# Promoting Technology Implementation in NSF ITEST Projects

Steven Moore
Science Approach
United States
steven@science-approach.com

**Abstract:** Best practices for promoting implementation of technology in K-12 instructional settings include supporting teachers with extended e-learning, face-to-face, and in-school contact; offering mentoring and technical assistance to help teachers marshal appropriate resources and overcome administrative barriers to change; being responsive to the needs of participants; developing a non-hierarchical community of learners; helping teachers localize learning experiences with technology; providing customizable instructional materials to serve as templates for teachers; and promoting commitment and comfort by building communities of practice. This panel presentation will discuss use of these strategies in four Innovative Technology Experiences for Students and Teachers (ITEST) projects funded by the National Science Foundation: *CoastLines*, *CREST*, *ITSI*, and *RI-ITEST*. Modeling best practices discussed in the session, the panel will offer an interactive and open forum for discussion and sharing.

## Introduction

Although technology is ubiquitous in many schools and in teachers' and students' lives, the effective use of technology in the service of education often remains elusive (Zao and Frank 2003). Uses of technologies, rather than the technologies themselves, may be viewed as "invading species" in K-12 ecosystems whose fate is affected by teachers' rational calculations of the costs and benefits of adopting technology; the local context, including the available technological infrastructure and attitudes toward technology integration; and competition, cooperation and commensalism among available technological applications (Zhao and Frank 2002). Fostering implementation of technology in school settings requires attending to the social, pedagogical, and administrative milieu in which technologies are introduced and supporting teachers with professional development that is timely, welcoming, hands-on, and technically appropriate (Gaible and Burns (2005).

In this panel session, five directors of projects funded by the Innovative Technology Experiences for Students and Teachers (ITEST) program at the National Science Foundation will address lessons learned and best practices identified from four ITEST projects. Established in direct response to concerns about shortages of information technology workers in the United States, the ITEST program funds projects that provide opportunities for both school-age children and teachers to build the skills and knowledge needed to advance their study and to function and contribute in a technologically rich society. The projects to be represented in this panel have served and are serving as laboratories for experimentation and refinement of strategies for fostering technology implementation in middle school and high school settings. Concrete examples of best practices identified by the programs will be highlighted in this session and attendees will be invited to contribute successful practices of their own.

## CoastLines

In its evaluation program, *CoastLines* is testing the hypothesis that GIS professional development for teachers that emphasizes commitment, comfort, competence, empowerment, and relevance will promote implementation of the technology in the classroom. The goal is to "graduate" thirty teachers per year from a program that connects GIS technology with science explorations derived from the National Science Foundation's Long-Term Ecological Research Network. The project recently completed its first year of activities.

In its first cohort, *CoastLines* attempted to build commitment to the project by providing personal and ongoing communication with the participants, offering incentives for participation, and building a community of practice. Of these practices, the most significant factor that fostered commitment was the two-week *CoastLines* Summer Institute offered in Miami during 9-20 June 2008. The institute solidified personal connections initiated during the spring Webinars and, through training and field events, gave plenty of opportunities for teachers, students, and staff to bond with one another. Less altruistic, though equally compelling in building commitment to *CoastLines*, were the impact of stipends and tangible rewards.

Comfort with GIS and global positioning system (GPS) technology was fostered by (1) scaffolding the introduction of the software and technologies so that the development of new skills and understanding of new concepts were not overwhelming; (2) offering training events and materials designed to give participants experiences of success; (3) diminishing the social discomfort of learning a new technology by conducting early training online; and (4) providing opportunities for the participating teachers to practice teach the technology to their peers and to small groups of students. All four strategies worked reasonably well, though the project had to re-adjust priorities at the summer institute because the participants thought that the introduction of new material was happening too slowly. Rejected by the teachers was practice teaching a lesson or activity to one's peers. Practice teaching to students met with some controversy, with the participant cohort divided into camps of those who found the opportunity beneficial and those who felt that too much time was spent interacting with students

In *CoastLines*, the term "competence" referred to the ability to install and use GIS software properly, understand the data that is used in GIS projects, and effectively use GIS to teach scientific content to middle school and/or high school students. Competence was promoted in *CoastLines* through online and face-to-face training coupled with e-mail, telephone, and Web-meeting enhanced technical support. A preliminary analysis of data from the pre- and post-project surveys for the 2008 cohort indicates that the teachers gained dramatically in feelings of preparedness, but less in actual use of their skills in the classroom.

Empowerment was operationalized by the *CoastLines* project as the ability to troubleshoot problems with GIS software oneself, looking forward to integrating GIS into instruction in the future, expecting to be successful when using GIS in instruction, and having a good sense of what problems may arise when trying to integrate GIS into teaching practice. Survey items about troubleshooting and anticipating problems showed particularly impressive gains with the ability to troubleshoot problems oneself moving from 37.1% to 80.0% agreement and having a sense about problems increasing from 45.8% to 81.3%. As with competence, empowerment was facilitated by frequent contact and follow-up with the participants.

In the pre- and post-project surveys, agreement with items designed to measure how much teachers felt prepared to integrate GIS into their curriculum was high in the pre-project survey, indicating that the group had embraced the relevance of the project to their work. Training and follow-up support specifically designed to help teachers use GIS to teach specific science skills and content knowledge was offered at various points in the project year. Regardless of the teachers' enthusiasm about the relevance of GIS to their work, at years' end it remained unclear whether many of the teachers would go beyond using GIS to engage students' interest to teach generalized science process skills. Professional development and evaluation research during the coming year of the project will explore this issue in greater depth.

**Community for Rural Education, Stewardship, and Technology (CREST)**

Rural school systems throughout the nation are looking for ways to access and use technology in a way that will be meaningful for their students. The Community for Rural Education, Stewardship, and Technology project (CREST) creates a non-hierarchal community of learners that uses GIS mapping, web design and ethnographic research skills in an interdisciplinary approach that reconnects students to their communities and provides insight into applicable IT and STEM careers through local service-learning projects.

Through qualitative and quantitative evaluations it has been determined that the strategies employed by CREST have been extremely successful in influencing teacher practice. By the end of the third year, 72% of CREST teachers report that CREST technologies have become a regular part of their instruction (Nave, 2008). That is, these teachers do not view the technologies as strategies to be reserved for special occasions, nor do they view the technologies as instructional "add-ons." One middle school teacher said it this way: "CREST has helped me teach the way I have always wanted to teach" (Nave, 2008).

What are the core concepts and methods of the project that lead to its success in influencing teacher practice? How can other STEM programs benefit from these findings? CREST has designed a successful model methodology, which entails weaving the core concepts of 1) Sustainable Learning Communities (SLCs); 2) integrated technologies; and 3) place-based education into a highly effective pedagogy that addresses the STEM education needs of rural underserved communities. This panel presentation will discuss CREST's model methodology and its impact on teacher practice, as well as highlight case studies showing implementation strategies for success.

In order to achieve the type of STEM program implementation exemplified in the case studies we will discuss there were a number of strategies employed to provide support and guidance to teacher and students in a collegial atmosphere geared to meet each teams needs. Based on evaluation and observation 7 of the 11 schools were more successful in engaging students, teachers, and the community in ways that deepened the students' connections to the community and enhanced the community's appreciation for the students' projects. What factors seem to be associated with the more successful CREST schools, and what factors seem to be associated with the less successful CREST schools?

In Table 1, factors associated with successful or challenging implementation are summarized.

| SUCCESSFUL STRATEGIES | CHALLENGES TO SUCCESS |
|---|---|
| Active support from school administration | Lack of proactive support from school administration |
| Use of ethnographic research methods as a motivator | Loss of student and teacher SLC members |
| Robust collaboration between teacher SLC team members | Inactive SLC team members |
| Focusing on timeline and goals created at the summer institute | No opportunities to meet as a SLC team |
| Using SLC meetings as a time to debrief, define goals and responsibilities | Technical problems |
| Using CREST technologies in existing curricula in addition to the "project" | Attempting to implement CREST as an after-school club |
| Frequent CREST staff site visits to each school site to assess progress | When school sites only tell the good stories and do not address challenges |
| Provide each school with targeted technology trainings to meet their needs | Geographic distance and isolation |

**Table 1:** Summary of implementation strategies employed and challenges the CREST program encountered.

Integrating technology in the classroom often requires overcoming challenges, both technical and curricular. Central to the success of implementing CREST at each school is adequate technology training and infrastructure, administrative support, and lasting community connections. The CREST model finds that building a strong community of learners (through SLCs) provides a school-wide network for ongoing technical support and acts as a cohesive team to move forward the common goal of technology curriculum integration. These findings and methods offer supported best practices to inform those who seek ways to engage students using technology and place-based learning in other rural communities.

**Information Technology in Science Instruction (ITSI)**

The core of science is about investigating, exploring, asking questions, analyzing, and collaborating—activities that information and communication technologies (ICT) are uniquely able to facilitate and deepen. The Concord Consortium facilitates inquiry through student investigations of real events with probes and explorations of highly interactive models of physical systems. These inquiry-based instruction and ICT applications are more challenging for teachers, but hold the greatest potential for improved science learning. Teachers must learn to enable instead of lecture, they must provide scaffolding instead of answers, and they need to be able to provide students with of a collection of flexible technologies that can be used in experimentation. Teaching using inquiry cannot be taught to teachers in the absence of content any more than teaching about content improves pedagogy. This is the premise behind one of the most influential ideas in teacher professional development: "pedagogical content knowledge" or PCK.

One method of delivering PCK professional development that has worked well for the Concord Consortium has been providing a set of well-tested sample activities to the teachers that align to the STEM standards addressed within their individual school districts. In addition to using the activities as is, these sample activities can be copied by the individual teachers and customized to fit more closely into their classroom goals and objectives. This customization is achieved by using an online authoring template in a web browser that allows text, graphic, computational model, and/or sensor (probeware) changes by the teacher.

Information Technology in Science Instruction (ITSI) is one of the Concord Consortium projects that the design for professional development applies PCK by engaging teachers in deep reflection with the goal of using customized versions of high-quality materials. This requires mastering both the content and pedagogy of materials designed for students in their discipline and at their educational level.

Teachers can choose to make these activities public so that other teachers within their district can view and even use them within their classes. During an online course, teachers are encouraged to share, review and compare customized activities in a discussion forum. Experience over the past year in ITSI has shown that teachers welcome this type of review. We did attempt to introduce a rating system for teacher customized activities initially and found that this was threatening to the teachers and the rating was dropped. Participation in the discussion forum improved after the rating was removed. Our software tracks the type of changes in the customized versions of activities and provides data about how often teachers are sharing activities between schools.

**Rhode Island Information Technology Experiences for Students and Teachers (RI-ITEST)**

All professional development (PD) is not created equal. It comes in many forms and covers many types of content. Some of the common forms of PD include one-day workshops, intensive multi-day institutes, online courses, periodic face-to-face discussions, and graduate courses. The content of these PD opportunities also varies greatly, but typically falls into two categories: content specific information, and pedagogical theory.

Designing professional development around educational technology necessarily involves addressing both content and pedagogy. Plus, it has the added component of needing to teach generic technological knowledge for those who are not completely comfortable with computers. In many cases the technology makes possible teaching topics which were previously out of reach for students, often including concepts teachers are not as familiar with. There are also pedagogical implications of using new representations such as those found in various modeling systems. “Merely knowing how to use technology is not the same as knowing how to teach with it.” (Mishra and Koehler 2006)

AERA’s quarterly publication “Research Points” (Holland 2005) cites factors that indicate positive outcomes for professional development, including:

1. Forming a community of participants either through multiple people in the same school or via some other type of social networking or online course has a positive effect on PD outcomes.
2. Subject-matter content of the PD should connect with the teacher’s current curriculum.
3. Focusing on student understanding of the content can increase both student and teacher capacity in the subject area.

Additionally, the numbers of teachers who self-reported that PD has helped them improve their teaching increased with increased length of PD (DOE National Center for Education Statistics 2001), indicating that to have a significant impact, the PD should extend over longer periods of time.

The Concord Consortium currently has many ongoing education technology projects, some of which incorporate professional development as a major component. One of these is the Rhode Island Information Technology Experiences for Students and Teachers (RI-ITEST) project (http://ri-itest.concord.org). This project trains teachers to use interactive computer models to teach science concepts across physics, chemistry, and biology. The PD component of the project takes into consideration all of the above points in its design and implementation. Teachers meet in the summer for an intensive multi-day institute where they experience, hands-on, the materials and technology they will use throughout the year. During the year teachers participate in an online course to help pull together the community of participants who are spread throughout the state. There are also quarterly face-to-face meetings when all of the participants gather for reflection, feedback, and additional training. Over the entire project a teacher will participate in approximately 120 hours of PD, expand their scientific knowledge base, and discover new ways to teach standard concepts through the use of dynamic computer models.

**References Cited**


Becker, H. & M. Riel. (2000)."Teacher professional engagement and constructivist-compatible computer use," University of California, Irvine, Irving, CA.

Burns, K. & J. Polman. (2006). The Impact of Ubiquitous Computing in the Internet Age: How Middle School Teachers Integrated Wireless Laptops in the Initial Stages of Implementation. *Journal of Technology and Teacher Education* 14 (2), 363-385.

Gaible, E., & M. Burns. (2005). *Using Technology to Train Teachers: Appropriate Uses of ICT for Teacher Professional Development in Developing Countries*, edited by M. Trucano. Washington, DC: InfoDev / World Bank.

M. Linn & B. Eylon. (2006). "Science Education: Integrating Views of Learning and Instruction," in *Handbook of Educational Psychology*, *2nd ed*, P. A. Alexander and P. H. Winne, Eds.: Lawrence Erlbaum Associates.

B. Nave. (2008). *Year Three Summative Evaluation Report: Community for Rural Education, Stewardship, and Technology (CREST).*

M. Linn, H.-S. Lee, R. Tinker, R. Husic, & J. Chiu, "Teaching and assessing knowledge integration in science," *Science,* vol. 313, 1049-1050.

O. de Jong. (2001). "Exploring science teachers' pedagogical content knowledge," in *Proceedings of the Third International Conference on Science Education Research in the Knowledge Based Society, Vol. 1*, D. Psillos, P. Kariotoglou, V. Tselfes, G. Bisdikian, G. Fassoulopoulos, E. Hatzikraniotis, and M. Kallery, Eds. Thessaloniki, Greece: Aristotle University of Thessaloniki. 7-9.

Zhao, Y., & K. A. Frank. 2003. Factors Affecting Technology Uses in Schools: An Ecological Perspective. *American Educational Research Journal.* 40 (4), 807.