

**Creating an Educational Pipeline Science, Technology, Math, and Engineering
(STEM) Initiative for Women, Minorities and Veterans in Information Technology
(IT) and Nanoscale Science and Engineering**

**By
Dr. Joseph Bowman, Jr.
Center for Urban Youth and Technology
University at Albany
Albany, New York**

**Dr. Harl'O Fisher
Excelsior College
Albany, New York**

**Ms. Celia Rouse
Center for Urban Youth and Technology
University at Albany
Albany, New York**

All Inquiries:
Dr. Joseph Bowman, Jr.
ED 114B, University at Albany
400 Washington Ave.

Albany New York 12222

Introduction:

As the impact of nanotechnology grows in New York State and the capital region, in particular, there is a growing concern that underserved and low-income communities are not being reached with the critical information and outreach resources necessary for effective introduction to, and engagement in, the foundational fields of nanoscience, nanoengineering, nanobioscience, and nanoeconomics.

“It is a quiet crisis of undeveloped and under utilized talent..... Women, minorities, and people with disabilities represent more than two-thirds of this nation's workforce. This population is "the new majority," a talent pool that is largely untapped and significantly under-represented in science and engineering. It is imperative to engage the "new majority" in science and engineering education as a vital component in New York's education and workforce strategy.”
(Jackson, 2005)

The Center for Urban Youth and Technology (CUYT), School of Education, has partnered with the College of Nanoscale Science and Engineering (CNSE) and The University Center for Academic and Workforce Development (UCAWD/ATTAIN LABS) to develop curriculum content, program activities, and address the collaborative concept of engineering and technology education for this population. This presentation focuses on high school and adult education students in alternative, career technology, and adult education programs.

It is essential to provide programs, information, and activities that build on students' fundamental concepts and skill sets in science, math and technology to establish robust, coherent, and lasting connections to these new fields of study. Through systematic planning, program-based solutions aimed at addressing this concern can tap additional federal, state, and private resources for expanded local, statewide, national, and international impact and reach segments of our communities that would not otherwise receive these resources. Such programs can improve the quality of life in these communities, dramatically expand potential career, educational, and economic opportunities, and insure their continued engagement and contribution to our society.
(Geer, 2008)

Our primary challenge is to identify new and effective ways to reach underserved segments of our communities. We created new opportunities (1) to ‘get the message out’ through the establishment of informal and after-school activities for students and adults (Math/Science Days). These activities were linked and integrated in that they comprised of Community or ‘field-based’ components to engage underrepresented and underserved student clienteles in familiar, non-threatening environments; (2) Nanotech-immersion components to provide ‘direct connection’ experiences between cutting-edge nanotech research and infrastructure and the breadth of career opportunities enabled by nanoscale science and nanoscale engineering; and (3) Distance-learning components

appropriate to tap into existing NYS community and state-wide learning networks. These innovative activities will also lead to and support the creation of other forums and activities that promote economic development and career options. We will present a case for reaching out to these populations, discuss our program initiatives, provide experiences of project based Nanoscale immersion, and our evolving collaboration to utilize a state-wide distance learning network. We will conclude with our findings and lessons learned from the process, and our future goals to utilize these models and formats for these populations.

Description of our work:

(1) “Get the message out”. Community or ‘field-based’ components: Math Science Days presentations:

The Center for Urban Youth and Technology Foundation has provided educational and career experiences for middle, high school, and adult education students in the Math, Science, and Technology areas for several years. We have hosted the Science Technology Entry Program (STEP) and held our Summer Youth Technology Institute for capital region students at the University at Albany. Our purpose was to stimulate student and adult interest and an appreciation for math, science, engineering, and technology. We provided tutoring and mentoring assistance to students preparing for statewide and local exams. We explored potential careers and provided college recruitment opportunities for students in STEM and IT related fields.

For ten years, we worked with the Science Technology Entry Program (STEP) at the University at Albany, leading their technology program initiatives (Video production, radio, and multi media design). As director of the program for five years, I expanded the integration of math, science and technology with real world learning experiences and creating student centered learning environments. We established informal, after-school, and weekend activities to address gang violence, hanging out, drugs, harassment, and abuse. Many activities were held in urban centers (New York City, Albany, Schenectady, Newburgh, and Troy) to develop a presence in these communities and to understand their needs. This gave us the opportunity to demonstrate the importance and relevance of STEM in their communities (brown fields, lead paint, home weatherization, traffic safety, global information systems, community cleaning, and gardening).

A series of math and science day activities to stimulate community STEM experiences were initiated at the University at Albany, CNSE, with various departments (National Weather Service, Geography and Planning, School of Education, Informatics and Computing), state agencies (Department of Children and Family Services, Department of Environmental Conservation, and Department of Transportation), private institutions (Capital Region Teachers Center and Rensselaer Polytechnic Institution), Community Based Organizations (Links Inc., One Hundred Black Men, and Macedonia Improvement Development Corporation). STEM career exploration opportunities, introduced students and adults to college and university life, gathered university support,

and provided outreach to participants and university recruitment staff. From 2003 through 2007, CUYT hosted five Math and Science Day events at the University at Albany and the College of Nanoscale Science and Engineering.

We held hands on workshops in student centered learning environments to improve their ideas and attitudes about Math, Science, and Technology. These events attracted over 400 students, 200 parents, and 100 volunteers. Workshops included: Marine biology, Wind Energy, The Human Body, Origami, Speak So Well, What is Pi, Cultural Math, Life Skills through Chess, Radio DJ's, Mall Design, Nanoscale biology, video production, Cisco Network Training, and Break Dancing.

We deployed a vision and model to reach urban and rural communities with STEM opportunities for elementary, middle, and high school youth and adults. We want to engage underrepresented and underserved student clientele in familiar, non-threatening environments in their communities. We invited people in these urban communities to the university to see the rich learning environments that we provide (Many of the students and parents had never to the university). We also invited university faculty and students into urban centers to meet students and parents in their homes, community based organizations, and churches. Getting the Message Out about STEM to takes on new meanings because of the interactions.

(2) Nanotech-immersion (onsite CNSE) components INTY 2009:

INTY provided a program intervention that teaches multi media design, character education, nanoscale sciences, environmental education, and information technology to high school students in special and alternative education programs in the capital region of New York State. CUYT held the first Institute for Nanoscale Technology and Youth (INTY) with the (CNSE) last summer, 2009. INTY brought 30 (14 to 18 years old) students from the capital region (Albany, Schenectady, and Troy) together for an intense four-week program. Eighty-five percent of the students were African American and the remainder was Latino with close to seventy-five percent male. They were all free and reduced lunch students and came from economically depressed communities to provide 'direct connection' experiences between cutting-edge nanotech research and infrastructure and the breadth of career opportunities enabled by nanoscale science and nanoscale engineering.

The students were immersed in Nanoscale workshops, seminars, and hands on activities. At the College of Nanoscale and Engineering, students were afforded the opportunity to participate in several activities using clean room facilities and other labs in which they worked with the professors and graduate students who instructed them in these hands-on activities with wafers, logic gates, nanoparticle synthesis, implantation of Boron in si wafers as electrical conductors, using microfluidics to show laminar flow. Students also collaborated and work in teams in nanoeconomics to come up with creative ideas for a business using Nanotechnology and then pitched it to an audience of their peers and instructors.

There are two sections of the immersion component that will be discussed: multi media design and nanoscale. Descriptions and student work will be presented to provide information and background about the intent of each workshop session. Multi media Design sessions emerged from the Department of Educational Theory and Practice, School of Education and their focus on the field of Instructional Technology (using technology in education).

MULTI MEDIA DESIGN:

Our Multi media design component focused on culturally situated design tools, video production, and presentation skills development. Students took pictures of institute activities, produced articles, and created a program newsletter. We provided digital literacy applications training (word and power point), Internet use, privacy concerns, and issues of cyber security.

Culturally Situated Design Tools (CSDT) or Ethnomathematics:

CSDT's demonstrated the real world connections between math, symbols, cultural locations, and activities around the world. Using a web based environment and students learned about historical places and the math concept that is associated with that region, people and society. Themes included hair braiding, American Indian bead looming, rhythm wheels from the Hispanic community, and graffiti art from urban cities.

Video Production:

The students decided that they would produce a video documentary the summer INTY program. Small groups were given 35 mm cameras or a video camera to document daily activities. They created interview questions, storyboards, a script, and program treatments. The students and staff created a one-minute promo, a ten-minute video INTY documentary, and a Quicktime slide program.

Environmental Justice:

Students worked in partnership with Albany's Summer Youth Employment Program, and Environmental Awareness Network (EANDC) to learn about environmental justice, water quality, fishery, and tree replanting. The closing ceremony was highlighted by the replanting of two freshly harvested White Pine trees that were provided by the Catskill Mountain Outdoor Training Institute of Green County. Students selected the trees, unearthed them, and replanted the trees at the College of Nanoscale Science and Engineering.

Character Education:

The character education component addressed self-control, team building, anger

management, life-long learning, and self-determination. The program invited special guest speakers for lunch, mentoring, and our “Rites of Passage” activities. The “Rites of Passage” model (Macedonia Initiatives in Community Development (MICD)), utilized the seven principles of “Kwanzaa called the Nguzo Saba”. Nguzo Saba requires that students define their common interests and make decisions that are in the best interest of the family and community through group discussions, handout responses, and student presentations. Our guest speakers were culturally diverse from business, state agencies, and community organizations (Price Chopper, Office of Technology, Office of Children and Family Services, Verizon, and Environmental justice/education). They provided role models, mentoring, and career exploration opportunities.

Game Design:

1st Playable Productions introduced students to the elements of game design, evaluation, and programming. All of the students enjoyed playing games on computers, PS3/ Xbox, Nintendo, and cell phone devices. Students were exposed to graphic design and various forms of game concepts.

INTY Entrepreneurship:

As part of the Nanoeconomics and multi media design components, students created an INTY logo design that is being used on tee/polo shirts, business cards, and calendars. They also discussed new ways of using nanoscale products for business and development. These resources will be used for future recruitment campaigns, program marketing, and demonstration of student entrepreneurship concepts.

Youth Employment Program:

Working with Albany, Schenectady, and Troy New York, and their summer youth enrichment program offices, we were able to provide employment opportunities for all program students. Each student was compensated for twenty – thirty hours each week for working with INTY for six weeks. This provided an added incentive for the students and assisted in keeping student attendance at a high level. We were concerned that these resources would compromise the main mission of the program: Learning about STEM opportunities for employment and college opportunities in the future. All of our past programs, which were voluntary, and focused on student’s desire to acquire knowledge and learning in a nonthreatening educational learning environment. Students, district administration, and city officials have requested that we continue this collaboration for student summer employment in the future.

NANOSCIENCE:

The second immersion component, nanoscience was created by the College of Nanoscale Science and Engineering (CNSE) and featured hands on, project based activities to stimulate interest in the nanoscale fields. CNSE faculty and students provided the

instructional activities for the INTY students.

Radio Frequency ID Chips:

The students created aircraft and assembled the wings, tail, and rudder using a hard cardboard material. Students attached RF chips to the propeller engines and then to the aircraft that they created. They learned how to use remote control devices to control the movements of the aircraft during flight. They related this work to the current events of the “Drone Warfare”, they saw during the war in Afghanistan and Iraq.

Nanobioscience:

Students learned how to make biopolymers and bio-fluidic devices. They discussed the importance and impact that this work has on the nanomedicine field.

Working in a cleanroom:

This interactive demonstration simulated the necessity for cleanroom 'bunny suits' and how to work safely in a modern 300mm cleanroom for nanochips.

Human calculator:

This workshop provided an Interactive game where students play the role of nanoelectronic transistors in a calculator to learn the basics of digital logic. They learned about binary numbers, conversion from decimal to binary, and how the computer uses logic gates.

Alternative energy:

This module demonstrated fuel-cell and solar-based energy sources for model cars. Students learned the basics of energy generation and the role of nanomaterials (solar panels and fuel cell power) to operate cars and other living resources (high speed trains, home water heating, utility bill cost saving).

Simulating what you can't see (Using models to explore nanotechnology):

Students worked with advanced computer simulators to predict behavior at the nanoscale level. This workshop explored fundamental science concepts in nanotechnology using computer simulations.

Nanochip fabrication:

This hands-on laboratory experience involved working with and processing Si wafers. Students learned how to make a transistor a better conductor by ‘implanting’ other types of atoms (Boron) to change how Si wafers conducts electricity. It was necessary to heat

the Si wafer after the Boron implant to increase the electrical conductivity.

Nanobusiness development:

Interactive activity where students work to develop a business plan based on a nanotechnology concept. They created a technology plan that identified current hardware and determined how nanoscale was used in these products. They observed trends in the market place and then discussed pricing, advertising, and potential target customers.

The immersion component in multiple disciplines, (nanoscale and multi media design) led to the development of the distance learning video conference component for adult education students (women, minorities, and veterans). This phase identified the needs and challenges of the adult education population and created an educational STEM curriculum to meet their needs.

(3) Distance-learning and Microsoft IT Academy components University Center for Academic and Workforce Development (UCAWD) ATTAIN-LAB:

This Partnership:

This partnership evolved because of the high technology career opportunity paths in the Nanoscale science field at CNSE. The ability to create curriculum materials around multi media and information technology design and program initiatives at CUYT. And the state-wide technology network resources and focus on adult education that exists at UCAWD. If we could forge a partnership that shared resources now, we would be able to develop a stronger relationship in the future. UCAWD provides technical assistance during the program development and recruitment aspects of INTY. Our students were part of the Microsoft IT Summer Academy, and we held the first “Nanoscale” video distance learning conference for adult and alternative education students. This interaction can lead to curriculum content material in the nanoscale fields. It opens additional pathways to high technology career opportunities for adult and alternative education students. The Microsoft Academy was part of the immersion component of the program, but is included in this section and showed the interaction that the partners demonstrated during all phases of the program.

Purpose of Program:

The INTY is designed to provide a program intervention that teaches multi media design, character education, nanoscale sciences, environmental education, and information technology to high school students in special and alternative education programs in the capital region and across New York State. The University Center for Academic and Workforce Development (UCAWD) has been an initial partner in this process because of their role in providing academic, college preparation, and workforce opportunities to underserved adult education populations in New York State.

Goals:

Our goal was to create a high technology (nanoscale, alternative energy, information technology, and life skills) secondary education curriculum that could be expanded to support adult education populations. Our second goal was to utilize the distance learning UCAWD/ATTAIN LABS and smart classroom resources to reach special/alternative and adult education students across the state with high technology curriculum.

Microsoft Summer IT Academy:

The Advanced Technology Training and Information Networking (ATTAIN) Summer Institute provided high school students and disconnected youth between the ages of 16-24 with Microsoft Office 2007 certification and Life Skills training. Students were from families that were economically challenged, enrolled in free and reduced lunch programs, on public assistance, living in urban communities, and have limited access to technology capable of developing their 21st century skill sets. Utilizing the Microsoft Official Academic Curriculum (MOAC), every student received 16 hours of training each week to become a Microsoft Certified Application Specialist (MCAS) in Microsoft Word applications. Participants also utilized the ATTAIN Life Skills courseware, Microsoft Digital Literacy, and the Microsoft IT Academy E-learning curricula to assist in their personal and professional development.

The IT Academy outcome goals were to certify participants as Microsoft Certified Application Specialist in Word, provide potential career track information related to Information Technology, and connect youth to the career development services available at Educational Opportunity Centers and ATTAIN labs. UCAWD provided an incentive for each student with perfect attendance of \$100 per week and \$100 for successful completion of the certification exam. The last two weeks of INTY the thirteen students from Albany and Troy NY went to the Microsoft IT academy at the Albany EOC/ ATTAIN Lab to learn Microsoft Word and to prepare for the certification test. The UCAWD provided a two-week intensive course for our students to learn Microsoft Word. After taking and passing the certification, students would be eligible to teach Microsoft Word as Microsoft word instructors. Each student who completed the class, pass the certification, would receive one hundred dollar stipend for their work. The Microsoft IT academy was a state-wide UCAWD initiative and our Institute for Nanoscale Technology and Youth students were invited to participate because of our partnership. The work with the planning and training of the IT academy component provided a working plan for the development of our nanoscale video conference.

UCAWD / CUYT /CNSE 1st Nanoscale Video Conference:

The INTY video-conference was held at the end of the fall semester of 2009 with participants attending in Albany, Troy, and Brooklyn, New York. The workshop presented was entitled "What is Nanoscale and what jobs are available in Nanoscale and renewable energy?". CNSE vice presidents Diana Dumsniel, Michael Fancher, and

Robert Geer convened the video conference. Vice president Geer opened the conference and Dr. Bowman welcomed the UCAWD students and staff. Diana Dumsneil then made the nanoscale presentation to the sites. This was followed by a full Q&A session, which vice presidents Fancher and Geer were the primary respondents. Students and staff asked several questions about job opportunities in the field of Nanoscale technology, skills required, and places of employment in the capital region. Other questions were asked about first offender and returning incarcerated adults status and opportunities in this field.

Participants were given a questionnaire to complete with a number of questions related to Nanoscale and the workshop. There were 19 participants ranging in from fourteen to fifty-two years of African American and Latino descent. When asked why they participated in the workshop, an equal number six or 36.8 percent said that they wanted to learn about careers in nanotechnology and that their counselor recommended the workshop. Four (26.3 percent) participants thought that it sounded like a fun way to learn about careers in nanotechnology.

For fifteen (78.9%) of the attendees the EOC was a good location to hold the distance learning Nanoscale workshop because it was in their community and close to home. When asked to describe in their own words what is nanotechnology, many of them understood it to be “very small” and “creating efficient technology on a nano-scale”. Many of the participants at the workshop did not attend the summer program so very few participants were able to give feedback on those sessions.

Results:

Results to date have indicated that these populations, which are significantly under-represented in science and engineering have keen interest in nanotechnology and high tech careers, but suffer from lack of exposure because they are not in the traditional academic setting. They are especially interested in more online instruction about careers and career development in nanoscale technologies.

When asked to compare the NanoCareer Day workshops with the Distance Learning Nanoscale workshop, 58.3 percent or seven participants agreed that they learned a lot about nanotechnology while participating in the online workshop and also that the time spent in this workshop was enough for them to understand nanotechnology. Six or fifty percent of participants agreed that the video clips helped them to understand more about nanotechnology and five or 45.5 percent also agreed that they like nanotechnology more than they did before participating in the online workshop. Six (46.2 percent) strongly agreed and another 46.2 percent agreed that the workshop made them more aware of careers related to nanotechnology. Five or 45.5 percent strongly agreed that they would participate in this workshop or one like it in the future.

Based on these results, there is a need to develop more structure STEM activities for

this population (adult, women, minorities, and veterans) and increased collaboration with instructors in technology and engineering to provide a more robust and enriched nanoscale curriculum. On-line web based and video conference course content in the nanoscience fields must be developed. Further partnerships between the science engineering faculty (at CNSE) and the School of Education faculty must be supported to create new on-line instructional curriculum material. This will address the work schedule, availability, and family responsibility issues that face the adult education population. The on-line nanoscale courses will also benefit the second career adults and the unemployed because it provides career opportunities in a 21st century STEM field.

Conclusion:

The Institute for Nanoscale Technology and Youth concept has evolved over the last six years after discussions with Micheal Fancher, Vice president of Development and Outreach, and Lisa Anderson, Vice president of the SEMI Foundation Inc. At that time (April, 2003) we were planning our Math and Science Day activities and requested technical assistance from CNSE and Semi, Inc (CNSE provided faculty/workshop instructors and SEMI Inc provided support equipment). This partnership has continued through the years culminating with our fifth Math/Science Day being held at the CNSE in 2007. In 2008, we began the development of INTY, which has successfully completed two years of operation with urban middle, high, and adult education students.

We plan to continue and expand the numbers of minority and underserved youth and adults that we introduce to these STEM opportunities. We are working on the deployment of on-line nanoscale and alternative energy curriculum for students. We are creating a career and college exploration STEM initiative that utilizes existing resources but does not reach urban and rural communities. We are developing new partnerships with businesses, school districts, legislative leaders, and community-based organizations to support sustainability and career opportunities. We are designing research and evaluation models that identify student achievement at the secondary education and college/ career levels. We are demonstrating the importance to continued support for “informal education” interventions that focus on an underrepresented population of our country.

We want to identify potential funding sources to continue to develop our High Technology 21st Century Careers Curriculum for adult learners. We want to expand and develop our nanoscale career curriculum for on-line instruction. We would like to provide more nanoscale on-line sessions with other sites across UCAWD network. We plan to create a series of research based articles about adult education and 21st Century Careers. We have developed a working model that can be built upon to create high technology curriculum materials and career opportunities in the nanoscale industry. UCAWD can realize significant progress with their workforce and pre-college programs that they support and campaign.

Acknowledgements:

Academic Support Partners included: School of Education, University at Albany, The Riverhead Foundation for Marine Research and Preservation, Rensselaer Polytechnic Institute, Empire State College (SUNY), Department of Environmental Conservation, Schenectady City School District, Troy City School District, and The Albany City School District.

Corporate Support was provided by: Center for Urban Youth and Technology Foundation, New York State United Teachers, Charles Touhey Associates, IBM Foundation, Compass Learning, Madame Alexander Doll Company, Decision Suites Inc, College of Nanoscale Science and Engineering, Excelsior College, and the University at Albany.

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