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Editorial: Innovative Professional Development for STEM Workforce Development

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Three papers in this special issue of *Contemporary Issues in Technology and Teacher Education* present examples of projects funded by the National Science Foundation’s (NSF) Innovative Technology for Students and Teachers (ITEST) program. More than 180 ITEST projects have been funded across the United States to provide students and teachers with formal and informal technology experiences and to increase awareness of, interest in, and readiness for science, technology, engineering and mathematics (STEM) careers.

The combined focus on workforce development and the integration of innovative technology applications into both classroom and out-of-school STEM learning has resulted in a stunning array of projects that range from DNA sequencing to urban ecology research. The youth and teachers who participate in ITEST projects have unique opportunities to engage in STEM through summer institutes and afterschool experiences for youth, and professional development and communities of practice for teachers (Parker, Stylinksi, et al., 2010).

In addition to the ITEST projects, the NSF has funded a resource center to provide technical assistance to the projects. Housed at Education Development Center, Inc., ITEST’s STEM Learning Resource Center has been providing technical assistance and capacity building support to project principal investigators and evaluators through an online and face-to-face community of practice. They can find resources, share expertise, and raise visibility of their work to inform STEM education policy and practice through conference presentations and publications. The Learning Resource Center provides an annual report summarizing the work of ITEST projects each year (Parker, Na'im, & Schamberg, 2010), as well as a website with both public and restricted access (http://itestlrc.edc.org).

Researchers and teacher educators in STEM fields have identified different best practices for conducting effective professional development (Guskey, 2003), and considerable overlap and agreement exists about the components among researchers. ITEST teacher education projects incorporate many of the key components: active learning (Desimone, Porter, Garet, Yoon, & Birman, 2002; Garet, Porter, Desimone, Birman, & Yoon, 2001); opportunities to collaborate with peers and reflect on teaching practices; collective participation (e.g., from the same school or teaching similar subjects) (Garet et al., 2001); a focus on content knowledge and classroom-based curriculum projects (Desimone et al., 2002; Garet et al., 2001); proximity to classroom practices; coherence with teachers' professional lives (Garet et al., 2001; Penuel, Fishman, Yamaguchi, & Gallagher, 2007); strong alignment with educational standards; and sufficient time to implement what has been learned (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003; Penuel et al., 2007).

The three ITEST projects described in this issue incorporate many of these characteristics, as well as incorporating innovative components common to ITEST projects: the interweaving of formal and informal learning environments, the engagement with hands-on, deep STEM content areas, and the commitment to improving the quality of research on the impact of the projects on participants.

Interweaving Formal and Informal Learning Environments

A large body of work is focused on out-of-school STEM learning (Falk, 2001; Falk, Randol, & Dierking, 2008; Fenichel & Schweingruber, 2010; "ITEST Program Findings on Youth Motivation," 2010; National Research Council, 2009), and an emerging literature on afterschool STEM learning (Friedman, 2005; Knapp, Heuer, & Mason, 2008; Noam, Dahlgren, Larson, & Dorph, 2008; Stake & Mares, 2005). Research has also been done on the role of afterschool in STEM workforce development (Cochran & Ferrari, 2009; Murnane & Levy, 2004).

ITEST projects provide a unique way of thinking about the ways in which out-of-school experiences can enrich classroom teaching. Bridging the worlds of formal and informal STEM learning has been a focus of ITEST since its beginning. For the first five years of the ITEST program, projects defined themselves either as youth-based or comprehensive (focusing on teacher professional development), with youth-based projects being housed in informal learning and comprehensive projects in the formal learning sphere. However, this separation was often a semantic one.

Projects that focused on teachers always had a summer out-of-school youth component, and many youth-based projects also had components in the formal learning setting. The ITEST community of practice strategically joined principal investigators from both youth-based and comprehensive projects in a series of learning exchanges helping projects share lessons learned and best practices across the formal/informal learning divide. ITEST is now a single community, addressing the challenges of STEM learning from multiple perspectives.

The most recent ITEST projects (since 2008) no longer include the designation of youth-based or comprehensive, and a brief review of the project descriptions (available at http://itestlrc.edc.org) indicates that many of them have deliberately been designed to include both formal and informal learning environments.

Each of the three ITEST projects described in this issue brings informal learning with students into professional development opportunities for teachers. Carole Greenes describes the Prime the Pipeline Project (P3), which invites students and teachers to participate in scientific villages, 9-week intensive afterschool projects that focus on one of more than 10 integrated science concepts, including 3-D Virtual Modeling for Emergency Services and Aviation: Flight Training. Village members include classroom teachers, students, college interns, and university scientists – a mix of learners that brings together adults from the formal classroom with students in an informal setting. In addition, the project provides participating teachers with a professional development component to make connections between the out-of-school activities and their classroom teaching.

Similarly, iQUEST, described by Hayden, Ouyang, Scinski, Olszewski, and Bielefeldt, includes a youth summer camp component as well as teacher professional development.

Middle-Schoolers Out to Save the World (MSOSW; Knezek, Christensen, & Tyler-Wood) focuses on in-school learning through teacher professional development, but its professional development is closely linked to teacher practice with students. Each of the projects includes students in the teacher professional development, often through informal learning opportunities. This holistic approach to professional development acknowledges the importance of student experiences in professional development.

Engagement With Hands-on STEM Content

In addition to weaving informal experiences into professional development, ITEST projects use innovative applications of technology to promote interest in and build skills and knowledge about STEM content. Youth and teachers have opportunities to use technologies that are more often found in scientific careers than in classrooms, they speak directly with and work hand in hand with scientists and engineers, and they learn about the myriad opportunities available in STEM fields. Teachers are provided with information about STEM careers to provide to their students. The STEM concepts, principles and skills that they learn have direct applications to possible future careers. The projects use technology that often is available only to scientists, but rarely accessible to middle or high school students, as well as using technology that is readily available, but in innovative ways.

The iQUEST project has students disassemble a camera to learn about the technology within the commonly used instrument, as well as using geographic positioning systems (GPS) to deepen understanding of Earth Science. The scientific villages in the P3 project cover a wide range of scientific areas, including wind energy and robotics. MSOSW focuses on monitoring home energy use and understanding the complexities of energy consumption and conservation. All of the projects share a commitment to providing teachers and youth with innovative ways of using technology to learn about myriad STEM content areas.

Improving Research on Project Impacts

These three ITEST projects also share a commitment to rigorous research and evaluation of the impact of their project on participants. Knezek et al. described how researchers in the MSOSW project have validated an instrument measuring interest in science, technology, engineering, mathematics, and STEM careers with a diverse group of stakeholders: middle school students and teachers, NSF project principal investigators, STEM leaders, and preservice teachers. The validated instrument can be used with both youth and adults, allowing them to compare differences in STEM attitudes between teacher participants and student participants.

The P3 project is using a quasi-experimental design to measure the impact of student participation in P3. They look at knowledge acquisition through pre- and posttests, as well as course-taking patterns. The iQUEST project uses a published instrument, the Test of Science-Related Attitudes (TOSRA) to measure change in STEM interest after project participation.

In and of themselves, the ideas that join together to form the ITEST program are not new. Providing youth with access to and information about STEM careers, encouraging hands-on STEM experiences, merging informal and formal learning, and carefully measuring the impact of the projects, by themselves are not unique. When they are put together in each of the ITEST projects, however, what emerge are unique experiences for students and teachers which use innovative applications of technology to provide access to new ways to engage in STEM learning and to think about STEM careers.

References

Cochran, G., & Ferrari, T. M. (2009). Preparing youth for the 21st century knowledge economy: Youth programs and workforce preparation. *Afterschool Matters*(8), 11-25.

Desimone, L. M., Porter, A. C., Garet, M. S., Yoon, K. S., & Birman, B. F. (2002). Effects of professional development on teachers' instruction: Results from a three-year longitudinal study. *Educational Evaluation and Policy Analysis, 24*(2), 81-112.

Falk, J. H. (2001). Free-choice science education: How we learn science outside of school. New York City: Teachers College Press.

Falk, J. H., Randol, S., & Dierking, L. (2008). *The informal science education landscape: A preliminary investigation*. Retrieved from the Center for Advancement of Information Science Education website: http://caise.insci.org/uploads/docs/2008_CAISE_Landscape_Study_Report.pdf

Fenichel, M., & Schweingruber, H. A. (2010). *Surrounded by science: Learning science in informal environments*. Retrieved from The National Academies Press website: http://www.nap.edu/catalog.php?record_id=12614

Friedman, L. N. (2005). *Where is after-school headed and how do science learning opportunities fit into the after-school landscape*. Retrieved from the Resources on Afterschool website: http://www.afterschoolresources.org/kernel/images/tascsci.pdf

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal, 38*(4), 915-945.

Guskey, T. R. (2003). Analyzing lists of the characteristics of effective professional development to promote visionary leadership. *NASSP Bulletin, 87*(637), 4.

Knapp, L. G., Heuer, R. E., & Mason, M. (2008). Upward Bound and Upward Bound Math-Science Program outcomes for participants expected to graduate high school in 2004–06, with supportive data from 2005–06. Washington, D.C.: RTI International.

Loucks-Horsley, S., Love, N., Stiles, K. E., Mundry, S., & Hewson, P. W. (2003). *Designing professional development for teachers of science and mathematics* (2nd ed.). Thousand Oaks, CA: Corwin Press.

Murnane, R., & Levy, F. (2004, April). *Preparing students to thrive in 21st century America: The role for afterschool.* Paper presented at the Reimagining AfterSchool symposium, Cambridge, MA.

Noam, G., Dahlgren, C., Larson, J., & Dorph, R. (2008, September). The lay of the land: Science learning in afterschool settings. Paper presented at the Science and Technology in Out-of-School Time Conference, Chicago, IL.

Parker, C. E., Na'im, A., & Schamberg, M. (2010). *ITEST Management Information System (MIS) 2009: Final report describing active ITEST projects*. Retrieved from the ITEST Learning Resource Center website: http://itestlrc.edc.org/sites/itestlrc.edc.org/files/MIS_Final_combined.pdf

Parker, C. E., Stylinski, C., Darrah, M., McAuliffe, C., Gupta, P., & Akbayin, B. (2010). Integrating innovative IT applications into STEM classrooms: A preliminary review of ITEST teacher professional development. *Journal of Teaching and Technology Education*, *18*(2), 203-230.

Penuel, W. R., Fishman, B. J., Yamaguchi, R., & Gallagher, L. P. (2007). What makes professional development effective? Strategies that foster curriculum implementation. *American Educational Research Journal*, *44*(4), 921-959.

Stake, J. E., & Mares, K. R. (2005). Evaluating the impact of science-enrichment programs on adolescents' science motivation and confidence: The splashdown effect. *Journal of Research in Science Teaching*, *42*(4), 359-375.

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