

Addressing the Goals

2d project in Year 3

Dr. Eric Wells (Physics) and Ryan Mello (student researcher)

Overall Goal #3:

In what ways have we explored and applied familiar and unfamiliar enhancements of the teacher-student relationship?

From what I have been able to gather, undergraduate research in physics was not conducted with any degree of consistency in the years immediately preceding my arrival. This award has helped demonstrate that such research can be done here, it can involve undergraduates in significant ways, and it can result in a high-level finished product. We have had six undergraduate students co-author publications in Physical Review in the last year^{1,2,3*}, and one of our students was the lead author on one of these publications.

The Bush Foundation's support of Mr. Mello last summer illustrates the unique way that research enhances the traditional student-teacher relationship. While understanding lessons from the classroom is a necessary condition for exploring open-ended problems, it is not, by itself, sufficient. This sort of instruction depends on a very apprentice-like instructional model. As he describes in his [report](#), Ryan was able to learn, over the course of a summer, some very advanced techniques that add layers of understanding to the standard course material. For science education, however, it is the other enhancement that is critical: research activity means the student in exploring the unknown. Recent graduate Nora Johnson put it this way,

“My point is you learn tons through research activities, and it gets really exciting when you start asking questions and even textbooks don't have answers, and you realize that you are now exploring the unknown. This realization is very important to an undergrad who comes to college with this naivety that they just need to sit in class and when they graduate they will have everything figured out, I felt I “knew” less when I received my diploma than the first day of classes as a freshman.”

¹ **Nora G. Johnson, R.N. Mello, Michael E. Lundy, J. Kapplinger**, Eli Parke, K.D. Carnes, I. Ben-Itzhak, and E. Wells, “*Single Ionization of Hydrogen Molecules by Fast Protons as a Function of the Molecular Alignment*”, Phys. Rev. A **72**, 052711 (2005).

² E. Wells, **K.J. Betsch**, C.W.S. Conover, D. Pinkham, M.J. DeWitt, and R.R. Jones, “*Closed-Loop Control of Intense-Laser Fragmentation of S_8* ”, Phys. Rev. A **72**, 063406 (2005).

³ E. Wells, Vidhya Krishnamurthi, K.D. Carnes, **Nora G. Johnson, Heather D. Baxter**, David Moore, Kristana M. Bloom, B.M. Barnes, H. Tawara, and I. Ben-Itzhak, “*Proton-Carbon Monoxide Collisions From 10 keV to 14 MeV*”, Phys. Rev. A **72**, 022726 (2005).

* Augustana undergraduates in **bold**.

Those of us that choose science as a vocation understand this excitement, but it is often a real challenge to convey this excitement to students in the classroom. On the other hand, it is relatively easy to show a student engaged in research why we do what we do. Small liberal-arts colleges are, in many ways, ideal settings for this important apprentice like learning to occur at the undergraduate level. If we are to become an elite institution, then we need to recognize this and obtain the necessary resources to continue finding opportunities for students like Mr. Mello. The Bush Foundation Grant award provided an important demonstration of this idea.