

## TEACHERS' COMMENTS on the VALUE of the MNS PROGRAM

As of 2010, almost 50 high school teachers have earned the Master of Natural Science (MNS) degree with concentration in physics, and 700 teachers worldwide have participated in Modeling Workshops and other MNS courses since the program began in 2001. Each summer 125 to 150 teachers participate. Twenty courses have been developed, and six to ten courses are offered each summer on a rotating basis. Comments from teachers, instructors, peer leaders, and NSF grant evaluators (below) were solicited one year; many unsolicited comments have been received throughout the years.

### In-service teachers in the MNS degree program

Five in-service teachers finished the MNS degree in summer 2003: three women and two men. Only one has a degree in physics education; the others had a weak physics background. Ages range from 30 to 53. Their high school teaching experience ranged from 2 years to almost 3 decades. Their opinions were solicited, regarding the value of the degree program to their teaching and their students' learning. They wrote:

" In the case of this program, everything offered has been valuable to me, and relevant to what I do, so I took all of it. ... As a private school teacher with 20 years experience there is no pay advantage. I took it purely for personal enrichment--because having done so **I have learned to be a better physics teacher, learner and thinker.**"

"The MNS program at ASU has provided enhancements to my ability to teach physics on multiple levels. First, the subject matter courses have broadened my own knowledge of physics. The modeling curriculum materials are invaluable. Second, **the integrated courses allow me to work with my students in ways that make them more successful in mathematics and other sciences.** I can also support and try to develop course integration in my school. Third, the degree itself is enabling me to offer my students premium opportunities such as dual-enrollment credit through the community college district. The master's degree programs available through the college of education would not qualify me for this option. **Finally, the direct contact with the university physics community has given me "connections" which I value highly.**"

"The MNS physics degree is more valuable than I thought it would be, not only in my physics classes, but my chemistry classes as well. The content courses such as Physics and Astronomy, Light and Electron Optics, Structure of Matter, and Matter and Light **not only deepened my understanding of quantum mechanics, models of atomic structure, and basic physics (other than mechanics) not emphasized in my undergraduate years, but I finally "saw" how much physics impacts the understanding of chemistry ...This program allowed me to apply what I learned in my classes to my classroom. I LOVED this program!!!!**

"**The opportunity to take both content rich classes and methods classes that were also content rich with colleagues sharing ideas and stories was very fulfilling.** The content classes were excellent."

"I started the Masters in Secondary Ed at NAU about 4-5 years ago and got nearly half way through it when I realized it was not making me a better science teacher. ... I was very unhappy

with what I saw as a waste of my time. ... **I finished the MNS - Physics last summer and am very pleased with my choice. I am a better science teacher!** I upgraded my skills in science in every class I took. My confidence has improved, and I know many science teachers now. Except for the modeling pedagogy, I think that interacting with other science/math teachers was the greatest benefit to me. ... **Most science teachers I know have been called upon to teach in more than one science or math discipline, and the integrated classes are perfect in meeting that need. Action research was also a very valuable experience for me because for the first time I did primary research on the teaching of science in my own classroom."**

A chemistry teacher midway through the MNS degree program wrote:

**MOST UNIVERSITIES' COLLEGES OF EDUCATION ADOPT THE "PLUM PUDDING" PHILOSOPHY OF AN INTRODUCTION TO EVERY TEACHING METHODOLOGY ON EARTH. THE ASU MNS PROGRAM IS FOCUSED AND DIRECTIVE, MUCH LIKE MODELING INSTRUCTION ITSELF. THE DEGREE IS STRONGER AND MORE SUBSTANTIAL. IT'S AN IDEAL MODEL TO PATTERN OTHER PROGRAMS AFTER. I FEEL VERY FORTUNATE TO BE IN THIS PROGRAM. MY STUDENTS WILL BE THE ULTIMATE BENEFICIARIES.**

Inservice teachers - non-degree

Inservice physics teachers who took the Modeling Workshop in mechanics in 2003 wrote:

- **Most useful course I have taken since becoming a teacher.**
- It was a great class. As soon as you know anything about next summer's classes, let me know. I would like to attend the next class in the series.
- It was a very intense 4 weeks but well worth it. I learned an incredible amount!
- It was an incredible experience and it has changed my outlook on how to teach completely.

A teacher wrote about PHS 570, Spacetime Physics: " Dr. Hestenes' obvious enthusiasm for GA [Geometric Algebra] sort of overwhelmed me, but it is interesting how much has become clear as I have had a chance to digest and even introduce some concepts to my Honors Algebra students."

Preservice teachers

Modeling Workshops attract a few preservice teachers each summer. Here are excerpts from weekly reflections of a participant in two Modeling Workshops in summer 2003 who student-taught in fall 2003. Her cooperating teacher, Dave, is a modeler.

WEEK 1: I'm going to sound like an advertisement for the modeling workshops, but I think I was able to jump right into working with the students and lesson planning because of those workshops. ... I really have to credit the research behind the modeling workshops because a lot of the things I was told would happen, really do happen. The fact that the students are resistant to taking a more active role in their learning at first and some of the common misconceptions they have were brought out over and over again in the workshop so I wasn't caught off guard by anything (yet – I know it's bound to happen). ...

It was also really cool to be able to talk to my cooperating teacher about lesson planning with this group and actually be able to contribute a lot of ideas and create a lot of activities and assignments based on the physical science modeling workshop. ...

Student teaching with a modeler is great because it is helping reinforce some of the ideas and methodologies I picked up during the workshops.

WEEK 2: I can see even more of the benefit of the modeling workshops now! I can't imagine how lost I'd be without them!

WEEK 6: ... Our CIT [freshman physics] students are really starting to shine and come into their own at this point. The biggest pleasure for me is watching the girls, especially the more quiet Native American ones, start to get things. Then their confidence starts building and they start participating more and more. ...

I am reassuringly comfortable with the CIT material because it is all the material that I just covered in the modeling workshops this last summer and I picked up all kinds of great tools to help guide students to a deeper conceptual understanding of mechanics concepts. I feel confident that I can explain things to students and help them get through their misconceptions.

WEEK 8: I received the best "evaluation" I could ever hope to receive this week. Dave was going through his mid-semester evaluation with me and he said the best way he could put it is that **he would want his own child to be in my class**. I know how high his standards are, so hearing that almost made me faint from shock! I do have full control of the freshman class now – lesson planning and all. I'm really having a blast with it!

[Update in 2010: she teaches physics in a public school in urban Phoenix. She chose to move to this high school in 2009 because the culture of the science department is strongly supportive of Modeling Instruction.]

The NSF grant external evaluator wrote in 2003:

" In summary, the project appears to be meeting its goals. **Courses have been developed, teachers are enrolling in them and finding them valuable, the MNS program is in operation with large numbers of participants, and aspects of the project are being institutionalized.**"

The NSF grant internal evaluator wrote in 2003:

" The MNS program distinguishes itself by attracting a motivated group of learners, providing useful and challenging courses, modeling the type of student-centered instruction promoted by the program's developers, supporting student-to-student and student-to-instructor collaboration, and following up on the impact of the program as teachers return to their high school classrooms. Simply put, **the MNS machinery is doing what it claims.**"

A physics faculty member wrote in response to the question, " How did teaching this course compare with other teaching experience?"

"Quite different in a number of ways.

- a. All the students were motivated.
- b. No students were hesitant to speak their minds.

- c. I have never taught \_\_\_\_ and initially felt out of my element. Consequently, I had to work a little harder on my own with some of the material....
- d. The atmosphere was positive and energizing all the time. I looked forward to every class, and **I hated to see the course end. ..."**

A teaching associate (TA) wrote:

**"This was one of the most worthwhile summer workshop experiences I have ever had.** I felt I made giant steps forward in my understanding of physics and chemistry concepts that were dealt with in the course, both from my interaction with Dr. \_\_\_\_ during our planning meetings, and during the course itself."

In 2005, the North Central Accreditation Academic Program Review Committee wrote:

"One of the important ways that ASU is currently elevating science education in Arizona is its unique Master of Natural Science (MNS) program for in-service teachers. There appears to be no comparable program at any other university in the United States, and it stands as an exemplary model of how physics departments can improve high school physics education."

In 2009, an Australian teacher wrote:

Date: Wed, 14 Jan 2009

Subject: thank you from Australia

Again I thank you for the opportunity to have completed the modelling instruction physics course. Although I completed the course in 2006, it has been highly beneficial and its philosophy is embedded into the way that I teach. Our curriculum is different from that in the US, however the techniques of teaching are still the same.

Since completing the course my teaching has been rewarded with the recognition from the NSW Department of Education in receiving a Ministers Award for Quality Teaching in 2007, and the Excellence in the integration of ICT award 2008. I have finally completed my thesis for a Doctor of Education. All of these have been a flow on effect of completing the course.

Could you please pass on sincere thanks to your instructors of the course who might be pleased that they are contributing not only to the science education of students in the US, but also internationally in Australia.

Appreciation letters from numerous teachers to Arizona State University administrators can be viewed at <http://modeling.asu.edu/MNS/MNS.html> Scroll down to the bottom of the page.