

## Project Summary

### **Vision and Goal**

Individual teachers, equipped with materials they and their students can access via the web, are a developing force in the modernization of both pedagogy and content. Although inquiry-based learning is often considered a method for helping students master facts and algorithms, the perspective from the modern workplace is that empirical discovery and reporting skills in the subject matter of a given course deserve to be a goal in themselves. We show here how the nano-frontier provides a robust setting for challenges which put the student in the shoes of real nano-world detectives, and how the web offers a reliable means to deliver such challenges in a lecture setting, or even on timed tests.

Our group has provided industry and university researchers across the state with access to new methods, and atom-resolution microscopy capability using both electrons and scanning probes, for over a decade. In addition, we've also had opportunities to further regional contributions in both *materials astronomy* (the laboratory study of small but previously stand-alone astrophysical objects) and *gigascale integrated circuit silicon manufacturing*. These experiences, and our contacts as part of a robust and growing regional nano-characterization alliance, give us insight into characterization tools, methods, applications, and most importantly a large and growing list of past and future challenges.

In this context, the proposed project activities will: (i) expand the list of web-accessible nano-worlds that we presently make available, (ii) develop and deploy storylines suitable for a variety of introductory undergraduate science courses based on real (past, present, or future) characterization challenges along with evaluation rubrics in the form of nano-world WebQuests, and (iii) implement/evaluate the effect of these exercises during two years of introductory classes at UM-StL involving a total of about one thousand students. The goals with respect to participating students are to: (a) increase understanding and ability to gather data, discern patterns, and solve problems posed by *real nanoworld studies involving the subject matter of each course*; (b) understand and successfully participate in a peer-review of their, and another student's, report about nano-world observations specific to course subject matter; and (c) enhance awareness of the nano-world, and challenges posed by characterization of matter down to the atomic scale, as it may be encountered in later course work and careers.

### **Broader Impacts**

1. *Observation and reporting challenges for courses elsewhere*: The materials being developed will be deployed on the web concurrently with their use in our courses (except for the Blackboard interface to individual students at UM-StL), and hence they will be immediately available. To get the word out, we are active with regional organizations already (e.g. Saint Louis Area Physics Teachers, American Chemical Society, American Association of Physics Teachers, Central States Microscopy and Microanalysis Society). This project will convert teaching assistants into active meeting participants as well. The project further allows us to follow through on undergraduate education committee interest in teacher workshops at national AAPT meetings, and suggestion by an *Am. J. Phys.* co-editor about a paper on the strategy. Our results on the experience will be published as well.

2. *Web-based content-modernization generally*: It is difficult for text publishers to lead content-modernization, particularly if the courses don't directly interface with specific career needs of the students taking them. This project generates web-based material for augmenting existing (and two emergent content) classes, at the discretion of individual teachers who have the energy and initiative to do so. Given the acknowledged need for inquiry-based augmentation, it could offer a significant contribution the pool of materials available to this end. The fact, that individual web-based nano-worlds can offer challenges to students at many different levels, makes development of such content all the more likely to be sustainable and worthwhile.