

NETL Educational Outreach

As the technical workforce ages, the United States and NETL face a potential shortfall of skilled scientists and engineers¹. NETL wants to see more U.S. citizens preparing for technical careers, but also recognizes that foreign-born scientists and engineers also are needed. Our Nation's research universities have seen increasing numbers of foreign-born students in their technical graduate programs. Fully 52% of the current Ph.D.s under the age of 45 performing research in the United States are foreign born. At the same time, over the past 10 years there has been a reduction of 20% in science degrees and a 34% reduction in engineering Ph.D.s of U.S. citizens.

The National Energy Technology Laboratory (NETL) recognizes these disturbing trends and is committed to helping prepare the next generation of scientists, engineers and researchers. We are doing so by effectively leveraging

the expertise and outreach efforts of our professional staff, our research facilities and our research programs. Our efforts in education will also help us achieve our goals in research and innovation. NETL is taking action to help create the next generation of researchers in three key ways: 1) Helping inspire our youth (*Transferring the Spark*); 2) providing the environment for learning skills required to perform research (*Mentoring and Experiential Learning*); and 3) providing tools and materials to our education system for K-12 science and math programs (*Equipment and Teaching Tools*).

It is easy to be complacent about U.S. competitiveness and pre-eminence in science and technology. We have led the world for decades, and we continue to do so in many research fields today. But the world is changing rapidly, and our advantages are no longer unique. Without a renewed effort to bolster the foundations of our competitiveness, we can expect to lose our privileged position. For the first time in generations, the nation's children could face poorer prospects than their parents and grandparents did. We owe our current prosperity, security, and good health to the investments of past generations, and we are obliged to renew those commitments in education, research, and innovation policies to ensure that the American people continue to benefit from the remarkable opportunities provided by the rapid development of the global economy and its not inconsiderable underpinning in science and technology.

Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology, National Academy of Sciences, National Academy of Engineering, Institute of Medicine

Transferring the Spark

A student's desire to pursue a lifetime of learning in the sciences, engineering, or math is often inspired by an event or experience that ignites passion and curiosity. It is essential that children

JASON's theory is that connecting students with "great explorers and great events" through innovative pedagogy, core curriculum and interaction with scientists and other role models sparks a deeper engagement in learning – and that this engagement leads to self-motivation and higher achievement.

**Education through Exploration:
A New Theory in Teaching and Learning Science**
Caleb M. Schutz, President The JASON Project

are given as many opportunities as possible to have such a triggering event to excite them into recognizing that science can be fun and rewarding. Many opportunities are lost because children dismiss opportunities in science, technology, engineering and math (STEM) career paths, thinking that science and math are boring.^{2,3} Good teachers can arouse that passion. There are also other ways to do it. The National Geographic's JASON Project⁴ is one such way.

The National Geographic Society initiated the JASON Project to excite middle school children about science by participating in inquiry-based science. JASON immerses students in the mission theme by framing each curriculum around five core elements delivered via print, video, HTML and interactive games. The core elements are: 1) Meet the researchers; 2) invitation to join the mission team - mission objectives; 3) mission briefing; 4) mission labs - what science knowledge is required and why; and 5) field assignments.

Fieldwork comprises inquiry-based assignments. Students synthesize and evaluate new, real-world scenarios, mimic researchers' fieldwork, create an experimental design, and make and record observations. JASON's first developed earth science and weather modules. Next, the organization decided to develop an energy education module.

Jason asked NETL to work with them. NETL and representatives of JASON agreed that it was an excellent collaboration. As a result, JASON will distribute an energy education module, with footage shot on location at NETL's Morgantown facility, through print, video, games, and online resources to tens of thousands of teachers and students in the United States and worldwide. This collaboration was such a good experience that JASON wants to continue working with us. NETL and JASON currently are discussing participation in a new "Geology" module which explores concepts of carbon dioxide storage in geological formations.

Operation: Monster Storms, has earned prestigious national awards since launching in 2007. The weather unit won a 2008 CODiE Award for Best Online Instructional Solution and a Finalist award for Best Science Instructional Solution. In February 2009, JASON's ecology curriculum, *Operation: Resilient Planet* was named a finalist for three CODiE awards: Best Science Instructional Solution, Best Online Instructional Solution, and Best Education Solution. The curriculum also won a 2008 Award of Excellence from *Technology & Learning* magazine, one of 35 honorees – including Apple, Adobe and Microsoft – cited for "innovative applications that break new ground" and "demonstrate clear superiority over similar products in the market."

Here are more examples of how NETL can help excite students about technical careers:

- The state of Pennsylvania requires all graduating seniors to complete a senior project that includes a job-shadowing exercise. NETL researchers at the Pittsburgh campus have volunteered to have students shadow them so the students can learn about STEM careers.
- NETL provides tours for interested groups and has a speakers' bureau that sends researchers to speak about science topics to audiences ranging from elementary school to professional societies. Each NETL campus sponsors a DOE Regional High School Science Bowl. The winners of the regional event move on to the DOE National High School Science Bowl in Washington, D.C.

Mentoring and Experiential Learning

The American workforce will continue to become more diverse.^{5,6} Technical jobs within the DOE and other Federal agencies are open only to American citizens. Students who train to become high-quality technical workers must be given opportunities to participate in high-quality

research activities.⁷ Creating opportunities for university research partnerships that allow students to meet and work with world-class Federal researchers is an effective workforce recruitment strategy. NETL therefore takes a “K through grey” approach to workforce development, nurturing individuals at every stage of the educational process from kindergarten through faculty membership.⁸

NETL’s mentoring and experiential learning efforts are designed to develop the highest quality technical workforce possible by training and recruiting the best and brightest students and researchers from a diverse population. The program nurtures these highly skilled students and workers within populations underrepresented in energy research.

The history of scientific investigation has a long tradition of mentor/protégé relationships. Experiential learning opportunities allow individuals to benefit from a personal relationship with NETL researchers. Several studies have demonstrated that direct experiential learning improves attendance, reduces dropout rates, increases participation in academic courses, increases grade point averages, improves achievement in math and science, increases post-secondary enrollments, and facilitates transition into the workforce.⁹⁻¹⁶

NETL has established a “collaboratory” with three universities within the Pittsburgh, Pennsylvania, and Morgantown, West Virginia, region. Carnegie Mellon University, University of Pittsburgh, and West Virginia University are jointly conducting research projects with NETL. The universities provide graduate students and professors to work within NETL laboratories and with NETL researchers.

NETL manages the University Coal Research (UCR) and Historically Black Colleges and University (HBCU) programs, where academic researchers work on problems of interest to the fossil energy industry. We also sponsor resident research programs at the university level for undergraduates through faculty. These programs are administered for NETL by the Oak Ridge Institute for Science Education and the National Academy of Sciences’ National Research Council.

Recently, NETL initiated additional resident research opportunities through partnerships with local and regional universities. We continue to seek additional strategic partners in STEM education.

NETL also participates in DOE’s Mickey Leland Energy Fellowship (MLEF), offering summer resident research fellowships for undergraduate and graduate students in minority groups that are underrepresented in STEM fields. Management and staff are alert to identify MLEF participants as potential candidates for DOE’s Minority Mentoring Internship Program (MMIP) that puts them on the path to employment in the Federal government.

NETL offers three student programs where students work as Federal employees. These programs focus on students majoring in science, technology, engineering, math, and occasionally business.

- **Student Career Experience Program (SCEP)** provides career-related employment that enriches students' academic experiences and offers them valuable work experience in their career fields. The program also gives students exposure to public service and provides financial assistance to support their educational goals. In addition, the program encourages partnerships between NETL and educational institutions and helps our agency to attract, recruit, and efficiently hire well-educated graduates into our work force.

Key features of the program include: formal on-the-job training; work that is related to the students' academic program; written agreement among all parties required; and flexible scheduling of work assignments. The SCEP status may be converted to a Federal career-conditional appointment.

- **Minority Mentoring and Internship Program (MMIP)** was established in 2001 to offer intern employment opportunities to women and minority students. This program meets the needs of NETL, and provides work that is directly related to the students' educational programs and career goals. These internships provide hands-on research opportunities at a state-of-the-art national laboratory, depending on the students' interests and experience.

Key features are the same as SCEP.

- **Student Temporary Employment Program (STEP)** offers flexible, temporary employment to enable students to earn a salary while continuing studies. As with SCEP, this program gives students exposure to NETL's programs, provides financial assistance to support their educational goals, and encourages partnerships between Federal agencies and educational institutions. The primary focus of this program is to provide students with temporary employment that does not have to be related their educational or career goals.

Key features of the program include: work that is not required to be related to students' academic program; flexible scheduling of work assignments; and may be converted to SCEP.

Feeding the System

Another way that NETL leverages its resources is to “teach the teacher.” Partnering with like-minded organizations, NETL offers the following opportunities for K-12 teachers to improve their knowledge and learn new ways to present science material to their students.

NETL's Energy, Environment and Economy (Triple E) Seminar is a two-day workshop consisting of lectures, demonstrations, and tours providing insight into the fundamentals of

K-12 curriculum materials modeled on world-class standards. Foster high-quality teaching with world-class curricula, standards, and assessments of student learning. Convene a national panel to collect, evaluate, and develop rigorous K-12 materials that would be available free of charge as a voluntary national curriculum.

energy, environment, and economics on all levels – regional, national, and global. NETL researchers, university professors, and innovative teachers are the speakers. The program is specifically tailored to provide hands-on activities for kindergarten to sixth grade classroom teachers. The teachers consistently rate the program highly. Follow-up revealed that nearly all of the attendees were using information from the workshop in

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their classes. Former participants frequently request speakers, copies of packaged educational materials, and loans of laboratory equipment and supplies. The seminar is offered annually.

The Light Color, & Spectroscopy seminar is a one-day seminar on introducing concepts of light and color to K-6 students. NETL partners with Spectroscopy Society of Pittsburgh.¹⁷

The High School Science Software teaches high school teachers to use free (or inexpensive) software teaching aids for high school classrooms. NETL partners with Society of Analytical Chemists of Pittsburgh.¹⁸

Serendipity^{19, 20} grew out of a need NETL saw to get students interested in the use of computers as analytical tools. We also found that many K-12 instructors also need training. Serendipity is being developed by the West Virginia University (WVU) School of Education working with local middle school teachers. Serendipity uses STARLOGOtm developed by Massachusetts Institute of Technology to introduce dynamic modeling e.g., epidemics, food chain, etc. NETL and WVU hope to take the pilot from Suncrest Middle School, expand it to the school and then make it county-wide.

Strengthen the skills of 250,000 teachers through training and education programs at summer institutes, in master's programs, and Advanced Placement and International Baccalaureate (AP and IB) training programs and thus inspire students every day. Use proven models to strengthen the skills (and compensation, which is based on education and skill level) of 250,000 *current* K-12 teachers:

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IEEE's Teacher In-Service Program^{21, 22} allows volunteers to share their technical expertise and demonstrate the application of engineering concepts to support the teaching and learning of science, mathematics and technology disciplines. NETL is partnering with IEEE to bring this program to the greater Pittsburgh area.

NETL also has the ability to assist educational institutions through equipment grants and loans. Executive Order 12999, April 17, 1996, directs all Federal agencies, to the maximum extent permitted by law, to give highest preference to elementary and secondary schools in the transfer or donation of education-related Federal equipment, at the lowest cost permitted by law. Furthermore, subsection II(i) of the Stevenson-Wydler Technology Innovation Act of 1980, as amended (15 U.S.C. 3710 (i)), authorizes the Director of a laboratory, or the head of any Federal agency or department to give excess research equipment to an educational institution or nonprofit organization for the conduct of technical and scientific education and research activities. These equipment grants and loans often comprise used but serviceable computer equipment or laboratory equipment.

Summary

NETL's ongoing education and outreach activities will help provide to students at all levels in the fields fundamental understanding of energy science and engineering systems. NETL's efforts provide graduate research fellowships in scientific and technical fields that advance the Department's energy mission; provide training grants to universities that establish multidisciplinary research and education programs related to clean energy; support universities

that dramatically expand energy-related research opportunities for undergraduates; build partnerships between community colleges and different segments of the clean tech industry to develop customized curriculum for “green collar” jobs; and increase public awareness, particularly among young people, about the role that science and technology can play in responsible environmental stewardship.

Regaining ENERGY Science and Engineering Edge (RE-ENERGYSE)

The Department (of Energy) is undertaking a broad educational effort that cuts across program offices to inspire students and workers to pursue careers in science, engineering, and entrepreneurship related to clean energy and other fields important to the Department’s mission. RE-ENERGYSE is a new initiative to focus on a number of critical areas that will build the foundation of a vibrant American workforce to participate in the green economy and advance science and innovation in the U.S.

Department of Energy FY 2010 Congressional Budget

References

1. RISING ABOVE THE GATHERING STORM: ENERGIZING AND EMPLOYING AMERICA FOR A BRIGHTER ECONOMIC FUTURE The National Academies Press, Washington, D.C. ISBN-13: 978-0-309-10039-7.
2. The Truth Is That Science Is Boring to School Children, Charles Arthur, Financial Times Ltd., Publication Name: The Independent, ISSN: 0951-9467, 1999.
3. Hanauer, D. I, Jacobs-Sera, D., Pedulla, M. L, Cresawn, S. G, Hendrix, R.W., & Hatfull, G. F., Inquiry Learning: Teaching Scientific Inquiry, Science, 314, 5807, 1880-1881, 2006.
4. <http://www.jason.org/>
5. Jennifer C. Day, *Population Projections of the United States by Age, Sex, Race, and Hispanic Origin: 1995-2050*. Bureau of the Census, Current Population Reports, P25-1130, 1996.
6. SESTAT Integrated Database, Division of Science Resources Studies, NSF. SESTAT, which contains information about the employment, educational, and demographic characteristics of scientists and engineers in the United States, is on-line at: srsstats.sbe.nsf.gov/.
7. National Center on the Educational Quality of the Workforce, “The Other Shoe: Education’s Contribution to the Productivity of Establishments,” University of Pennsylvania, Philadelphia, PA, 1995.
8. Ensuring a Strong U.S. Scientific, Technical, and Engineering Workforce in the 21st Century, April 2000, National Science and Technology Council.
9. N. Brown, C. H. "A Comparison of Selected Outcomes of Secondary Tech Prep Participants and Non-Participants in Texas." *Journal of Vocational Education Research* 25, no. 3 (2000): 273-295.

10. Stern, D.; Dayton, C.; and Raby, M., Career Academies: Building Blocks for Reconstructing American High Schools. Berkeley: Career Academy Support Network, University of California at Berkeley, 2000. (ED 455 445).
11. Hollenbeck, K. An Evaluation of the Manufacturing Technology Partnership (Mtp) Program, Technical Report No. 96-007. Kalamazoo, MI: W. E. Upjohn Institute for Employment Research, 1996. (ED 413 440).
12. Silverberg, M.; Bergeron, J.; Haimson, J.; and Nagatoshi, C., Facing The Challenge of Change: Experiences and Lessons of the School-to-Work/Youth Apprenticeship Demonstration Project. Final Report, Plainsboro, NJ: Mathematica Policy Research, 1996. (ED 413 402).
13. Bragg, D. D., Promising Outcomes for Tech Prep Participants in Eight Local Consortia: A Summary of Initial Results. Minneapolis: National Research Center for Career and Technical Education, University of Minnesota, 2001. (ED 453 363).
14. MacQueen, A. B. "Assessing Tech Prep in Rhode Island." Tech Directions 55, no. 7 (February 1996): 21-23.
15. Adler, L.; Searls, P.; Weihel, L.; Hemsley, R.; and Dick, J. "The Impact of a Community Based School-to Work Program for High Risk Youth." In: Research for Education in a Democratic Society. Proceedings of the 1996 Aera Vocational Education Special Interest Group, edited by R. L. Joyner, pp. 45-62, Washington, DC: Vocational Education Special Interest Group, American Educational Research Association, 1996. (ED 398 417).
16. Frome, P. High Schools That Work: Findings from the 1996 and 1998 Assessments. Research Triangle Park, NC: Research Triangle Institute, 2001.
http://www.sreb.org/programs/hstw/ResearchReports/RTI_study.pdf
17. http://www.ssp-pgh.org/2008_09/Workshops/LCSKRegForm09.pdf
18. http://www.sacp.org/pac08/workshop/TSWW_Reg_Form09.pdf
19. <http://claytablet.hre.wvu.edu/Serendipity>
20. Ahern, T., Hando, T., Abu Hassan Shaari, N. & Rahman, A. (2008). Serendipity: Data modeling for middle school teachers. In K. McFerrin et al. (Eds.), Proceedings of Society for Information Technology and Teacher Education International Conference 2008 (pp. 1600-1605). Chesapeake, VA: AACE
21. www.ieee.org
22. www.tryengineering.org