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STEM Learning & Resource Center (STELAR): Supporting Engineering Education within the NSF ITEST Program

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Clara McCurdy-Kirlis, Project Staff, has 10+ years of experience in project management in health and education fields at state, tribal, community, and international levels. She has played lead roles in instructional design for adult learners, e-learning design and delivery, higher education curricula development, and interdisciplinary project coordination. In addition to supporting the ITEST projects, Clara also designs virtual and face-to-face training materials, creates tools and one-pagers for dissemination, and coordinates and facilitates webinars and trainings. She is passionate about the role of education in transforming society and bringing about positive change through collaboration and commitment.

STEM Learning & Resource Center (STELAR): Supporting Engineering Education within the NSF ITEST Program

The National Science Foundation's Innovative Technology Experiences for Students and Teachers (ITEST) program supports the research and development of innovative models for engaging PreK–12 students in authentic experiences designed to build their capacity to participate in the science, technology, engineering, and mathematics (STEM) and information and communications technology (ICT) workforce of the future. The ITEST program is unique in that it is the only NSF program devoted to STEM workforce development at the primary and secondary school levels. With a focus on populations traditionally underrepresented in STEM fields, it aims to develop a diverse and innovative pipeline to STEM careers. Funded by revenue collected from the H-1B visa program, which permits U.S. businesses to use overseas workers to fill vacant positions U.S. occupations, ITEST aims to remedy the shortage of highly skilled workers while also addressing the diversity issues and inequities present in STEM fields [1], [2].

All ITEST projects are research and development (R&D), and are focused on providing innovative learning models designed to inspire future STEM leaders. The main pillars of the ITEST program, which all projects are asked to address in their proposals, are as follows: (1) increase awareness of STEM and ICT occupations; (2) motivate students to pursue appropriate education pathways to those occupations; and (3) develop STEM-specific disciplinary content knowledge and practices that promote critical thinking, reasoning, and communication skills needed for entering the STEM and ICT workforce of the future [1]. It is this focus on preparing diverse PreK–12 youth to become a knowledgeable, skilled, and well-prepared future STEM workforce that makes the ITEST program unique.

Education Development Center (EDC) has served as the resource center in support of the NSF ITEST program since the program's inception in 2003. EDC, a global nonprofit, advances lasting solutions to improve education, promote health, and expand economic opportunity. EDC has a strong commitment to issues of equity, diversity, and inclusion, and believes equity is central to improving systems and shaping policies that will enable a more just future [3]. Aligned with NSF's commitment to broadening participation in STEM, EDC has supported the ITEST portfolio of projects initially as the ITEST Learning and Resource Center (LRC) from 2003-2012, and from 2013 through today as the STEM Learning and Research Center (STELAR).

The STELAR Center serves the NSF ITEST program's grantees, as well as those interested in pursuing ITEST funding, by: 1) providing technical support that facilitates ITEST projects' success in developing and articulating innovative models for STEM learning environments; 2) synthesizing and disseminating ITEST projects' findings nationally in order to inform and influence a national community of other stakeholders; and 3) broadening participation in the ITEST community through outreach to individuals, organizations and communities not currently represented in the ITEST portfolio. By providing support to the ITEST community of practice, STELAR ensures that projects can build on prior learning, share best practices, and inform the broader field of STEM education research. STELAR also performs outreach and proposal development support for those interested in pursuing new projects, offering a proposal development course, advising those new to the program, and providing feedback on draft proposals to support the next wave of innovation, which is essential to the health and vitality of science and engineering.

STELAR's access to longitudinal project data, combined with our ongoing analysis of the ITEST portfolio, has enabled the synthesis and dissemination of a variety of findings. The ITEST program has awarded nearly $521 million across more than 490 projects since 2003, with programs spanning 48 states and the District of Columbia. Each project explores innovative models of engaging Pre–K through 12 youth in both formal school settings and informal STEM education programming. Data collected between 2003 and 2018 shows that ITEST projects have served more than 830,000 youth, with a focus on students from populations that have been traditionally underrepresented in STEM fields. In addition to the youth served by the program, ITEST has also impacted 52,000 educators and involved more than 10,000 parents & caregivers through their engagement with a variety of STEM disciplines.

While the overall program has shifted in response to NSF research priorities over time, ITEST has always included engineering as a key discipline within the broader STEM education landscape. Data collected by STELAR shows that of the nearly 500 ITEST projects funded since 2003, 165 projects, or roughly 1/3, have focused on engineering. Realizing the importance of engineering education, in 2011 STELAR organized a working group of principal investigators and evaluators of ITEST projects to learn about their work. The group produced the report, *ITEST Engineering Model: Building a Better Future for STEM Learning* [5] that includes underlying theoretical frameworks and a theory of action that described the cumulative effect and interaction of essential elements of the ITEST program that led to increased interest and engagement in and preparation for STEM careers. It also described the common elements that characterized ITEST projects, and shared examples of claims and a sampling of evidence that supported those claims.

The innovative nature of the ITEST program is demonstrated in both the technologies used within projects, as well as in the approaches these projects employ. Project descriptions for ITEST projects can be viewed on the STELAR website, but the objectives listed below offer examples of projects' focus:

- engaging youth with age-appropriate, technology-rich STEM learning experiences fundamental to the engineering process;
- developing and studying community-connected, integrated science and engineering curriculum units that leverage mobile maker space and digital notebook technologies to support diverse elementary students' science and engineering ideas, practices, and attitudes;
- engaging in collaborative design, implementation, and study of recurrent engineering-focused interventions with middle school youth, with a potential for recruiting future engineers who are unaware of their abilities and career possibilities because of the rural Appalachian communities in which they live; and
- introducing basic applied physics concepts in rigid-body dynamics where students design, test, and redesign model stock minicars using computer assisted design software, 3D printers, and virtual and desk-top wind tunnels.

Each ITEST project impacts communities in different ways, with a wide variety of participants, project settings, and partners. For more details, visit the STELAR website to view all past and presently active projects [6], and to and read about how these engineering projects are making a difference in their communities:

- Project BUILD (Building Using an Interactive Learning Design) [7]
- Community-Engaged Engineering Interventions with Appalachian Youth [8]
- Connections in the Making: Elementary Students, Teachers, and STEM Professionals Integrating Science and Engineering to Design Community Solutions [9]
- Zipping Towards STEM: Integrating Engineering Design into the Middle School Physical Science Curriculum [10]
- Collaborative Research: American Innovations in an Age of Discovery: Teaching Science and Engineering through 3D-printed Historical Reconstructions [11]

In addition to the profiles of ITEST projects like those listed above, the STELAR website is home to a rich library of more than 600 ITEST project developed curricular materials, evaluative instruments, and publications [6].

Those who study the future of work understand that discovery and innovation is occurring at the intersections of disciplines, where a common language can create bridges of understanding. In "Building the Foundational Skills Needed for Success in Work at the Human-Technology Frontier," the STELAR Center called out engineering education an essential ingredient in the development of a skilled future workforce [5]. That report posited that design thinking will play a significant role in the future of work, not only because it captures the process by which ideas are translated into products, but also because it provides a common language and process for engineers and team members from other disciplines (management, production, marketing/sales, customer relations, and many more) to define a problem and develop pathways toward a solution.

Foundational skills and knowledge of engineering and design thinking, therefore, should be integrated into PreK–12 education to provide students with the grounding they will need to succeed in any career field. Students preparing for work at the Human-Technology Frontier would benefit from learning the language/terminology used in the engineering design process, no matter what their role on the dynamic interdisciplinary teams that will be creating new products and services to meet societal needs. ITEST's engineering projects provide rich examples of what students know, and are able to do, as they explore engineering in and out of school; and provide both students and teachers with opportunities to use cutting edge methods and technologies used in industry, and work hand-in-hand with engineers on the edge of innovation.

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