

WHY WE MUST EXPAND HIGH SCHOOL PHYSICS IN MARICOPA COUNTY

By Earl Barrett, Larry Dukerich, and Jane Jackson (fall 2015)

Data from the U.S. Bureau of Labor Statistics predict that U.S. employment in STEM occupations — science, technology, engineering, and mathematics—will grow to more than 9 million between 2012 and 2022. That’s an increase of about 1 million jobs in 10 years.

High school physics incorporates all elements of STEM better than any other course. Physics is STEM! Research shows that a student who takes high school physics is 2 to 3 times more likely to earn a STEM degree than a student whose last high school science course was chemistry.*

Thus, to prepare our students for Arizona’s share of these 9 million jobs, we should do all we can to interest high school students in physics, while preparing a world-class group of physics teachers. We should expand physics enrollment with our current staff and retrain interested teachers of other sciences.

Arizona is doing poorly compared to the rest of the nation: **In Maricopa County, only 20% of high school students take physics, while the nationwide average has grown to almost 40%, to meet 21st century needs.** Arizona legislation requiring three years of lab science for graduation has not increased the number of students who enroll in physics. Instead, students are taking advanced life sciences as their third science course. Research shows that taking advanced life science courses instead of physics hinders students from pursuing STEM majors in college, including health & medical majors.* After all, physics is the foundation of all other sciences, engineering, and technology, and is prerequisite for almost all STEM careers.

The push in Arizona in the last decade, to promote AP courses and increase the graduation rate with limited resources, had an unintended, troubling effect: high schools replaced regular/core physics with honors or AP physics, instead of adding them to regular/core physics-- thus giving physics *the appearance* of being a course for only the mathematically adept. This hinders all but top students from pursuing STEM majors and STEM careers. Disadvantaged minorities and girls are left out, because they tend to have a weaker background in math. Physics is the ideal course to make algebra make sense; and the disappearance of regular/core physics closes doors in careers and higher education for the middle half of students.

Maricopa County has 120 physics teachers employed in the 90 school district high schools that offer physics. Only 30% of these teachers are fully utilized; i.e, teach physics full-time.**

The pedagogy that has shown the most success in actively engaging students of all abilities in high school physics is Modeling Instruction. Modeling Instruction began at Arizona State University in 1985, in a partnership between a physics professor and a physics teacher at Marcos de Niza High School in Tempe. It is designated as an *Exemplary K-12 science program* and a *Promising Educational Technology Program* by the U.S. Department of Education. The American Physical Society recognized it with the *2014 Excellence in Physics Education Award*, and Change the Equation rates it an *Accomplished STEM Program*. Most physics teachers in Maricopa County have attended one or more 3-week intensive summer Modeling Workshops. The Boeing Company and Salt River Project fund the program, and 70 teachers participate

each summer in 4 Modeling Workshops and advanced courses that can lead to an MNS degree. ASU has prepared many physics teachers from other sciences, and 2nd career teachers.

To learn more about our plans to grow physics enrollment in Maricopa County, and/or to contribute: contact Jane Jackson, Co-Director, ASU Modeling Instruction Program.

480-314-1522. Jane.Jackson@asu.edu <http://modeling.asu.edu>.

* References are at <http://modeling.asu.edu/modeling/STEMpathways-PhysicsAZ.htm>

* Further reading: <http://modeling.asu.edu/Projects-Resources.html> (Scroll to bottom of page.)

** Six of these 90 schools have 9th grade physics. Private & parochial schools have 20 physics teachers. Charter schools have 60: chiefly BASIS & Great Hearts, where every high school student takes 2 or more years of physics. About 60 charter high schools for at-risk students do not offer physics. (Charter schools reach a small fraction of students.) Maricopa Cty has 2/3 of Arizona high school students. Maricopa Cty has 200 physics teachers, and Arizona's total is ~300.

Outline of our Plan to Grow Physics Enrollment, and Budget

by Earl Barrett, with lab equipment estimates by Larry Dukerich (updated October 2015)

In order to increase and sustain the physics program at a school, first district and school administrators must commit to support that change. With that commitment in place, at a site that has a teacher with adequate physics training, some experience in Modeling Instruction, and a classroom in which to grow the physics enrollment, we propose the following **intervention strategy**.

1. Interview science teachers, counselors, and administrators, to determine their level of support for increasing enrollment in physics. Explore these possibilities: a double-period 12th grade core class that integrates physics and math; 9th grade physics; physics & technology with CTE credit.
2. Analyze classroom/lab equipment limitations, and prepare a budget that meets minimum requirements for Modeling Instruction success.
3. Provide students, counselors and parents with information needed to understand benefits of taking physics in high school. (This involves creating & supporting materials & procedures.)
4. Train the physics teacher to make effective use of the new technology in their classroom. (This includes ASU 3-week summer Modeling Workshops.)
5. During student selection of their high school courses, provide support to the physics teacher and counselors, for effective guidance of students.
6. Bring all target teachers together for two days in the summer and twice during the school year. The purpose is training, problem solving and designing a strategy specific to each school. Teachers will be paid \$30/hr for their participation.

Implementation cost is based on lab equipment analysis and time needed to complete steps 1 to 6. We estimate 60 hours of on-site presence and 20 hours of administrative and off-site support.

Budget for each school:

Support: \$4000.

Lab equipment for data collection and analysis: up to \$10,000 (depends on existing equipment).

Equipment list: <http://modeling.asu.edu/Projects-Resources/PhysicsTechBudget-mechanics15.pdf>.

More recent related documents: ASU Modeling Instruction home page: <http://modeling.asu.edu> at bottom.