last for two semesters, and we expect to see change in practice primarily during the second semester and later. After evaluating the processes and results of the quasi-experimental study, the approach could be applied in New York pilot sites if the project extends beyond the proof-of-concept phase.

The study design will involve voluntary selection, with random assignment of schools (and thus teachers) to participate first in the program (treatment group), or second (control group). Both groups will be pre assessed via an online survey. The program will be offered to the first group during the first semester of the study, and follow-ups (including interviews and observations with a random sub-sample) will continue until the end of the second semester. Additional impact analyses will be performed using the webmetrics data. Members of the control

group will participate in the program during the second half of the second semester, after impact data has been collected for comparison purposes.

PERSONNEL AND PROJECT MANAGEMENT

This project builds upon existing collaborative relationships established within NSDL (USU and CI) and between existing outreach efforts with middle and high school teachers (DLConnect in Utah, New York Project) while establishing new collaborations with teachers in the SUNY Cortland School of Education and USU.

At *Utah State University*, **Dr. Mimi Recker**, **Dr. Andrew Walker,** professors of Instructional Technology, and a graduate student will collaborate with CI to develop and test the program with Utah pilot sites. With an interdisciplinary background spanning computer and cognitive sciences, education, and instructional technology, Dr. Recker will take the lead on developing and collecting measures of teacher design capacity and adapting them for use in other pilot sites. Dr. Walker brings a strong background in problem based learning.

At *NSDL Core Integration*, **Sarah Giersch**, Director of Development and Special Projects, and **Susan Van Gundy**, Director of Education and Outreach, will collaborate with USU to develop and test the program with New York pilot sites. CI will also collaborate with project members at SUNY Cortland to adapt workshop curricula for piloting with pre-service teachers. Drawing on NSDL's experiences with outreach, CI will take the lead on developing a plan for supporting teachers' use of STEM resources and adapting workshop curriculum for delivery in alternate formats.

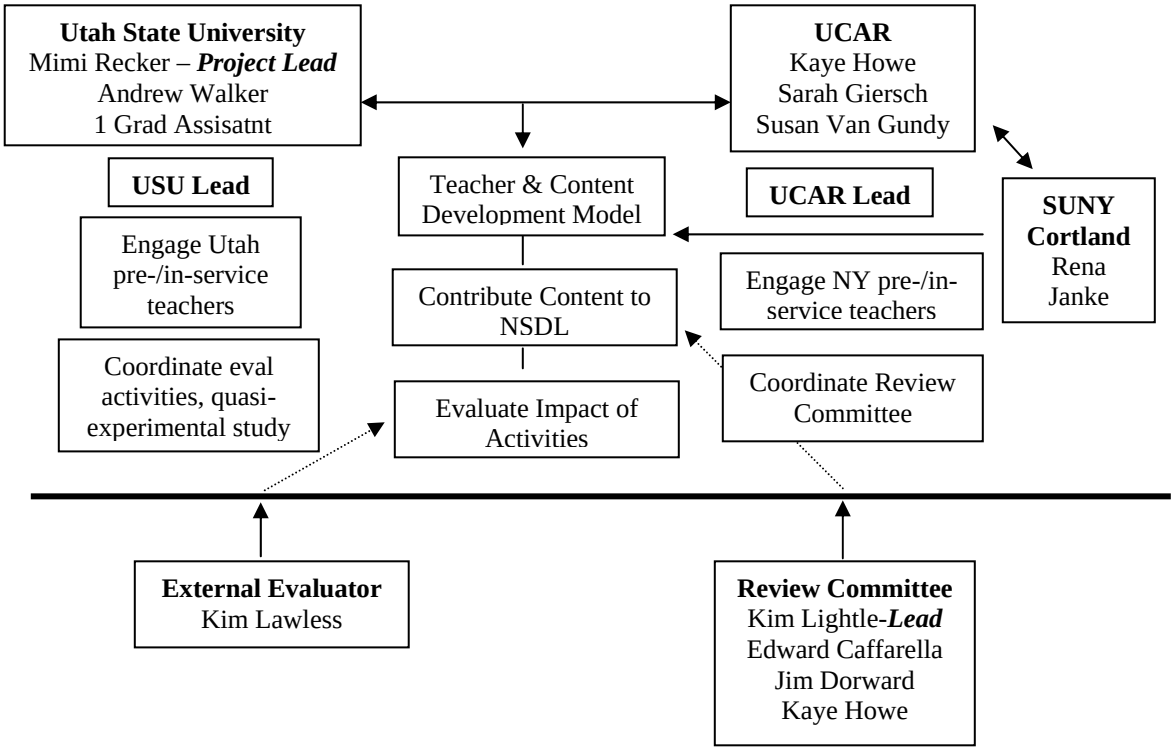
At *SUNY Cortland*, **Dr. Rena Janke**, Assistant Professor of Adolescence Science Education (SUNY Cortland), will collaborate with USU and CI to adapt and pilot workshop curricula that meets pre-service teacher education curriculum requirements.

The *Review Committee* is comprised of: **Dr. Kimberly Lightle**, Director of the Center for Digital Library Research, College of Education, Ohio State University; **Dr. Edward Caffarella**, Dean of the School of Education, SUNY Cortland; **Dr. Jim Dorward**, Professor of Mathematics Education in the Department of Elementary and Middle Level Education at Utah State University; and **Dr. Kaye Howe**, Director of the National Science Digital Library's Core Integration. Dorward and Caffarella will provide expertise on the education and curricular requirements of their respective states while Lightle (Committee Chair) and Howe will provide expertise on reviewing online resources for quality and pedagogical soundness. (See supplementary documentation for details on members' expertise and roles and a letter of support from Dr. Lightle.)

Dr. **Kimberley Lawless**, Evaluation Consultant, and Associate Professor of Educational Psychology at the University of Illinois, Chicago, will direct the *external evaluation*. She brings extensive experience in evaluating a range of educational technology innovations.

Project leadership and assigned roles and responsibilities are clearly defined for the efficient administration of each activity (see Figure 5). Project management is coordinated through monthly leadership meetings accompanied by bi-weekly conference calls and ongoing interaction and sharing using Internet communication technologies, including a dedicated project website.

Figure 5: Project Leadership Responsibilities



DISSEMINATION PLANS

Members of the project staff have access to several pre-existing dissemination networks. Coordinating dissemination efforts with the NSDL's ongoing outreach to core audiences (K-16 STEM teachers and learners) through conferences such as AAAS, NCTM, and NSTA will allow the project to cultivate opportunities to conduct the workshop face-to-face on a cost-recovery basis or online. At conferences for digital library developers, such as JCDL, NSDL Annual Meeting, and the Instructional Technology Institute at USU, the project can share results of evaluating the workshop model and teacher feedback about how STEM teaching is affected by digital libraries. These results will be submitted for review to the TE-MAT database. Additionally, the project budget contains support for in-service teachers from pilot groups to attend regional or national meetings to demonstrate their use of materials and processes they developed as a result of participating in this project. Finally, some of the materials created by pilot participants will be placed in NSDL for further dissemination and re-use (see Objective 2).

Looking to the future, we propose to scale the dissemination of workshop materials and the support network from an *enterprise* and *grass roots* level. We will take an enterprise approach to disseminating workshop materials to in-service teachers by offering materials in an easily distributable online format, such as CD-ROMs (to give away at conferences) and as a download from the support website. Additionally, we will seek strategic partnerships with NSDL projects (e.g., NSDL Middle School Portal; Phenomena and Representations for the Instruction of Science in Middle School (PRISMS); Career Resources Education Network for STEM (CaREN); Design and use of a concept map interface for helping middle school students navigate digital libraries (CoMPASS-DL); and Students Using NSDL (SUN)) who have established

middle school connections and relationships with district and state curriculum administrators. We will take a similar enterprise approach to disseminating materials for pre-service teachers by providing the materials on CD-ROM and for download and by approaching math and science education curriculum directors at teacher education schools.

As noted above, workshops are much less effective without follow-up support. We propose to take a grass roots approach to grow the support network for pre-/in-service teachers. This will involve developing a train-the-trainer service to empower local in-service teachers to reach their peers. This will also involve codifying a regional mentor network to support pre-service teachers. And the support website will be maintained with an emphasis on supporting a community of teachers practicing good design with online resources.

RESULTS FROM PRIOR NSF RESEARCH

Dr. Mimi Recker is PI on NSF DUE 0333818 (2003-2005), DUE 0085855 (2004-2007), and was PIs on NSF DUE 0085855 (2000-2003). These grants have help support development of the NSDL service called **The Instructional Architect (IA),** and a digital library teacher implementation approach called **DLConnect.** Early evaluations suggest that teachers find the IA easy-to-use, and a useful means for finding and using NSDL resources. Accompanying focus on classroom implementation of digital libraries and services has provided documentation of enablers and barriers. This work to date has resulted in ten peer-reviewed articles, three book chapters, over 25 presentations at national conferences, one MS thesis, and one PhD dissertation.

Dr. Kaye Howe is PI on NSF DUE 0424671 (2000-2006). This grant has provided a central organizational and technical infrastructure for the development of the **National Science Digital Library**. NSDL's mission is to provide organized access to high quality resources and tools that support innovations in teaching and learning at all levels of STEM education. NSDL draws upon a broad network of collaborators to extend the research on and practical applications of using digital libraries for education. As of August, 2005 NSDL's holdings included 480 unique collections containing nearly 1,004,384 multimedia and text resources that support state and national content standards.

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