ISSUE 1
WINTER 2007

Insights and Innovations in STEM Learning

A Publication of the ITEST National Learning Resource Center at EDC

ITEST Learning Resource Center

About ITEST

The Information Technology Experiences for Students and Teachers (ITEST) program was established by the National Science Foundation (NSF) in direct response to the concern about shortages of IT workers in the United States. The ITEST program funds projects that provide opportunities for school-age children and teachers to build the skills and knowledge needed to advance their study and to enable them to function and contribute in a technologically rich society. The NSF-funded ITEST National Learning Resource Center at EDC supports projects and synthesizes and disseminates the program's learnings to a wide audience.

Learnings from ITEST Project Evaluations

Leslie Goodyear, PhD, Research Scientist

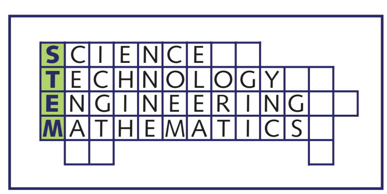
About This Issue

This is the first issue of the Insights and Innovations in STEM Learning *series. The purpose of* Insights and Innovations *is to highlight important issues in IT-enriched STEM education, evaluation, and research and to share the ITEST community's perspectives on emerging national STEM issues. This first issue synthesizes learnings from a thematic analysis of ITEST projects' reported outcomes, challenges, and innovations. Future issues of* Insights and Innovations *will explore the strategies of ITEST projects, analyze cross-project trends, and connect the lessons learned in ITEST to critical questions that drive research in the STEM community.*

The Source and Significance of the Learnings

The National Science Foundation's (NSF) ITEST program funds the National Learning Resource Center (LRC) at Education Development Center, Inc. (EDC), to support and study the 76 ITEST projects. Our LRC team has the task, and the privilege, of examining the work and evaluations of all of the projects. This unique bird's-eye view of the ITEST program has enabled us to become "knowledgeable about patterns of program effectiveness . . . [and] . . . to provide guidance about development of new initiatives, policies, and strategies for implementation" (Patton, 2001, p. 333).

In this issue of *Insights and Innovations,* we present learnings from a thematic analysis of ITEST projects' 2005 evaluation reports. We believe that these project-level findings can serve to highlight the impact a program like ITEST can have on a national level. By sharing ITEST's "patterns of effectiveness," we hope to inform efforts to plan, implement, and study IT-enriched STEM initiatives, as well as to identify implications for further research.



NSF established the ITEST program in 2003 to help determine what it takes to build a strong and robust pipeline of technology-enabled citizens who are able to transition smoothly into careers in which technology plays an important role. ITEST is a key part of NSF's vision to expand and diversify the future IT workforce to meet the workforce needs of a technology-rich society.

The 2012 IT workforce will need a solid foundation in science, technology, engineering, and mathematics (STEM) (Cole & Allen, 2005). Thus, nationwide, 76 ITEST projects are exposing youth to exciting IT tools and careers—from forensic science to robotics—within the context of STEM learning. To advance NSF's vision, these projects serve a wide range of students—including large percentages of young women and youth of color—from urban, suburban, and rural areas.

There are two kinds of ITEST projects. *Youth-based projects* (see Snapshots of Youth-Based Projects on page 5) for grades 7–12 students offer rich, year-round, hands-on STEM and IT experiences in out-of-school settings. Students work on extended research projects that carry them beyond the classroom—into their communities, museums, university labs, and research institutes. In *Comprehensive projects* (see Snapshots of Comprehensive Projects on page 7), teachers participate in intensive professional development and use their experiences to enhance their students' learning.

The ITEST Negotiated Research Agenda

The research agenda leverages the combined achievements of the ITEST projects into new knowledge about what works. We use a collaborative approach—adapted from Lawrenz and Huffman's (2003) multi-site participatory evaluation model—to design and conduct ITEST research. Working closely with projects and their evaluators, we carry out a multi-site, coordinated research program in which we answer questions of interest to the ITEST community and the field and pursue four objectives:

1. To generate research questions that will inform project practice and development
2. To build on project evaluations and data collection to inform the generation of research areas and questions
3. To leverage local evaluation data collection and analysis to form the base of the larger inquiry
4. To highlight issues of equity, access, informal learning (voluntary, primarily self-directed, and independent learning), and formal learning (in schools and classrooms)

Our research team is uniquely qualified for this role. EDC has extensive experience studying the intersection of formal and informal learning. For many years, we have investigated the developmental process of lifelong learning. Our organization has a long and successful history of building collaboration among partners and incorporating principles of equity and diversity into education. We also specialize in advancing IT skill development initiatives in the United States and internationally. In implementing the ITEST research agenda, we draw on these strengths and make good use of the expertise of our colleagues and partner organizations worldwide.

Research Methods for This Publication

ITEST projects report to NSF on an annual basis, and these annual reports include evaluation reports. For this publication, we conducted a thematic analysis of 29 projects' 2005 annual and evaluation reports. Participation in LRC-led research is voluntary, and we could not obtain all reports from all sites. Thus, we examined reports from 11 of the 12 Cohort 1 (2003–2006) projects and all 19 Cohort 2 (2004–2007) projects—a total of 18 evaluation reports and 29 annual reports. At the time of the 2005 reports, Cohort 1 projects had been underway for two years, and Cohort 2 projects had just completed their first year of work. As a new program, the insights and innovations discussed here reflect the patterns found at the mid-point in the ITEST projects reviewed and do not constitute their final results. To date, the ITEST program has funded four cohorts of projects.

It is important to note that, as a new program, the ITEST community has not yet established agreements about standard practices for gathering data to inform research and practice. Thus, the reports we reviewed did not follow a standard format or use the same data collection techniques. Currently, individual projects and their evaluators work out reporting details to serve projects' needs, without giving consideration to how the data might be compiled to inform the larger ITEST program research agenda. As the ITEST program matures, the LRC will work with the ITEST community to determine agreed-upon common data collection and reporting procedures. While the full effect of the ITEST program's leveraged learning has yet to be realized, individual project evaluations have a great deal to tell us about the ITEST experience and outcomes. Evaluations of ITEST projects were based on mixed-methods approaches to formative and summative evaluation. Specific methods include case studies, observations, satisfaction surveys, content exams, skills tests, standardized instruments for measuring IT skills, achievement tests, comparisons to national datasets, daily journals, interviews, focus groups, and document review.

As we analyzed the reports, we looked for evidence of the following factors related to ITEST project goals:

- Short-term and intermediate outcomes for participants
- Participants' general satisfaction with project services
- Innovative approaches/activities
- Challenges faced and how they were resolved

We screened each of the resultant findings using Patton's (2001) eight criteria for "High-Quality Lessons Learned" as a framework (p. 335):

1. "Evaluation findings—patterns across programs
2. Basic and applied research
3. Practice wisdom and experience of practitioners
4. Experiences reported by program participants/clients/intended beneficiaries
5. Expert opinion
6. Cross-disciplinary connections and patterns
7. Assessment of the importance of the lesson learned
8. Strength of the connection to outcomes attainment"

Patton notes that "high-quality lessons learned" constitute "knowledge that can be applied to future action and derived from screening according to specific criteria. . . . The idea is that the greater the number of supporting sources for a 'lesson learned,' the more rigorous the supporting evidence and the greater the triangulation of supporting sources, the more confidence one has in the significance and meaningfulness of a lesson learned. Lessons learned with only one type of supporting evidence would be considered a 'lessons learned hypothesis'" (Patton, 2001, p. 335). All of the learnings that we present in the next section meet at least two of Patton's criteria for being a high-quality lesson learned.

Lessons Learned

In the pages that follow, we present our learnings regarding ITEST projects' outcomes, innovations, and challenges.

Outcomes and Satisfaction with Services

Our analysis of the reports revealed that students and teachers believed that ITEST projects were increasing their understanding of, competence with, and confidence in applying IT tools. Students and teachers alike felt that they were gaining a better understanding of IT careers from their ITEST project experiences. ITEST's "real world," informal, and experiential approach to learning also appeared to enhance STEM learning and teaching for participants. As one youth-based project participant noted, “It’s not just reading science, but doing science. We’re not bored and we do projects.” A teacher in a comprehensive project reflected, “I know my lectures and use of technology will be light years ahead of what I was doing last year.”

Student outcomes were reported for both comprehensive and youth-based projects, for example:

- By the end of their ITEST experiences, students were able to identify careers in media technology, science, and engineering. In the words of one participant in a youth-based project, “I want to be a wildlife biologist like [staff member]. It’s fun to be outdoors.”
- Students gained the technology skills and experiences necessary to obtain science- and IT-related internships and jobs.
- Students reported an increased understanding of IT and science concepts and real-world applications.
- In addition to IT skills, students demonstrated enhanced content knowledge.
- Students reported being able to see the connection between science and culture and said that they expected they would need science knowledge in their future careers. One participant in a youth-based project stated, “I definitely want to find a scientific career that will allow me to explore my own cultural heritage.”
- In more than one project, more than 80 percent of student participants planned to attend college. Students reported improved motivation to continue in school, as they gained a better understanding of the courses they would need to take to pursue STEM careers.

“I really enjoyed being able to be a part of this program and it’s one of those things that is going to stay with me for a while. It was great fun learning all the software and working with my teacher. I feel that our relationship next year will be bettered by the fact that I got to work with her during the summer.”

—Student in a comprehensive project

Teacher outcomes reported for comprehensive projects included the following:

- Projects reported measurable gains in teacher competence and confidence in IT and in integrating technology into the classroom. One participant observed, “I feel much more prepared to implement research because of this workshop. We developed activities and presented them to students. The presenting to students was key in this workshop to help us as teachers figure out how things work.”
- The teachers with the least amount of technology experience showed the greatest growth with regard to technology skills.
- In addition to teachers reporting an enhanced understanding of use of technology in science careers, projects also found evidence of increased knowledge of specialized content.
- Teachers returned to their schools from summer workshops as IT enthusiasts. One participant noted, “I really think I’ll be able to implement this technology in my classroom. From the response of the students during our module, I feel sure that [the program’s] objective to bring IT to students will be met.”

- Working with summer workshop students gave teachers the confidence to put their new knowledge to use in their classrooms.

Challenges

Our analysis of ITEST reports revealed that projects faced a number of challenges. The "newness" of IT, and some aspects of STEM, for some students, teachers, and schools meant that projects needed to bridge sizable knowledge gaps. Further, despite their innovative approaches (see **Innovations,** below), projects often found it difficult to recruit and retain participants.

- Projects found that students, particularly those in the middle grades, had not yet developed an understanding of the scientific process and the connection between scientists' work and scientific knowledge.
- Many of the teachers that participated in the comprehensive projects had a limited understanding of how to conduct research, and they had difficulty designing research experiences for their students. Because they were unfamiliar with the research being conducted in their topic of interest, and did not know what kinds of data might be available, most teachers did not know how to ask research questions that could be studied effectively with IT tools.

SNAPSHOTS OF Youth-Based Projects

Youth-based projects place strong emphasis on career and educational paths. They offer year-round enrichment experiences for middle and high school students.

- In Pennsylvania, female, Hispanic, and African American students are using GIS technology in Spanish and English to learn about and map their community.
- In Minnesota, students—with a special emphasis on girls and youth of color—team with museum, community, and industry mentors to explore the connection between technology and art.
- In Baltimore, students, particularly girls, are engaged in IT learning experiences related to robotics, digital storytelling, animation, genealogy, and nature.

- Weaknesses in teacher training translated into weaknesses in student understanding and interest. The key to success for comprehensive projects was the link between teacher outcomes and student outcomes.
- While computers are a part of daily life, many projects reported that computers were not part of the ongoing teaching and learning processes in schools.
- Projects competed with other after-school or summer activities, including summer school, for student participants. Teacher recruitment was challenged by

> **"This has already impacted how I plan my classes. It has inspired me to go to greater lengths to make more field experiences possible for my students."**
>
> ***—Teacher in a comprehensive project***

competition from other professional development programs.

- Student recruitment depended on relationship building with referring teachers and other influential adults, influence of youth leaders, and parent support. Building these relationships was critical to project success, but also time-consuming. Projects reported that to improve recruitment and retention, they needed to be actively involved at all school sites and to target schools rather than individuals.

Innovations

From our analysis of the reports, we identified several innovations in STEM education and enrichment activities. Projects adopted a variety of new approaches to program recruitment, strategies to introduce students to IT tools and careers, and routes to mainstream IT into classrooms and students' lives. The presence of collaborations and partnerships of various kinds was a strong, cross-cutting theme underlying many of these innovations:

- Parents served as a recruiting network. Projects successfully engaged parents in booster clubs and technical advisory committees to support recruitment and retention.
- Partnerships developed across organizations, which augmented recruitment and retention efforts, created a pool of professionals and potential mentors to draw from, and provided opportunities for students and teachers to work on real-world issues.
- IT, science, and media professionals partnered with teachers and students in project activities.
- Interviews with STEM and IT professionals on DVD exposed students to STEM and IT careers.
- Students had role models who were working and successful in IT. Women and minorities who were successful IT professionals visited schools and served as role models for students. Students also became role models for one another.
- Projects involved students in teaching one another and recognized their efforts and successes.
- With teachers acting as students, projects modeled hands-on pedagogy and integration of IT into classroom teaching.
- Projects added a math component to IT after-school activities and highlighted the relationship of math to computer science.

Strengths and Limitations of the Research

ITEST is a one-of-a-kind-program, combining workforce development and education; ITEST projects' experiences and lessons learned can influence multiple fields. These lessons learned represent a new data source on the collective "impact" of the ITEST program, and the data have significant strengths. In our thematic analysis, we used a rigorous, clearly defined process to identify findings and screen them for soundness. The findings also serve to capture and convey participants' perspectives regarding the program's efficacy.

At the same time, several factors limited our ability to gather, analyze, and cross-compare data from the reports:

1. As noted, we could not obtain all reports from all sites. Projects and their evaluations were not on a set, shared time schedule. Further, reports were often incomplete or submitted mid-cycle.

SNAPSHOTS OF Comprehensive Projects

Comprehensive projects support teachers in infusing their STEM courses with IT concepts and tools. Summer workshops for teachers cover a wide range of concepts, skills, applications, and pedagogical strategies that promote investigation and inquiry.

- In Alaska, teachers and their students—mostly Native Alaskans—are gaining experience with spatial analysis IT tools in a culturally responsive geo-science education program.
- In North Dakota, teachers and their students are learning how to use IT tools to conduct surface water quality monitoring activities, to analyze data, and to disseminate their results.
- In Massachusetts, STEM teachers and their students—with an emphasis on girls and students of color—are building assistive technology devices and learning, hands-on, the engineering process.

2. Projects were very different from one another in terms of their content and approaches, even within the two categories of projects.
3. Projects were at very different phases in their development. For example, some projects reported the numbers of participants they expected to serve, while others cited targets for recruitment.
4. We did not have consistent demographic information from all projects, so we could not aggregate across projects the number of participants served or the demographics of the participants.
5. Student and teacher outcomes come straight from the reports. Many reports were not supported by data (e.g., analytic tables, descriptions of data collection), and many projects used self-report methods.

Summary

In this publication, we provided a high-level overview of the themes and lessons learned that emerged from our analysis of the 2005 ITEST evaluation and annual reports. The positive outcomes reported indicate that the ITEST model has the potential to realize NSF's vision to expand and diversify the IT workforce. In both informal and formal settings, projects are opening doors to STEM-related IT careers for students who might never have envisioned themselves in that field. Projects are also building the capacity of teachers to use IT tools to enhance STEM learning.

The information about project innovations and challenges has many implications for professional developers, school districts, program planners, and researchers. Below, we highlight a few:

- **For professional developers:** The findings indicate that teachers urgently need additional training and support in how to conduct, and involve students in conducting, research projects in the classroom.
- **For school districts:** The findings indicate that school systems can play an important role in weaving IT into the fabric of teaching and learning—and that more need to do so.
- **For in-school program planners:** The findings indicate that the comprehensive project's two-tiered approach—engaging teachers *and* their students—can strengthen teaching and enhance learning.
- **For after-school program developers:** The findings indicate that students respond to informal, hands-on, project-based experiences, which can help students develop an understanding of science and the scientific process; they then bring this knowledge back to their schoolwork.
- **For researchers:** The findings indicate that partnerships of various kinds can help projects advance their goals. However, more needs to be known about how and why these partnerships work.
- **For ITEST project principal investigators:** The findings indicate that developing consistent formats and practices for gathering and reporting data could enhance the information generated from each project's research contributions.

We encourage readers to reflect on these lessons learned and their implications and to build on the work of the ITEST program. We urge others to take the lessons learned and to test them in their own contexts, adding to the knowledge base and contributing to testing "their wisdom and relevance over time in action in new settings" (Patton, 2001, p.335).

To learn more about the ITEST projects and the work of the LRC, please visit the **LRC's Web site: http://www2.edc.org/itestlrc**

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