SUCCESSFUL STAFF DEVELOPMENT IN PHYSICS
by Hal Eastin, retired physics teacher at Cortez High School, with Jane Jackson (1999)

Staff development for physics teachers is succeeding in the Glendale Union High School District (GUHSD), where most physics teachers implement the Modeling Method in their classroom. GUHSD teachers report that their no-cost school district inservices in physics are valuable. This is in sharp contrast to other physics teachers in Arizona. In a 1998 survey of one-third of Arizona’s physics teachers, all others said that their school-based professional development was of little value or worthless.

What makes for GUHSD’s success? Essentially, a cadre of physics teachers who are skilled at exemplary practice; and two district staff development days each year where all physics teachers work together to refine their reform-based physics curriculum.

GUHSD consists of nine high schools in northwest Phoenix. The average school population is 1500 students. Physics is taught at each high school, with a total of twenty-three classes that use a wide variety of textbooks and programs. Of the nine physics teachers in the district, seven have completed a four-week Modeling Workshop in mechanics at ASU, and five have completed a second semester Modeling Workshop in electricity (as of fall 2000).

This outstanding staff development started in 1996, when GUHSD required that performance-based assessments (PBA) be developed as part of each science teacher’s semester evaluation process and as a way of holding teachers accountable for implementing in their class hands-on, inquiry type labs. The district needed to unify the curriculum so that as students changed schools they would not suffer a great loss of content. Modeling Workshop experiences proved extremely helpful in the development of the PBA.

Each fall and spring, the nine physics teachers meet on their district staff development release day to plan what three experiments they want their students to accomplish for their PBA. They work through these experiments, devise problems to solve using student-developed models, and write scoring rubrics. At the end of the year, the district assigns one of the three PBAs to each student by giving each teacher a roster listing their students’ names with a PBA number ranging from one to three. Students are allowed one week to do the experiment.

The PBA is essentially a lab practicum, a crucial element in the Modeling Method of Instruction. Measurable student gains in understanding of physics concepts are typically double or higher under Modeling Instruction, compared to traditional lecture - lab - demo methods! In the Modeling Method, each modeling cycle starts with a paradigm lab in which teams of students design an experiment to answer a question about nature. The teacher guides students to identify the independent and dependent variables, and to use multiple representations such as graphs, motion maps and system schema to derive a mathematical model. Through classroom discourse that includes extensive Socratic questioning, misconceptions are clarified and consensus is reached on the model. Students deploy the model to solve real-world problems, often by a lab practicum. Since the PBA employs aspects of the modeling cycle, students of modeling teachers earn high scores on PBAs.

PBAs promote reform by requiring non-modelers to apply effective strategies of the modeling cycle in their classroom instruction. They serve also to motivate teachers to participate in Modeling Workshops. For example, one non-modeler’s students averaged 38% on the PBA. Their poor results motivated him to learn the Modeling Method. The year after he took a Modeling Workshop, his students’ PBA scores rose to 90%! He became an enthusiastic advocate of modeling!
Some PBAs that have been used are:

a) Measuring the acceleration of gravity, $g$, for 5 different masses.
   Students choose the equipment and procedure to determine gravitational acceleration. They use the information and planetary data to find the gravitational acceleration of another planet.

b) Conservation of Momentum.
   Two carts are placed end to end. A force causes the carts to separate and move in opposite directions. The carts have different masses, resulting in each cart having a different speed. Students plot mass vs speed and derive an equation for momentum. They solve a related problem involving mass, velocity and conservation of momentum.

c) Conservation of Energy.
   Students change the height of a pendulum bob and measure the speed of the bob at its equilibrium point. Then they find the equation relating height and speed and solve a related problem involving conservation of energy.

Each student writes a lab report on one of the three PBAs. Students are allowed to collaborate with other students while collecting data as long as they are doing different PBAs. Teacher input is limited to providing necessary equipment, clarifying any questions concerning the assessment, and ensuring that each student is working independently. Individual teachers are encouraged to grade the PBAs themselves and to use it as part of their final exam grade. All physics teachers then grade the PBAs according to the grading rubric at the district office. (Teachers get paid for this). Each PBA is graded twice and a computer program is used to determine the final grade. Each teacher is informed of the performance of his/her students on the PBA. The percentages of a teacher’s students who achieve a grade of outstanding, highly successful, successful, and not yet successful, are reported to both the teacher and the principal.

Because of the PBA, students’ lab reports have improved immensely and the level of technology in the physics labs has increased. Physics teachers continue to share teaching strategies in district-wide physics inservice meetings, and they work together to produce lab activities that incorporate more technology. As a result, physics education in the Glendale Union High School District is approaching exemplary practice.

Appendix: Development of the PBA:

To implement the district-wide physics professional development, a three-year schedule was accepted to develop PBAs. **Year one** involved development of support materials, identification of suitable lab activities and a survey of technology requirements.

*Development of supporting materials* began by deciding on units to be tested on the PBAs. After much discussion, the nine units in the Modeling Instruction manual in mechanics were selected. Next, an assessment model was constructed to identify the outcome, task overview, and parameters with special conditions. Because of their common experiences in modeling workshops, the physics teachers agreed unanimously on necessary components of an outstanding lab report. They made a grading rubric which mirrored the assessment model. During this process, each teacher had an opportunity to express the special requirements that his/her students were required to demonstrate in producing a lab report. Finally, assessment requirements for the lab report were outlined. The assessment allowed teachers four levels to characterize each student’s achievement: outstanding, highly successful, successful, or not yet successful.
Next, teachers came together to select lab activities to use for assessment. A group of teachers did each suggested lab activity; they collected and graphed sample data and derived math models from linearized functions of the graph. Finally, teachers agreed upon reasonable written conclusions to each lab, with any ambiguous instructions rewritten and redefined.

When all teachers were comfortable with the activities, assessment model and grading rubric, the technology at each school was surveyed. Activities that required technology not available at a particular school served as a catalyst for that school or the district to acquire it, generally within a year.

In year two, the pilot year, lab activities to be used for assessment were done by selected schools. In year three, the district ran the initial PBA at all nine high schools.

Download: http://modeling.asu.edu/modeling/professdevelop/GUHSD_physics_Inservice.pdf
Or http://modeling.asu.edu/modeling/professdevelop/GUHSD_physics_Inservice.doc
(updated July 2001)


Some PBAs that have been used are:
a) Conservation of energy. Students change the height of a pendulum bob and measure the speed of the bob at its equilibrium point. Then they find the equation relating height and speed and solve a related problem involving conservation of energy.
b) Modified Atwood machine experiment: Students determine the relationship between the force on a hanger and the acceleration of the system while keeping the mass of the system constant.
c) Projectile motion: Students determine the relationship between the horizontal launch velocity of a ball and the horizontal distance it travels after being launched from the table.

Each student writes a lab report on the PBA. Teacher input is limited to providing necessary equipment, clarifying any questions concerning the assessment, and ensuring that each student is working independently. Individual teachers are encouraged to grade the PBAs themselves and to use it as part of their final exam grade. All physics teachers meet for a day to grade the PBAs according to the grading rubric at the district office. (The district pays for a substitute for each teacher; grading is done on the day after the AP test, e.g., on May 13, 2008.) Each PBA is graded twice and a computer program is used to determine the final grade.

The percentages of a teacher’s students who achieve a grade of outstanding, highly successful, successful, and not yet successful are reported to both the teacher and the principal on the first day of the next school year. Then each teacher writes a personal improvement plan based on the results. For example, if a teacher’s score is “100% of students were successful”, the teacher might write of how he/she intends to move some students to a higher level of success.
PBAs in other sciences:
Dawn Harman wrote to Jane Jackson in January 2008:

“There is a PBA for Chemistry. However, in the Chemistry PBA, students are given a story line and asked to solve a problem involving chemistry. Because of safety concerns, students are given a procedure to follow.”

“Biology and Thinking Science used to have PBAs as well; however I think this has changed in the past year. I think the format has changed to a multiple choice to better align with AIMS Science.”

Related GUHSD staff development. (This was written by Jane Jackson):

a) Using physics modelers as course leaders, GUHSD held a 1-week modeling workshop in summer 2000 (for 15 teachers) and held two 1-week modeling workshops in June 2001 (for 30 9th & 10th grade teachers & a waiting list!).

b) In 2002, GUHSD partnered with the Modeling Instruction Program at Arizona State University in a NCLB Higher Education "Improving Teacher Quality" grant for two 3-week modeling workshops for ninth grade science and math teachers, with 7th and 8th grade teachers from their two feeder districts. Debi Plum, the GUHSD math coordinator in those years, organized all this professional development. Later she returned to classroom teaching, and she reported to Jane Jackson in 2005 that the professional development contributed significantly to improved student achievement.