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STEM PBL is a project of the New England Board of Higher Education (NEBHE) and is funded in part by the Advanced Technological Education (ATE) program of the National Science Foundation (NSF).

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www.stempbl.org

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Challenge Field-testing Continues Across United States

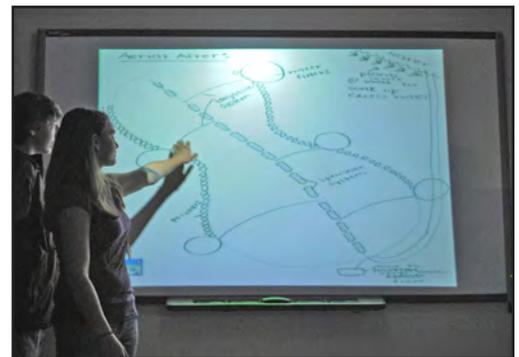
“My colleagues and I are determined to include problem-based learning in all of our classes,” said JoAnn Flejszar, a physics teacher from Oak Ridge High School in Michigan, and one of seven instructors who field-tested STEM PBL Challenges over the 2010-2011 academic year. Flejszar welcomed problem-based learning into her classroom several years ago as a participant in NEBHE’s previous PHOTON PBL Project. She and her colleagues have realized that “the ability to problem solve is a skill that is needed for our students to become successful in school as well as the workplace. Students need to see PBL as a part of what we do in class, and not out of the ordinary.”

Funded by the Advanced Technological Education (ATE) program of the National Science Foundation (NSF) and developed in collaboration with industry partners, the six

New PBL Course for Pre-service Teachers

To support the goal of increasing the pipeline of students prepared and motivated to pursue STEM careers, STEM PBL Principal Investigators (PIs) have developed new course materials that introduce pre-service middle and high school teachers to Problem Based Learning (PBL). An existing required course for all Technology and Engineering Education (TEE) majors at Central Connecticut State University (CCSU) in New Britain, Conn., “Teaching Technology and Engineering Education” (TE 399) has been adapted to include PBL principles and practices. The adapted course was offered for the first time during the spring 2011 semester.

In the course, TEE students utilized the STEM PBL Challenges and related instructional



Students from South River High School, Md., presented plans for a sustainable cranberry bag.

STEM PBL Challenges are being field-tested by participating STEM instructors representing high schools and colleges across the country. Field-testing began in fall 2010 and will continue through spring 2012. The multimedia Challenges, which apply STEM principles to sustainable technologies, confront students

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resources to learn the principles of PBL and develop their capacity to teach using PBL methods in their future classrooms.

Upon completion of the course, each student was expected to be able to:

- Demonstrate proficiency using a variety of multimedia programs to develop PBL tools.
- Describe the characteristics, benefits and challenges of integrating PBL into their classrooms.
- Develop strategies for implementing PBL in their future classrooms.

End of course feedback from students was collected as part of the research and evalua-

[PBL Course continued on page 3](#)

STEM PBL Online Course: Collaborative Problem Solving on the Web

By Judith F. Donnelly

Following the summer 2010 Introductory Workshop, STEM PBL participating instructors took part in an online collaborative course hosted by Three Rivers Community College (TRCC) and taught by Co-PI Judy Donnelly. To gain experience with the STEM PBL Challenge problems and resources, teachers in the online course engaged in problem-solving the same STEM PBL Challenges they would field-test with their students.

The STEM PBL course was structured in three five-week sessions over the course of a full academic year to allow participants to reflect on previous material before beginning the next session. This professional development model was developed and refined during PHOTON2, a prior NEBHE NSF/ATE project. Each session was designed to use one of the three levels of Challenge instruction: first, *structured* (entirely instructor led), then *guided* (moderately structured) and, finally, *open-ended* (instructor as consultant). To accomplish this scaffolding, the amount of time between the introduction of the Challenge Problem and Discussion videos was increased from session to session, requiring participants to perform increasing levels of independent research and problem solving on their own with the course instructor serving as facilitator.

To facilitate online communication, the course used two asynchronous web-based instructional platforms: Blackboard Vista for group discussions, and PBworks (www.pbworks.com) for wikis, which are editable documents that support teamwork discussions. Both platforms were introduced to participants during the introductory workshop held at Boston University in July 2010.

Different PBL Challenges were introduced during each session. The Tookany/Takony Frankford (TTF) Watershed Partnership Challenge was selected for the first session's *structured* Challenge problem, as the issue addressed, stormwater management, is of universal concern. Participants were divided into seven teams of four to five persons each from the same geographical region to stimulate future collaboration among participants. Each team was assigned a private wiki discussion area at the PBworks website

where members worked collaboratively to complete four Whiteboards (templates used to guide problem solving; see image below) and form a solution to the problem. In mid-November, teams presented their solutions to the entire class on the Blackboard Vista site for discussion and comparison to the organization's solution.

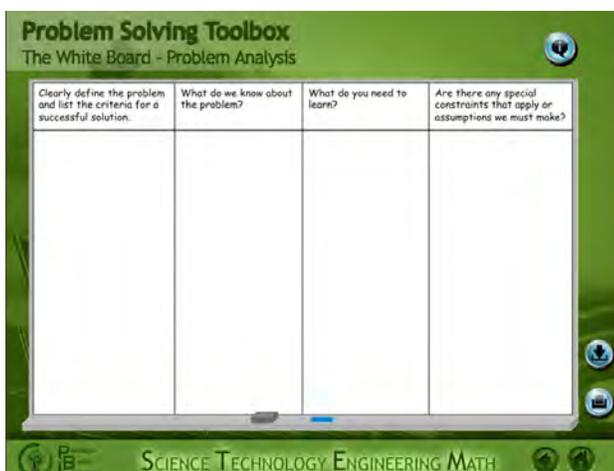
Between the first and second sessions, STEM PBL evaluator Anita Kite conducted a survey of participants to determine the level of satisfaction with the course. Survey respondents were generally satisfied with materials and instruction but some expressed frustration with the web platforms used for the course and the asynchronous nature of online problem solving. To assist participants who were still having technical difficulties, PI Hanes and Co-PI Donnelly held conference calls before both the second and third sessions to resolve any remaining usage issues.

In the second session, to facilitate participants working together on a Challenge more closely aligned with their curricula, participants were offered a choice between two PBL Challenges. They were: the SPG Solar/City of Tucson (see p. 8) installation or Watt's My Light?, a PHOTON PBL Challenge, which compares the light output of incandescent and compact fluorescent light bulbs. The *guided* format was used. Emphasis on communications and teamwork, as well as offering a choice of Challenge topic, increased participation in the second session by nearly 250% over the first session, as measured by the average number of wiki messages posted by all teams.

In the third session, teams were encouraged to choose a team leader to ensure that everyone stayed on track and to decide on a preferred mode of communication (wiki, email, phone, Skype). To enhance collaboration in an online learning environment, a "Teachers' Lounge" was created on the PBworks site that included participant photos and biographies. The teams that used these techniques expressed satisfaction with more real-time communications.

Using the *open-ended* format in session three, participants again chose from one of two Challenges: either Johnson & Johnson's natural eczema treatment or Of Mice and Penn, a PHOTON PBL Challenge on non-contact measurement of mouse tendons.

The STEM PBL online course demonstrated that distance learning for collaborative problem solving in teacher/faculty professional development has promise, but that real time, synchronous conversation is critical to improving outcomes and participant satisfaction. ■



One of four sample Whiteboards completed by participants in the distance learning course.

Judith Donnelly is Professor of Laser and Fiber Optics Technology at Three Rivers Community College in Norwich, Conn. She can be reached at: donnelly@lasertechnology.org.

Disseminating STEM PBL

The project PI and Co-PIs continue to disseminate STEM PBL materials and research findings throughout the United States. They have presented the multimedia Challenges at conferences, workshops and teacher trainings, published articles, appeared before the press, and attended conferences in order to reach a variety of stakeholders.

Co-PI Judy Donnelly was featured with Challenge partner and engineer Nathan White of RSL Fiber Systems on “Windham Works” for Charter Community Access TV, Conn., and “Let’s Talk About It,” a radio show co-hosted by Connecticut state representative Susan Johnson. Co-PI Nicholas Massa and STEM PBL board member Doug Webster, president of the National Association for Workforce Improvement (NAWI), were featured on the Regional Educational Technology Network (RETN) in Burlington, Vt.

Papers, presentations and appearances can be found at the following links:

HI-TEC: Educating America's Technical Workforce July 25 – 28, 2011, San Francisco, Calif.	STEM PBL Co-PIs Judy Donnelly and Nicholas Massa delivered a presentation. Advisory Committee member Karen Wosczyzna-Birch, executive director of the College of Technology for the Connecticut Community Colleges and the ATE Regional Center for Next Generation Manufacturing, also gave a presentation.
Boston University (BU) National Science Foundation Research Experience for Teachers (NSF/RET) Workshop July 2011, Boston, Mass.	The STEM PBL PI team presented a hands-on workshop on Problem Based Learning at BU for Boston area middle and high school STEM teachers participating in BU's NSF/RET summer program.
The American Society for Engineering Education (ASEE) June 26 – 28, 2011, Vancouver, Canada	STEM PBL Co-PIs Michele Dischino and Nicholas Massa presented a paper.
The National Association for Workforce Improvement (NAWI) May 24 – 25, 2011, Burlington, Vt.	Co-PI Nicholas Massa gave a presentation.
International Association of Journals and Conferences (IAJC)/ASEE April 29 – 30, 2011, Hartford, Conn.	Co-PIs Michele Dischino and James DeLaura, chair of the Technology and Engineering Education department at Central Connecticut State University, presented a paper.
ITEEA: The International Technology and Engineering Educators Association March 23 – 26, 2011, Minneapolis, Minn.	Co-PIs Dischino and DeLaura delivered a presentation.
SustaiNext Summit East March 22 – 23, 2011, Philadelphia, Pa.	PI Fenna Hanes and Co-PI Judy Donnelly delivered a presentation.

Conference presentations by STEM PBL Co-PIs in 2011.

Conference Papers: <http://www.nebhe.org/programs-overview/professional-curriculum-development/about-stempbl/stem-conference-papers/>

What’s New: <http://www.nebhe.org/programs-overview/professional-curriculum-development/about-stempbl/whats-new/> ■

[PBL Course continued from page 1](#)

tion data gathering segment of the course. Pre-test and post-test data was collected as well as an inventory of pre- and post-test learning styles and individual student exit interviews. The data are currently under review.

“Problem-based learning encourages students to pursue learning through their own style,” said one student who took the TEE course.

Initial TEE student comments included the following:

“It [PBL] makes the students think a little more critically about certain events or certain problems. The great thing about it is that they come up with their own solutions and what they feel is the best solution to the problem at hand. And it’s their own ideas. They’re taking concepts that they learned in other classes and bringing them all into one area,” said one student.

A second student commented, “PBL encourages students to pursue learning through their own learning style. When they go out to research the problem, there could be one kid that’s more apt to sit down and read an article and another who will go search YouTube to watch a video about the same thing.”

Several students plan to develop their own PBL Challenges for their Senior Projects and will share their work with other teacher candidates.

Members of the Technology & Engineering Education faculty at CCSU are working with the Connecticut Community College’s College of Technology’s (COT) existing Technology Pathways Program to increase awareness of the career potential in TEE education, thereby encouraging graduates of Associate Degree technical programs to transfer into the TEE Bachelor’s degree program at CCSU. COT is a consortium of the engineering technology programs at the 12 community colleges in Connecticut. In addition, dissemination of this new course will be directed to colleges and universities across the country that offer teacher preparation programs in science, mathematics, engineering and technology programs. ■

For additional information about the TEE program at CCSU, please contact: James DeLaura, Ed.D., chair, Technology & Engineering Education Department, at delaura@ccsu.edu, or Co-PI Michele Dischino, Ph.D., at dischinomic@ccsu.edu.

Course and degree program information can be found at: <http://www.ccsu.edu/page.cfm?p=6498>.

Field-testing continued from page 1

with authentic real-world problems facing companies today. Students learn to research, design and present a solution by taking on the role of an engineer, scientist or technician tasked with solving a problem for a client.

Challenges have been implemented in a variety of STEM disciplines across high schools, two-year and four-year colleges in classes ranging from ten to more than 100 students. Instructors have the option to choose an implementation approach to PBL from the *structured* (entirely instructor led), *guided* (moderately structured) and *open-ended* (instructor as consultant) models developed by the project team.

Having participated in a summer workshop in 2010 and a subsequent distance-learning course (see p. 2) over the 2010-2011 academic year, instructors are expected to field-test two or more of the six STEM PBL or eight PHOTON PBL Challenges developed during the PHOTON PBL project (2006-2009). Instructors must respond to a survey and write a narrative describing the field-testing experience. Students are also expected to complete a survey documenting their experience. Feedback from instructors and students is being analyzed and synthesized into formative reports that will inform current as well as future Challenges. Findings will be shared in conference presentations and with NSF.

The following case studies represent two high schools and one four-year college that field-tested Challenges.

Oak Ridge High School, Mich.

"I am finding that students really resist this method," continued Flejszar, who introduced the Challenges as a supplemental activity to a group of students who remained after graduation, over a period of one to two weeks. "[It's] a bit like medicine they need to cure an ill. The 'ill' in my mind is that they cannot use what they have learned in class in order to come up with a solution to a different problem. Students are coming back from college stating how difficult it is for them and that they are responsible for so much more creative problem solving. Our goal in the science department is to make sure we address those areas of weakness."

Using the *guided* approach, Flejszar, who teaches physics to grades 10-12, split the 28 students into teams, giving them the choice to work on any one of the 14 STEM and PHOTON PBL Challenges. Students used computers and the media lab to collect their data and presented their findings using PowerPoint. Assessment was based on students' presentations. Students chose to work on the FloDesign, SPG Solar, Tookany/Takony-Frankford Watershed Partnership, Hiking 911, and Shining Light on Infant Jaundice Challenges. (See www.pblprojects.org for descriptions of the Challenges.)

Based on the results of the student surveys, it was clear that students experienced difficulty completing a project based primarily on the results of their research. Others had trouble being exact in their answers, as well as relating some of the Challenge topics

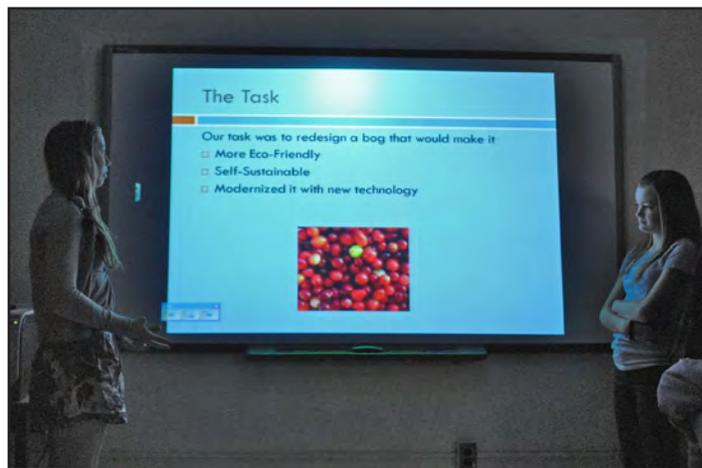
to their own lives. At the same time, students expressed pride in having completed a difficult assignment. Others enjoyed the experience of working in a group.

"I lost some of my fear of science through this Challenge," wrote one student after completing the SPG Solar Challenge. "I feel like I can understand something I was too scared to try on my own."

South River High School, Md.

Deborah Lesko, of South River High School in Maryland, teaches science as well as a first year (9th grade) and second year (10th grade) PBL course.

Over the course of six weeks, Lesko introduced groups of 9th- and 10th-grade students to the STEM PBL Challenges on sustainable agriculture and energy efficient lighting. The groups met separately for nine 43-minute sessions. Each group was presented with the *open-ended* implementation model. Students were assessed based on their concept maps (see p. 2), PowerPoint presentations and individual and group reflections. Lesko used Google SketchUp (a 3-D modeling program designed for uses ranging from architecture to gaming), group summaries and status reports as supplemental materials with both groups.



A team of Lesko's 9th-grade students presented the Cape Cod Cranberry Growers' Association task to their classmates during a final presentation.

In the first class of 121 students, the 9th-graders were split into teams to complete the Cape Cod Cranberry Growers' Association Challenge on sustainable agriculture. The students were told that they were now consultants and tasked with creating bids for the redesign of a cranberry bog. Since it was the freshmen's first time experiencing PBL, the focus was more on the students' collaboration than on their solving of the problem, explained Lesko.

Though some students had difficulty relating the Challenge to their STEM skills, many enjoyed the creative process of designing the bog and the challenge of performing hands-on work. Overall, many felt they would be more confident tackling a real-world problem in the future having proven that they could do it.

Field-testing continued from page 4

In the second class of 101 students, 10th graders in their second year of the PBL course were tasked with creating “top secret bids for the US Navy” in solving the RSL Fiber Systems Challenge, which asks students to design an ergonomic and energy efficient lighting system for submarines. The second year of the PBL course, explained Lesko, is focused more on project presentation. Presentations were recorded so that students could better hone and self-evaluate their presentation skills.

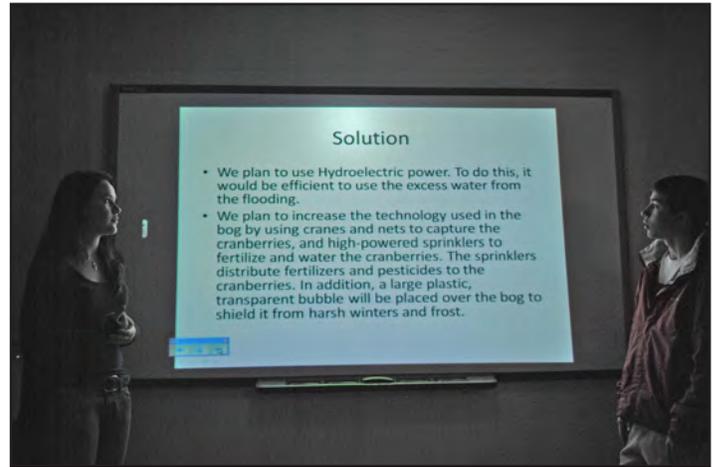
Students also learned that they were important to a group and enjoyed exchanging ideas with their teammates. Many students liked completing the Challenge because they felt accomplished in having finished something that they started. Students valued the problem’s authenticity and learning about the effects of circadian rhythm on the human body.

“What I liked most was presenting our solution,” said one student. “It let me get a feel for what professionals do every day.”

Stonehill College, Mass.

Susan Mooney, director of the environmental studies program at Stonehill College, implemented the Tookany/Takony Frankford (TTF) Watershed Partnership Challenge in her sophomore biology class using the *structured* approach. The class of 20 students participated in the Challenge over one four-hour class period. Mooney conducted a 30-minute post-evaluation during the following class.

Students spent the first four hours of the Challenge in the library, where they conducted their research and delivered their



A team of 9th graders in Lesko’s PBL course presented their solution to the Cape Cod Cranberry Growers’ Association Challenge.

solutions using PowerPoint presentations. Students were permitted the use of laptops, wireless Internet, library facilities, access to reference librarians and their course textbook as resources.

Mooney had students respond to a pre-Challenge list of STEM concepts included in the Challenge by checking off “Know/Don’t Know/Think I Know” before watching the Introduction, Organizational Overview and Problem Statement videos. Afterward the students were divided into teams, given Whiteboard templates used to organize their research and study rooms in which to work while Mooney circulated to ask and answer questions.

“They actually needed very little prompting and guidance from me,” she said. “They were engaged in solving the problem, and most pushed themselves and their teammates to better understand the issues.”

After the first brainstorming session, the students reconvened to watch the Discussion video before being sent back to their teams to revise their Whiteboards and present their solutions. In the following class, students filled out a post-Challenge version of the STEM concept list “Know/Don’t Know/Think I Know” detailing what they had learned. Students were assessed based on their presentations and pre- and post-concept lists. Though Mooney did not assess the students’ team participation, she noted that some performed better quality research than others. Despite this, it was clear that each student contributed to the group. Mooney says that she plans to work team assessment into the next Challenge.

“I liked it,” said one of Mooney’s students. “I didn’t feel that it was super scientific, though. Or maybe it was scientific, but disguised in fun.”

To access the Challenges go to www.pblprojects.org. ■



Continuing with the work of NEBHE’s College Ready New England (CRNE) program and the New England 2025 Initiative, the Office of Policy and Research is working on systematic, data-driven analyses of the region’s higher education landscape in order to boost student degree enrollment and completion.

The Office provides:

- Support and assistance for state-based work on policies, programs and other change levers;
- Resources for states to implement advanced data-mining and analysis techniques; and
- Research to inform legislative, executive, and institutional decision making.

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STEM PBL Instructors and Students Recognized with Awards

Participating STEM PBL instructors and their students received awards in 2011 for their outstanding achievements in STEM education. Nathan Usrey, an integrated science teacher at Taft Union High School, Calif., was awarded a Fulbright Scholarship in the Japan-U.S. Teacher Exchange Program for Education for Sustainable Development (ESD) in part for his involvement in the STEM PBL project. Usrey has field-tested several STEM PBL Challenges in his classroom since the project's inception and is dedicated to integrating PBL into Taft Union High School as a whole. The mission of the Japan-US ESD program is to raise awareness around ESD-related school programs, enhance ESD-related curricula in both countries and deepen the connection

between teachers in the U.S. and Japan. The program invited awardees to participate in a Joint Conference in San Francisco in May 2011, and a Joint Conference in June 2011 in Tokyo, Japan.

Back on the east coast, science instructor Stephen Barner of South Burlington High School, Vt., was awarded "Technology Educator of the Year" at the 2011 Vermont Design Technology Education Association's annual meeting. Over the last three years Barner has led an increasing number of teams in the Vermont Real World Design Challenge (RWDC) Governor's Cup competition, and one of his teams has taken first place each year. This year, Barner proudly watched his students take the top three prizes.



The Blue Angels took first place in Vt.'s RWDC (Front, L-R): Neharika Khandavalli, Basundhara Mukherjee, (Rear L-R): Matthew Gilmartin, Neel Desai, Vishnu Premsankar, Jonathan Girard, Austin Goddard.

The annual RWDC asks teams of high school students to solve a design challenge facing industries today, use engineering software and present their solutions. This year's challenge was to design a wing for a business jet aircraft. Students researched airfoils, modeled their wings in PTC ProEngineer 3D CAD software, analyzed the results using Mentor Graphics' FloEFD and MathCAD software, and designed the wing's internal structure. Students worked with mentors in the aerospace industry, logging hundreds of hours after school for the challenge. The top two teams each won a laptop computer. The first prize team was entered into the national competition and awarded an all-expense-paid trip to Washington, DC in April 2011 to present their design to a panel of industry and governmental aeronautics experts. ■

Warner Babcock Institute/Beyond Benign Host Advisory Committee Meeting

STEM PBL Advisory Committee members gathered at the Warner Babcock Institute for Green Chemistry/Beyond Benign (WBI/BB) in Wilmington, Mass. to attend this year's advisory committee meeting in May. Eighteen advisory committee members representing education, industry and government were in attendance.

WBI, co-founded by President and Chief Technology Officer Dr. John C. Warner, is a green chemistry laboratory producing chemically benign products. Co-founded by Executive Director Dr. Amy Cannon, BB is WBI's non-profit educational arm promoting the implementation of sustainable science. With a focus on green chemistry, BB specializes in K-12 curriculum and training, workforce development and community outreach communications.

On May 19, 2011, advisory committee members met for a networking reception at WBI/BB, where they received a tour of the facilities and laboratories, listened to presentations by Drs. Warner and Cannon and sat down to dinner at the WBI/BB facilities where they had the chance to speak with the organizations' founders. The next morning, committee members joined the STEM PBL project team for the advisory committee meeting held in one of BB's educational classrooms.

Principal Investigator Fenna Hanes welcomed the group and delivered presentations on the STEM PBL Summer 2010 work-

shop, as well as the Capstone professional development workshop to take place in 2012. Co-PI Dr. Nicholas Massa demonstrated the TTF Watershed Partnership Challenge and delivered a presentation about the CCSU pre-service technology education course offered for the first time in spring 2011 (see p. 1). Co-PI Judy Donnelly presented the "Introduction to PBL" distance learning course (see p. 2), which took place over the 2010-2011 academic year.

Cosultant Sandy Bell presented the team's research with Massa. This was followed by a presentation by project evaluator Anita Kite. The meeting also included a committee member break-out session and dialogue with the PI team focused on project achievements and planning for the third year of the project. ■



Dr. Cannon (second from L) and Dr. Warner (third from L) discussed the green chemistry movement with advisory committee members.

Career Profile: Glenn Nystrand Brings Green Chemistry to Personal Care

The STEM PBL Principal Investigators met Glenn Nystrand, a research fellow at Johnson & Johnson (J&J), in Skillman N.J., while videotaping the J&J green chemistry Challenge on personal care products in February 2011. A leader of the formulation technology development at J&J, Nystrand co-developed the formulation of a topical skin care product to treat eczema, a skin disease characterized by redness and itching, on which the J&J STEM PBL Challenge is based.

Nystrand recently passed his 20th service anniversary at J&J. He has also been employed with Bristol Myers Squibb, Givaudan and the Mennen Company. He possesses an AAS in Chemical Technology, a BS in Chemistry and an MA in Cosmetic Science.

In 2009, Nystrand and two of his colleagues were honored with the Johnson's Medal for Research and Development, the most prestigious award given for research and development excellence within J&J, for their work associated with natural based extracts designed for individuals with sensitive skin, and a basis for the eczema product on which the J&J Challenge is focused.

In addition to developing formulations for J&J products, Nystrand directs, recommends options and guides the development process for new product launches.

As a young student, however, Nystrand lacked a clear path. He came into his career by chance, he explained, mostly through the fortuitous meeting of a community college chemistry professor who influenced and guided him. Nystrand was always interested in math and science but explains that, lacking concrete guidance and direction, he was unable to connect these interests to a marketable career path. At County College of Morris in Dover, N.J., Nystrand was able to explore the options available to him

through a departmental program that developed relationships between students and leaders in industry. With the help of his mentoring chemistry professor, Nystrand secured both part-

time and summer jobs in the fields of science and engineering.



Glenn Nystrand in the research laboratory at the Johnson & Johnson's facility in Skillman, N.J.

Nystrand feels that teachers need to demonstrate to students how their field of study can be utilized in work environments. Visiting STEM-focused businesses, inviting guest speakers into the classroom to discuss their career paths, and exposing students to demonstrations and videos related to scientific careers enable teachers to connect students with what they learn in class to real world applications.

Though Nystrand believes individual skill sets are molded by one's scientific field, he explained that the educational environment should provide the foundation for scientific learning by fostering the development of thought processes, problem-solving and individual skills. In his own work, Nystrand cited attention to detail, innate curiosity, the drive to research, communication, teamwork and delivery as key skill sets.

Communication skills, he explained, are highly valued in the world of business, yet often overlooked in scientific training.

"Technical jargon can get lost when presenting to marketing and business associates," he said. "Being able to bring information down to a basic level of understanding is critical to getting your business team aligned with R&D [Research & Development]."

Students need to understand that they are competing in a global environment and as such need to put greater emphasis on their education, Nystrand believes. No matter how inspiring a teacher may be, it is up to the student to be motivated and to demonstrate enthusiasm in learning. In the age of outsourced labor, post-graduates competing for technical jobs are faced with both national top-notch peers, as well as highly qualified individuals abroad. Students need to push themselves to be better and have a vision of what they want to be and do, said Nystrand. As a Challenge partner, it's one of the reasons he supports the STEM PBL project.

"What you are doing will help link basic scientific learning in the classroom with science in industry," he said. "You're making it fun and interesting. I hope students will find it challenging, and learn."

To learn more about the Johnson & Johnson Green Chemistry Challenge, please visit www.pblprojects.org. ■

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STEM PBL Challenges to Date

In collaboration with industry partners, the STEM PBL project team has developed six problem-based learning Challenges focused on sustainable technologies. The Challenges are being field-tested in high schools, two- and four-year colleges, and universities across the United States. The Challenges' real-world applications include: green chemistry, lighting design, solar power, stormwater management, sustainable agriculture and wind power.

Real-World Application	Industry Partner	The Challenge	Principles Learned
Green Chemistry	Johnson & Johnson	Students are part of a team developing new treatment for eczema using active ingredients.	<ul style="list-style-type: none"> - Green chemistry - Lifecycle analysis - Chemical toxicity
Lighting Design	RSL Fiber Systems	RSL Fiber Systems is designing an ergonomic and energy efficient lighting system for submarines.	<ul style="list-style-type: none"> - Circadian rhythm - Visible spectrum - Illumination sources
Solar Power	SPG Solar/City of Tucson	The city of Tucson, Ariz. wants SPG Solar to put a solar array on a large building but the roof is not strong enough to support a traditional panel array.	<ul style="list-style-type: none"> - Solar irradiance - Load limits - Voltage, current, power - DC to AC conversion
Stormwater Management	TTF Watershed Partnership	Can the problem of urban stormwater be addressed by local communities without investing in huge infrastructure projects?	<ul style="list-style-type: none"> - Area and volume - Unit conversion - Stormwater management
Sustainable Agriculture	Cape Cod Cranberry Growers' Association	Can technology be used to make a cranberry bog more energy efficient?	<ul style="list-style-type: none"> - Biochemistry and toxicity - Irrigation technology - Environmental science
Wind Power	FloDesign	Students need to design a new way to extract electrical energy from a wind turbine.	<ul style="list-style-type: none"> - Energy conversion - Electromagnetics

To view the six STEM PBL and eight previously developed PHOTON PBL Challenges, please visit www.pblprojects.org. ■

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