

# ITEST Cohort 8 Abstracts

## **Bridging Math Literacy and Digital Media Creation: Students as Learners, Teachers, and Leaders of STEM Content**

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**Program Manager:** Patricia Wilson  
**Start Date:** December 1, 2010      **Expires:** November 30, 2011 (Estimated)  
**Investigator(s):** Chad Milner (Principal Investigator)  
Eli Tucker-Raymond (Co-Principal Investigator)  
Maisha Moses (Co-Principal Investigator)  
**Sponsor:** Young People's Project, Inc.  
**Award Number:** 10-31633

The project leaders will guide high school students through a mathematics-based, programming experience which prepares them to in turn teach mathematics and programming to middle school students. Using a "drag and drop" programming language, the participants will explore mathematical concepts. Products of the project will include two modules, the first using video games based on existing mathematics games and the second using simulations to explore social issues. The goals of the project are (1) to develop computational literacy as well as mathematical literacy and (2) encourage students to pursue STEM careers.

## **Clean Energy Literacy and Leadership**

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**Program Manager:** Monya Ruffin  
**Start Date:** September 15, 2010      **Expires:** August 31, 2011 (Estimated)  
**Investigator(s):** Kevin Cuff (Principal Investigator)  
Darrell Porcello (Co-Principal Investigator)  
**Sponsor:** University of California-Berkeley  
**Award Number:** 10-31901

The Clean Energy Literacy and Leadership (CELL) project will develop, implement, and evaluate a community-oriented program designed to better inform youth and their families about clean energy practices and "green" career opportunities. The target audience includes predominately African American and Latino youth, ages 13 to 16, and their families from five underserved communities in the East San Francisco Bay area. The University of California-Berkeley and a host of partner organizations and advisors; the East Bay Green Corridor Partnership, a consortium of major academic institutions, local municipalities, work force development and training organizations, a Department of Energy operated national laboratory, school districts, and clean energy and green business practitioners will work collaboratively to develop and implement the project.

Twenty students at five high schools and one middle school will participate in the project each year, totaling 300 students over the duration of the project. CELL activities will take place in after school settings, during the summer, and at public events. Participants will: (a) learn clean energy concepts, (b) participate in clean energy research investigations to better understand energy impacts within their communities, (c) engage in activities linking science content to sustainable positive behavioral changes, (d) use ICT applications to build knowledge, communication and presentation skills, and (e) attend presentations by clean energy professionals (entry-level-degree required positions) to learn about their careers and career pathways. CELL instructional materials & learning modules, an Instructor's Guide, and a digital learning platform (e.g., website, wiki, blog) are the primary project deliverables and will be publicly available.

Evaluative data will be collected through surveys, digital portfolios, interviews, and constructed reflections and will be used to monitor, assess, and inform the project and the extent to which project goals have been met and the intended impacts achieved. Increased awareness, understanding, and interest in critical energy related concepts are the intended project outcomes.

### **Conducting Authentic Molecular Biology and Genomics Research in High Schools**

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**Program Manager:** Julia Clark  
**Start Date:** November 15, 2010      **Expires:** October 31, 2011 (Estimated)  
**Investigator(s):** Andrew Vershon  
**Sponsor:** Rutgers University New Brunswick  
**Award Number:** 10-31158

This Rutgers University proposal, Conducting Authentic Molecular Biology and Genomics Research (MBGR) in High Schools, is a three-year strategies-based ITEST project that provides avenues for science teachers and their students to become part of, and contribute to, authentic research in biotechnology, molecular biology, and bioinformatics. Teachers and students will use Information and Communication Technology (ICT) to analyze their experimental findings and publish their results in databases used by scientists throughout the world. The primary goal of MBGR is to determine what strategies promote authentic student research and thereby foster student interest in STEM careers. In this proposed study, MBGR will examine the role of five key elements and how they are related to the strategies that the program will use to a) broaden the research content of the project and, b) study the individual program components that are used to support genuine research in high schools. These strategies will be implemented and studied at three Universities: the lead facility, Waksman Institute, Rutgers University, and two other sites, John Hopkins University in Baltimore, Maryland and at the University of Texas at Austin. Participants will include 20 teachers and 40 students at the Rutgers Summer Institute; 10 teachers and 20 students at John Hopkins University Summer Institute and 6 teachers and 12 students at the University of Texas Summer Institute.

### **Design Loft STEM Learning Program**

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**Program Manager:** David Hanych  
**Start Date:** April 1, 2011      **Expires:** March 31, 2012 (Estimated)  
**Investigator(s):** Shelley Goldman (Principal Investigator)  
Bernard Roth (Co-Principal Investigator)  
Sheri Sheppard (Co-Principal Investigator)  
**Sponsor:** Stanford University  
**Award Number:** 10-29929

The Design Loft STEM Learning Program is introducing 400 underserved middle school students in California to engineering careers. The goal of the program is to develop students' ability to define and create solutions for real world problems by using "design thinking." The program's learning activities expose students to design thinking tasks that produce low-cost engineering solutions to improve the lives of poor people around the world. Students are designing cost-effective ways of increasing impoverished people's access to water, shelter, and energy.

The project's objectives are to (1) develop design-based intersession career camps, (2) create a professional community institute and web site for camp educators and teachers from partner schools, (3) develop a participant-mentoring course for STEM college students, and (4) assess the effectiveness of the design-based STEM career camp model. Anticipated outcomes include exposure of middle school students to design thinking and engineering careers, development of instructional resources for teachers,

creation of a scalable model program for teaching and learning about design thinking and engineering careers, and collection of project effectiveness data.

### **From Learning to Research: Developing Future Earth System Scientists and Professionals**

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**Program Manager:** David Hanych  
**Start Date:** August 15, 2010      **Expires:** July 31, 2011 (Estimated)  
**Investigator(s):** Edward Geary (Principal Investigator)  
Michael Odell (Co-Principal Investigator)  
Tamara Sumner (Co-Principal Investigator)  
Christopher Hoadley (Co-Principal Investigator)  
**Sponsor:** University Corporation For Atmospheric Res  
**Award Number:** 09-29725

The University Corporation for Atmospheric Research is collaborating with the GLOBE program, the University of Colorado, New York University, the Texas Regional Collaboratives and several other partners to design, implement, and evaluate an Earth System Science learning experience for teachers and students. The goals of the From Learning to Research project are to prepare 80 teachers to engage middle and high school students in Earth System Science research on local, regional, and national scales, expose teachers and students to Earth Science careers, and allow students to interact with scientists from around the world.

The project is providing onsite and virtual professional development activities for teachers and the GLOBE Student Research Collaboratory (GSRC) is supporting teacher and student learning about climate science and research. Teachers and students are learning about climate science and develop systems thinking, problem-solving, data analysis, communication, and collaboration skills. The project is (1) producing research findings on teacher and student use of GIS visualization tools, modeling programs, and social collaboration technologies; (2) implementing and evaluating GSRC's impact on motivating and preparing middle and high school students for careers in STEM; and (3) providing teachers with resources and strategies for ensuring that their students know about and prepared for STEM careers in earth science-related careers.

### **Game Design with Mentoring for Computer Science and Math Achievement for Educationally Disadvantaged Students**

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**Program Manager:** Leslie Goodyear  
**Start Date:** February 1, 2011      **Expires:** January 31, 2012 (Estimated)  
**Investigator(s):** Vahl Scott Gordon (Principal Investigator)  
Kimberly Gordon Biddle (Co-Principal Investigator)  
Jean Crowder (Co-Principal Investigator)  
**Sponsor:** University Enterprises, Incorporated  
**Award Number:** 1031926

This project will utilize computer graphics, game development and mutual mentoring as elements in an innovative Computer Science curriculum for two cohorts of underrepresented high school students. The design, development and implementation of this curriculum will be conducted through a partnership of California State Sacramento (the Department of Computer Science and the College of Education), Mathematics Engineering Science Achievement (MESA) and local K-12 schools. Key goals of the project are to test the new curriculum's efficacy for 1) increasing the likelihood that students will study computer science in college, 2) improving students' readiness to study computer science and mathematics in college, and 3) determining which of two computer languages that are candidates for use in the curriculum is best suited for engaging students and promoting their understanding of computer science.

Another major component of the proposed project is mutual mentoring which will form a mentoring pipeline from the early grades through high school and into college: elementary students will test games and meet with high school students; middle school students will test the games that high school students develop; and teachers and faculty will mentor high school students.

To achieve its goals, project includes the following elements:

- Two consecutive MESA cohorts of introductory computer science high school students (one cohort for each of the two programming languages),
- Mutual mentoring for the high school students by college students,
- Involvement of middle/elementary school students in field-testing,
- Professional development for educators,
- Support modules for educators and students, including training, mentoring panels, learning circles, and bonding events.

A robust project evaluation will document whether project objectives have been achieved, how the project worked in implementation and what were its strengths and weaknesses, and measure the outcomes and benefits for participants. The evaluation will investigate whether learning computer programming - specifically game programming - provided a domain in which students found mathematical problem-solving relevant and exciting.

### GUTS y Girls

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**Program Manager:** Sylvia James  
**Start Date:** September 1, 2010      **Expires:** August 31, 2013 (Estimated)  
**Investigator(s):** Irene Lee (Principal Investigator)  
Jennifer Dunne (Co-Principal Investigator)  
**Sponsor:** Santa Fe Institute  
**Award Number:** 10-31421

GUTS y Girls is a three-year ITEST Strategies project targeting middle school girls in Santa Fe, Las Cruces, and Albuquerque, New Mexico. This project builds on a previously funded NSF Academies for Young Scientist award (06-39637) and includes partnerships between the Santa Fe Institute and MIT, University of New Mexico, New Mexico Tech, New Mexico State University, Santa Fe Complex, Girl Scouts of New Mexico Trails, the Supercomputing Challenge, regional educational organizations, and local schools. GUTS y Girls is designed to build the STEM and ICT workforce by engaging girls in exciting cyber-enabled learning experiences that prepare them for future careers, create and study a network of support using social networking tools, and develop a replicable program model.

Project deliverables include Monthly Saturday Workshops and two-week Summer Intensive Workshops. The 7-hour Saturday workshops expose girls to a wide variety of STEM/ICT jobs and professionals while engaging them in creative projects that build their confidence. During the two-week Summer Intensive Workshop, girls gain an understanding of complex systems concepts through hands-on activities and participatory simulations. Participants investigate topics of local relevance, view them through the lens of complex systems, and then apply agent-based modeling and network analysis tools. By fostering an understanding of complex systems and developing girls' computational thinking, computer programming, computational modeling, critical thinking, and spatial skills, GUTS y Girls prepares participants for a wide range of STEM and ICT fields including computer science, ecology, engineering, and mathematics. GUTS y Girls' secondary strategy is to develop and study a support system for girls by creating a virtual clubhouse using social networking to communicate with female STEM/ICT practitioners and student mentors. All project activities are designed to support the New Mexico state standards in science and math for grades 5-8.

The target audience includes 300 low-income Hispanic and Native American youth. Project activities are hands-on, address real-world problems, and engage professionals from the field, all characteristics found in successful science and math programs that serve young women. A mixed-methods evaluation approach is planned which assesses changes in awareness of STEM and ICT fields; technical and thinking skills; understanding of complex systems and uses of computer modeling; and interest and attitudes towards STEM content and careers. This project provides insight into whether student engagement in cyber-enabled STEM learning experiences builds capacity for future endeavors in STEM and if the use of social networks and STEM mentors can sustain student interest and involvement.

### I-C-STEM IN My FUTURE

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**Program Manager:** Julia Clark  
**Start Date:** September 15, 2010     **Expires:** August 31, 2011 (Estimated)  
**Investigator(s):** Edna Holbrook (Principal Investigator)  
**Sponsor:** Jackson State University  
**Award Number:** 10-31404

I-C STEM In My FUTURE is a two-year, year-round, informal learning program for 80 students focusing on mathematics, the use of hand-held technology, computer literacy skills, technical training and career paths. The project will examine the impact of this technology-enriched intervention program on the STEM career interest of underrepresented minorities. It is an ITEST strategies proposal designed to provide middle and high school students with challenging technological learning experiences that will foster STEM career choices, promote academic success in high school, and prepare students academically to attend a college or university. The project proposes to provide interdisciplinary exposure to concepts in computer science and mathematics. The goal of the project is to allow students to gain experience in critical thinking, to reinforce an understanding of topics discussed through hands-on activities, and to ignite an interest in STEM that will ultimately lead to pursuit of STEM careers.

The project will explore the influence of applications of mathematics, engineering, and technology on student interest in college, high school STEM courses, and STEM careers. The project activities will consist of Saturday sessions during the school year, tutoring sessions with college mentors and a two-week residential summer camp. Programmatic activities are provided for both students and parents.

Project outcomes will determine which strategies are most effective in encouraging 80 middle and high school students to prepare for STEM career. A database will be used to track information on students as they progress through the program. The project will seek to answer the following questions: (1) Do informal hands-on scientific algebra and geometry experiments combined with technology enriched activities encourage middle school students to take STEM courses in high school? (2) Does technology training and exploration promote the pursuit of STEM careers by underrepresented minorities in middle and high school? (3) Does academic support through one-on-one tutoring promote academic success in STEM courses and in STEM career choices among underrepresented minorities? (4) Does academic support through mentoring increase the self-efficacy in the academic pursuit of underrepresented minorities in STEM courses and career choices?

### ICT-SPACE: Developing ICT-STEM Career Interest, Engagement and Self-Efficacy in Middle School Students through Serious Games

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**Program Manager:** Orrin Shane  
**Start Date:** February 1, 2011     **Expires:** January 31, 2012 (Estimated)  
**Investigator(s):** Jamie Kirkley (Principal Investigator)  
**Sponsor:** WisdomTools Enterprises Inc

**Award Number:** 1031488

Wisdom Tools (WT), in partnership with the Indiana STEM Resource Network (I-STEM), will design, develop, and test ICT-SPACE (ICT-STEM Professions And Careers Exploration), a game-based career exploration environment for 7th and 8th grade students. The primary deliverable for this ITEST Strategies project is a suite of six online mini-games that will allow students to "try on" five ICT-STEM professions, and then work collaboratively to solve a capstone challenge mission requiring skills from each profession. The primary goal of this project is to encourage middle school students, particularly those from underrepresented populations, to pursue STEM careers, and specifically Information and Communication Technology (ICT) careers, by increasing their awareness, engagement, interest, knowledge of and self-efficacy related to ICT and STEM activities and careers.

ICT-SPACE will be designed to be played at school, at home, and at other free-choice environments, thus providing multiple opportunities for continued career exploration at different times and locations. To support the games, Wisdom Tools will develop an online teachers' professional development program to assist with curriculum integration, lesson plans, standards alignment, technical issues, and strategies for extended learning.

A second project goal is to use the affordances of video games to design ICT-SPACE in a way that will attract underrepresented populations (females, ethnic/racial minorities, rural and urban economically disadvantaged populations) to ICT-STEM fields. The games will incorporate research-based serious game features that will appeal to under-represented populations, such as diverse non-player characters; the ability to choose diverse attributes for one's avatar; a variety of mission objectives; different reward structures; and different task types.

This project will strengthen the ITEST Strategies portfolio by contributing to our understanding of how to design a game-based career exploration environment to engage and interest middle school students, and underrepresented groups in particular, in ICT-STEM activities, coursework and careers.

#### **ITEST Convening: Advancing Research on Youth Motivation in STEM**

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**Program Manager:** Sylvia James  
**Start Date:** September 15, 2010     **Expires:** August 31, 2011 (Estimated)  
**Investigator(s):** Sarita Nair-Pillai (Principal Investigator)  
Anthony Streit (Co-Principal Investigator)  
Beverly Farr (Co-Principal Investigator)  
**Sponsor:** Education Development Center, Inc  
**Award Number:** 10-29540

The ITEST Learning Resource Center at the Education Development Center, Inc., (EDC) requests funding for a convening designed to develop a theoretical framework to guide future research on youth motivation in STEM with a particular emphasis on populations most underrepresented in the STEM workforce. Two guiding questions will be the focus of the event: What is currently known about motivation in STEM for underrepresented youth? What can be done to cultivate new research around STEM motivation for underrepresented youth? The primary target audience is sociologists, psychologists, and researchers in STEM motivation and career development research, and members of the ITEST community including principal investigators, evaluators, and program directors. Secondary audiences include STEM program developers and practitioners, policymakers, and industry leaders that are building the STEM workforce.

Prior to the conference, a select number of attendees will be invited to draft white papers on topics such as motivation, self-identity, and educational practices in formal and informal settings. The white papers will be presented during the 2.5 day convening and used to guide the conversations. A unique feature will be the inclusion of 12 youth participants who will populate a pre-conference blog with reflections of their experiences in ITEST projects and respond to an online survey. Youth will be fully integrated into the meetings as presenters and participants in sessions that focus on STEM program design. The deliverables include a theoretical research framework to guide future STEM motivation research, survey data and analysis from ITEST projects related to interest and motivation, survey data from youth participants, suggestions for ITEST PIs to integrate measures into their programs, and a post-convening webcast.

The project evaluation will be conducted by MPR Associates using qualitative and survey data. Evaluation questions address planning, convening logistics, synthesis of information, and dissemination. After the convening, a final report will be published on the ITEST Learning Resource Center website. A post-convening web-conference will be held to stimulate new research projects and the development of STEM motivation instruments. It is anticipated that the convening will result in new working relationships among participants, identification of ITEST program elements that foster effective STEM motivation, career discovery, and motivation, and a map of ITEST impacts on youth motivation in STEM. New research efforts that address youth motivation in STEM should result from the research framework and the ITEST community and the field at large will be better informed about how to define, validate, and replicate motivational aspects of the STEM workforce development strategies.

#### **Middle School Science Readiness Program**

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<b>Program Manager:</b>	Celestine Pea	
<b>Start Date:</b>	September 15, 2010	<b>Expires:</b> August 31, 2011 (Estimated)
<b>Investigator(s):</b>	Nancy Moreno (Principal Investigator)	
<b>Sponsor:</b>	Baylor College of Medicine	
<b>Award Number:</b>	10-28771	

This project focuses on the critical drop-off point between elementary and middle school, often identified as the first major roadblock to the success and interest of students in STEM. To help elementary students successfully transition to middle school science, the Principal Investigator will design, implement and test a model after-school program (Middle School Science Readiness program) aimed at supporting science teaching and learning at this critical juncture. The model uses year-long activities in real-world science, technology, engineering, and mathematics fields such as aerospace (NASA-Johnson Space Center), energy (petrochemical industry), and biotechnology (Texas Medical Center). Sixteen teachers and 320 students from eight high need elementary schools in Houston will participate in this after-school program.

Through a longstanding partnership with the Houston Independent School District (HISD), Baylor College of Medicine (BCM) will engage an interdisciplinary project team (e.g., university faculty members from STEM disciplines, educational psychologist, data managers, online education providers, principals, teacher leaders, and parents) to develop the model program. Within the STEM learning experiences, the project embeds language and social skills that support career awareness in STEM related fields.

The PI uses a quasi-experimental design and an external evaluator for methodology and assessment, respectively. The project will disseminate the model after-school program without charge, locally and nationally via BCM award-winning websites, BioEd Online ([www.bioedonline.org](http://www.bioedonline.org)), and K8 Science ([www.k8science.org](http://www.k8science.org)).

## Promoting 21st Century Science Technology-Enhanced Learning Across Formal and Informal Environments

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**Program Manager:** Larry Suter  
**Start Date:** September 15, 2010      **Expires:** August 31, 2011 (Estimated)  
**Investigator(s):** Timothy Zimmerman (Principal Investigator)  
James Slotta (Co-Principal Investigator)  
**Sponsor:** Rutgers University New Brunswick  
**Award Number:** 10-31680

This project investigates the relationship between elementary-secondary students information technology skills, their success in an inquiry ocean science curriculum designed to target those skills, and their understanding of the new characteristics of 21st century science. It is concerned with the design of a curriculum and its impact on students of high compared with low digital literacy. It also examines student engagement with the various curriculum elements and their progress with conceptual understanding of science topics, belief and understandings about the nature of science, and growth of digital literacy skills.

The project creates new measurement techniques for understanding the relationship between technology skills that students bring with them to the classroom, the science curriculum they encounter, their understandings of the nature of science, and their "digital literacy." The project intends to develop a digital skills assessment tool to capture student action in collaborating with virtual environments, using social information, and developing skills with computing.

The investigators will conduct an analysis of video and audio recordings of student interviews, classroom observations, and field-trip conversations of students. The analysis will draw associations between class-based learning and field trip-based learning. The study will measure changes in students' epistemic commitment to learning science and science careers as intended by the ITEST program; that is, do the students increase their belief that they are capable of learning the science material as it is found in nature and presented in class.

## Real World Externships for Teachers of Mathematics and Science

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**Program Manager:** Patricia S. Wilson  
**Start Date:** April 15, 2011      **Expires:** March 31, 2012 (Estimated)  
**Investigator(s):** Jeffrey Weld (Principal Investigator)  
**Sponsor:** University of Northern Iowa  
**Award Number:** 10-31784

The Real World Externships project provides professional development for 150 mathematics and science teachers in grades 7-12 in Iowa. The teachers participate in externships with local science-based industries for six weeks during the summer. Teachers learn current applications of science and mathematics that they can use to enhance their teaching. The teachers work with university science and mathematics faculty to design hands-on, problem solving activities for their students based on applications in industry, and consequently enhance the learning of approximately 15,000 students during the project and even more beyond it.

The project was designed to enhance partnerships between various industries and schools. During the academic year, people from participating industries work with school personnel to provide speakers, resources, and tours, and school personnel select the teachers who participate in the externship program. The project helps teachers provide relevant content and provide current applications so that students can see the value of what they are learning. Students, teachers, and those mentoring the externs are

encouraged to participate and to expand the program. Evaluators, external to the program, provide feedback on the use of application during instruction, changes in the curriculum, and the achievement levels of participating students.

The externships facilitate needed interactions between industry and schools. Teachers learn applications for the mathematics they are teaching, and people from industry learn more about mathematics and science curricula, issues of instruction, and how they can work with schools. Sharing the design of the program and implementation insights are part of the dissemination plan that will assist other communities who are designing externship programs that focus on improving curriculum and instruction.

### **Society's Grand Challenges in Engineering as a Context for Middle School Instruction in STEM**

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**Program Manager:** Darryl Williams  
**Start Date:** September 1, 2010      **Expires:** August 31, 2011 (Estimated)  
**Investigator(s):** Amy Wendt (Principal Investigator)  
Steven Cramer (Co-Principal Investigator)  
L. Allen Phelps (Co-Principal Investigator)  
Susan Hagness (Co-Principal Investigator)  
Kimberly Howard (Co-Principal Investigator)  
**Sponsor:** University of Wisconsin-Madison  
**Award Number:** 10-30126

Society's Grand Challenges for Engineering (GCE) is the backdrop of this particular project as it works to develop socially-relevant engineering curricular modules for middle school instruction in STEM. The project team at the University of Wisconsin-Madison consists of engineering and education faculty, along with 23 middle school teachers and guidance counselors from 5 rural and urban public schools who are collaborating to design and test curricular modules and career exploration activities. Through summer professional development, the project equips teachers and counselors with the tools they need to delivery relevant content to enhance STEM curriculum and market the field of engineering to a broad student demographic, especially girls.

The research team utilizes Social Cognitive Career Theory (SCCT) to design the process of instruction, focusing on building self efficacy and outcomes expectations. The research is answering whether students engaged in GCE courses (1) report higher levels of STEM career interest, (2) report higher math and science self efficacy and outcomes expectations, and (3) engage in more exploration of STEM careers and post-secondary STEM education options. Students who are not exposed to the modules serve as the comparison group on these outcomes variables. The effects of the program are being evaluated by a variety of measures of student and teacher learning and practice, as well as counseling practice.

The project will demonstrate a strategy for transforming the attitudes and increasing the participation of underrepresented groups in STEM-related disciplines by embedding the societal context of STEM fields into middle school curriculum.

### **STEM Digital Images in Geoscience Investigations: Teaching Analysis with Light (STEM DIGITAL)**

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**Program Manager:** David Campbell  
**Start Date:** September 15, 2010      **Expires:** August 31, 2013 (Estimated)  
**Investigator(s):** Morton Sternheim (Principal Investigator)  
Stephen Schneider (Co-Principal Investigator)  
**Sponsor:** University of Massachusetts Amherst

**Award Number:** 10-31115

This project will enable high school and middle school STEM teachers and students to conduct environmental research aided by the analysis of images from digital cameras, scanners, and the Internet. The project explores how digital image analysis can be applied to environmental quality issues that can readily be introduced into STEM courses, engaging students and encouraging them to think about related careers. The project will develop research agendas that will employ a variety of image analysis tools. The air quality theme will focus on the three components of the atmosphere that primarily affect visible, infrared and ultraviolet light, respectively: particulates and aerosols, carbon dioxide, and ozone. The water quality theme will look at the role of plant biomass on drinking water quality and on global carbon cycling. Arsenic is listed as number one in the US in terms of environmental contaminants that pose a potential threat to human health; research topics will include the identification and mapping of local arsenic contaminated sites and bioremediation possibilities.

The project staff includes UMass and school faculty with extensive experience in teacher professional development and curriculum design. STEM DIGITAL will use the AnalyzingDigitalImages software which provides free, easy-to-use tools for spatial, temporal, spectral, and intensity measurements. There will be three cohorts of 30 teachers. More students and teachers will be reached later by the dissemination effort. The first two groups will attend one week summer institutes in 2011 and 2012. During each of the following school years, the staff will continue working online with the teachers on approximately six more projects spread over the fall and spring semesters. The 2013 institute will be entirely online, with a 6 week summer course which will become part of an online M.Ed. program. Curriculum materials will reflect Pellegrino's "Construct-Centered Design" (CCD) model in which assessment is an integral part of their design and use. All the curriculum materials and software developed for STEM DIGITAL will be made freely available via the web. Additional dissemination will include journal articles and conference presentations. The evaluation will include a study of the effects on student career interests. It will also compare the efficacy of the face-to-face and online models.

STEM DIGITAL will enable teachers and their students to use digital images and image analysis software for qualitative and quantitative analysis, engaging students, improving their in-depth understanding of fundamental science and technology, and ultimately increasing their interest in STEM and information technology careers. It will add to our knowledge of important environmental processes related to the movement of arsenic compounds in the environment and the dissolution of natural organic matter. It will also allow the comparison of the efficacy of the in-person and online professional development programs. The project will demonstrate to the educational community that already available computers and digital cameras, along with online data, can easily and effectively serve as hands-on scientific instruments, adding a new dimension to the way STEM subjects are taught.

**STEM Teams: Promoting Science, Technology, Engineering, and Mathematics Skills, Knowledge, Interest, and Career Awareness through Strategic Teaming**

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**Program Manager:** Kusum Singh  
**Start Date:** September 1, 2010      **Expires:** August 31, 2011 (Estimated)  
**Investigator(s):** Margaret Blanchard (Principal Investigator)  
Braska Williams (Co-Principal Investigator)  
Thomas Alsbury (Co-Principal Investigator)  
Naikoa Aguilar-Amuchasgui (Co-Principal Investigator)  
**Sponsor:** North Carolina State University  
**Award Number:** 10-31118

The primary goal of the STEM Teams strategies project is to build a bridge from isolated middle schools in rural NC to the high tech resources at research universities, to effectively teach STEM (science, mathematics, & technology) content and instill an understanding of the potential of STEM careers. The middle school teachers in the selected schools will be supported by an administrative team to guide, coach, and empower the teachers to make the most of the resources. The project builds on extensive pilot studies done by the Project Team with teachers, leaders, and students in similar districts in the region. STEM Teams will directly serve 45 STEM teachers, 60 students through the STEM after-school program, 32 leadership personnel, and all of the 2,300 students located in teachers' classrooms in 4 middle schools in these districts, each academic year. STEM Teams is driven by four research-based, key strategies: 1) Adopt new and emerging technologies to network and enhance learning across all teams, 2) Provide up-to-date STEM careers information to districts through a variety of student, teacher, and leader professional development featuring minority STEM scientists and STEM education experts, 3) Update students' and teachers' STEM skills and content knowledge, and skills explicitly connected to state/national STEM content standards and the school curriculum, and 4) Use a Strategic Teaming Model that builds leadership goals from within.

STEM Teams will study the efficacy of the Strategic Teaming Model using a comparison group. Both quantitative and qualitative measures will be used to collect data on students' content knowledge, STEM interest and career awareness. Data will also be collected on teachers' attitudes, dispositions, and classroom enactment related to such factors as self efficacy, teacher dissatisfaction, & technological confidence. The project will leverage the on-going projects such as NC State College of Education's Friday Institute ([www.fi.ncsu.edu](http://www.fi.ncsu.edu)) and the MEGA technology support network ([www.ncsu.edu/mega](http://www.ncsu.edu/mega)). Research findings will provide evidence in support of the Strategic Teaming model to increase students' STEM content knowledge and STEM career awareness.

## The FabLab Classroom: Preparing Students for the Next Industrial Revolution

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**Program Manager:** Robert Gibbs  
**Start Date:** September 15, 2010     **Expires:** August 31, 2011 (Estimated)  
**Investigator(s):** Glen Bull (Principal Investigator)  
Gerald Knezek (Co-Principal Investigator)  
Hod Lipson (Co-Principal Investigator)  
Robert Berry (Co-Principal Investigator)  
**Sponsor:** University of Virginia Main Campus  
**Award Number:** 10-30865

This project introduces 4th and 5th grade students and teachers to engineering design and associated mathematics by developing and implementing a new, scalable, personal fabrication laboratory, the Classroom FabLab, and supporting curriculum. The University of Virginia and the University of North Texas are providing preparation in personal fabrication to pre-service teachers in their methods courses. The pre-service teachers are doing their student teaching under master teachers trained by the project in ten classrooms in Virginia and five in Texas. Participants include several hundred pre-service teachers and 15 in-service teachers and their students. Cornell University is developing the FabLab by modifying an existing, more expensive and complex system. FableVision and Software Mackiev are developing the software in cooperation with Peggy Healy Stearns. Curriculum is being developed by the University of Virginia and Hofstra University. The Society for Information Technology and Teacher Education (SITE) is creating an online Digital Fabrication Library to house the curriculum, activities, and digital designs.

The evaluation is a quasi-experimental design for 15 experimental classrooms and 15 comparison classrooms in matched schools. Evaluated groups are the pre-service teachers, the in-service teachers, and the elementary school students. There are pre-post tests in math and engineering design concepts, STEM dispositions, career interests, and teaching efficacy. Data is being analyzed with Hierarchical Linear Modeling and General Linear Modeling.

The products include the Classroom FabLab, a computer-controlled manufacturing unit appropriate for use in elementary schools that allows students to design 3-dimensional objects on a computer and have them built by the FabLab using simple materials. Curriculum activities are being created, piloted, and housed in a free access Digital Fabrication Library. The software for the FabLab is being created by the commercial partners to be marketed at reasonable cost. In addition, the project contributes knowledge to the fields of mathematics and engineering education by evaluating a model that integrates them through the FabLab, curriculum, and professional development.

## The Robot Algebra Project - Collaborative Research

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**Program Manager:** Gerhard Salinger  
**Start Date:** September 15, 2010     **Expires:** August 31, 2011 (Estimated)  
**Investigator(s):** Christian Schunn s (Principal Investigator)  
Robin Shoop (Principal Investigator)  
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**Sponsors:** University of Pittsburgh and Carnegie-Mellon University  
**Award Number:** 10-29404

The Robot Algebra Project creates three scalable, middle school level units for use in informal settings. The units are designed around fundamental robot movement concepts but emphasize proportional reasoning - a big idea in mathematics. There are over 12,000 FIRST Lego League teams across the U.S.

that purport to use robots as a motivator to engage students in STEM. However, most of the time the students use guess and check procedures thwarting the opportunity to learn STEM content. The units being developed build upon model eliciting activities, project-based learning and mathematics education to specifically improve student understanding of a few key mathematics concepts. The programming of robots is scaffolded so that students concentrate on the mathematics. Rather than only doing hands-on activities, the students also produce toolkits for other students to engage in similar experiments. Paper-based word problems are developed to bridge the mathematics learned in the context of robotics to generalized mathematical problem-solving strategies. Professional development is provided both face-to-face and through webinars to early adopters who are also trained to provide professional development to others. Materials to supplement the professional development are produced to support teachers and informal educators understanding of the rationale, the agenda, the mathematics and the perspectives that underlie the student materials as well as to also support them in anticipating student responses to the tasks. The materials can be updated online.

Pre and post tests against a control group in standard robotics programs are used to provide formative and summative evaluation. Ten students are interviewed each year about how the experiences affect their career choice. The scalability of the use of the units is measured through observation of and interviews with teachers. In the third year the units will be used in beta sites.

The fundamental goal of the current proposal is to improve middle school level student's algebraic reasoning ability, specifically their understanding of proportionality. A secondary but critically related goal is to improve informal educator's pedagogical content knowledge with respect to algebraic reasoning ability.