Boston University Challenge
Implementation Stories from PHOTON PBL Field Testing Teachers

Institution/Grade level Four-year college in New York state.

Course College Physics II and University Physics II

Class size/group size 9 students

Challenge level Open-ended

Details of Implementation

The PBL Challenges were introduced as a supplemental activity in two traditional lecture classes, College Physics II and University Physics II, which included students from different engineering fields. Students were allowed to select two challenges most closely related to their major. The challenges were delivered to both classes as an open-ended assignment in the fourth week in the spring semester of 2009.

The challenge was introduced by presenting Introduction, Company/University Overview, and Problem Statement videos. Additional resources were introduced as was the Problem Solvers Toolbox, in which the Whiteboards were explained as a means of properly framing the problem. With my guidance and assistance, students completed the Whiteboards and some very interesting plans were submitted one month later.

Students were allowed to work individually or in teams for about three months on their two selected challenges. Each student or team had to submit a progress report every two weeks. I also had a 20-minute meeting with each group once every two weeks. For resources, key concepts involved in all challenges, and how to find reliable information online were posted on Angel, which is a web-based course management for course materials and communication. My role was to answer questions concerning the logistics of challenges and to make sure that deadlines were met.

Assessment

Each student or team developed, documented, and presented solutions to two challenges. Since two challenges were worth 20% of students' overall grade, students in College Physics II and University Physics II had put a lot of effort and time into the challenges. Students took full advantage of Whiteboards, additional resources, and key concepts involved in the challenges. Each student or team was required to submit a hardcopy report of their solution proposal.

Comments As a physics teacher, one problem I have had is that I cannot cover optics in both algebra- and calculus-based physics courses in depth simply because I do not have enough time to do so. The PBL Photonics challenges appear to be the solution to this problem. Using the PBL approach, students learned a great deal of optics through two selected challenges without my spending 8 lecture hours quickly covering optics.

Penn State Electro Optic Center, *Hiking 911*
Implementation Stories from PHOTON PBL Field Testing Teachers

Institution/Grade level Community college freshmen in the Northeast

Course A one-semester interdisciplinary course in engineering technology

Class size/group size 18 students/3 per group

Challenge level Structured

Details of Implementation

The class met for one 150 minute block, allowing for hands-on experiences and field trips. During the first week of class, students were introduced to concept mapping as a means of organizing their knowledge about a particular topic. The class created a concept map on the topic "coffee" and for homework, students developed a concept map of their own based on the "Pasta Made by an Italian Mother" exercise in the PHOTON PBL Teachers' Guide.

The Hiking 911 Challenge was completed during the second two-hour block. Students were shown the Challenge Introduction and Organization Overview videos, followed by the Problem Statement. They were given printed versions of the Whiteboards and asked to complete the Problem Analysis Whiteboard by brainstorming with their group. After about one hour, the class regrouped to view the Discussion Video, then teams continued to work on the remaining Whiteboards for approximately one hour more. Students were perplexed by the "how do you test your solution?" column. We had a discussion about testing and whether it would be appropriate when lives were in danger. We also talked about "testing" in terms of reviewing the problem criteria and being sure everything had been addressed.

Solutions were informally presented to the group; each team stated which combination of camera/optics/aircraft they chose and why. One group wanted to deploy all available assets and that led to a lively discussion about who would pay for the rescue operation and the ethics of requiring people who get themselves into danger because of their own lack of preparation to pay for their own rescue.

Assessment The homework assignment was to create a concept map of the Challenge using 10 words provided by the instructor and 6 words chosen by the student. A list of propositions was also required. Assessment was done using the rubric provided in the Teachers' Resources.

Comments The course, Introduction to Engineering Technology, was one of three linked courses in a grant-supported program to increase the success of students in engineering technology associate degree programs. The students placement-tested at or below the cut-off for College Algebra and English Communications. They spent one month before the semester in a "college readiness boot camp", and were taking this course plus math and English as a cohort of 18 students. The course objectives were to introduce/strengthen ideas common to all engineering technology programs- critical thinking, problem solving, data analysis, drawing conclusions, using math in context. The vehicle (topic) used was nano-photonics; this was not a topic covered in any of the students courses of study, so none had an advantage in terms of background knowledge.

IPG Photonics Challenge, *High Power Laser Burn-in Test*
Implementation Stories from PHOTON PBL Field Testing Teachers

Institution/Grade level High school seniors in California

Course Physics

Class size/group size 24 students in 12 groups (only one female in class)

Challenge level Structured

Details of Implementation

I delivered the curriculum using an NSF supported methodology called Modeling Physics. This method is a blend of lecture, inquiry based labs, and peer review. The PBL Challenges were presented during the last three weeks of school after our state testing. By this time the students had many opportunities to experience open-ended inquiry type activities and work in teams with expectations of completed projects on a timeline. In prior lessons, students observed a CO_2 laser in operation and had seen the interferometer demonstration from the PHOTON2 kit. These gave the students some prior knowledge to work with.

I spent the first day talking about the PHOTON PBL concept and introducing the IPG Photonics PowerPoint. Students were then assigned to teams of two. I draw Popsicle sticks with student names on them out of a container to determine team pairing. Students have leaned to bow to the "Fate of the Sticks". Each team has access to a laptop with the IPG PowerPoint (with the solution page removed) and all of the video and support material available on a network folder.

The students were required to complete the worksheets in the Problem Solving Tool Kit and then prepare a presentation of their solution. The students had the intro day plus 3.5 class periods (57 minutes) of research and development time. But by the time the laptops were distributed and the students logged on and navigated to their workspace and the cleanup afterward, the students really had only 40 to 45 minutes of actual work time. The presentations then lasted two days.

My role during this time was of a facilitator. I would not answer specific questions that I felt could be directly found on the internet. I tried to offer suggestions on search words and helped students refine searches. I would endeavor to explain some of what students found on the internet and suggest simpler models of what they found. I also would ask each team for a status check each day. I did not do any formal evaluation or record any grades at these checks. My goal was to provide an atmosphere of

accountability in the room and keep them on task. I would also try to evaluate each team's direction. Some teams needed some intervention to get them moving in a direction. Many times getting them to revisit the Problem Solving Tool Kit and the flow chart was enough to get them back on track.

Assessment I felt 2 teams had vary viable solutions, 5 teams had minor flaws in their solutions, 3 teams arrived at a solution but had major flaws, and two teams did not complete the challenge due to attendance and medical problems. Ten teams made class presentations, students asked questions, and then wrote a critique of each presentation/solution. Each critique must include positive and negative comments with extra points for including details that no classmate notices.

Comments The PBL challenges gave students some independence and power to make decisions about their own learning. I did not have to stand in the front of class and dictate procedure and practice. Students chose their own level of engagement in the problem and received the reward or consequences of that decision. I was able to get more interest and engagement out of the class as a whole using the Challenges than any other activity that I have used in the past. Student feedback was positive and most students preferred this method to some of the more opened ended inquiry activities that we did earlier in the year.

In the future, I need to develop rubrics and more scaffolding / structure for the challenges. Students have very little experience as to the size and scale of the labs where the solutions will go. They may need to be given a platform size for the IPG challenge.