Proposal Summary

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STEM Digital Images in Geoscience Investigations: Teaching Analysis with Light (STEM DIGITAL) is a proposed Strategies ITEST project from the University of Massachusetts Amherst (UMass). It will enable high school and middle school STEM teachers and students to conduct environmental research aided by the analysis of images from digital cameras, scanners, and the Internet.

Image analysis plays a large role in the workplace and offers excellent career opportunities. Digital cameras are powerful tools for inquiry based curricula, classroom research, and learning about image analysis. They have become ubiquitous as their prices plummet and capabilities improve, making them affordable for classroom use. However, teachers and students mainly use digital images for documentation: creating PowerPoint presentations, handouts, posters, etc. There are good examples in the literature of how to use digital imaging as an investigative tool, but these are seldom seen in classrooms.

STEM DIGITAL will explore how digital image analysis can be applied to environmental quality issues that can readily be introduced into STEM courses, engaging students and encouraging them to think about related careers. The project will develop research agendas that will employ a variety of image analysis tools. The air quality theme will focus on the three components of the atmosphere that primarily affect visible, infrared and ultraviolet light, respectively: particulates and aerosols, carbon dioxide, and ozone. The water quality theme will look at the role of plant biomass on drinking water quality and on global carbon cycling. Arsenic is listed as number one in the US in terms of environmental contaminants that pose a potential threat to human health; research topics will include the identification and mapping of local arsenic contaminated sites and bioremediation possibilities.

The project staff includes UMass and school faculty with extensive experience in teacher professional development and curriculum design. STEM DIGITAL will use the AnalyzingDigitalImages software which provides free, easy-to-use tools for spatial, temporal, spectral, and intensity measurements. There will be three cohorts of 30 teachers. Secondary teachers typically have over 100 students, so we expect to ultimately reach at least 9000 students each semester. More students and teachers will be reached by the dissemination effort. The first two groups will attend one week summer institutes in 2011 and 2012. During each of the following school years, the staff will continue working online with the teachers on approximately six more projects spread over the fall and spring semesters. The 2013 institute will be entirely online, with a 6 week summer course which will become part of an online M.Ed. program.

Curriculum materials will reflect Pellegrino’s “Construct-Centered Design” (CCD) model in which assessment is an integral part of their design and use. An essential component will be the feedback from five teachers and their students who will serve as “alpha testers” before the first institute as well as input from participating teachers. Connections with curriculum standards and careers will be highlighted. Teacher incentives will include stipends, food and housing as needed, and funds for materials. They will receive free “Professional Development Points” needed for continuing licensure, or optional reduced-cost graduate credits. The project will encourage applications from teams with STEM teachers and computer teachers or coordinators in order to strengthen the impact of the program in the school.

All the curriculum materials and software developed for STEM DIGITAL will be made freely available via the web. Additional dissemination will include journal articles and conference presentations. The evaluation will include a study of the effects on student career interests. It will also compare the efficacy of the face-to-face and online models.

The intellectual merit of STEM DIGITAL is that it will enable teachers and their students to use digital images and image analysis software for qualitative and quantitative analysis, engaging students, improving their in-depth understanding of fundamental science and technology, and ultimately increasing their interest in STEM and information technology careers. It will add to our knowledge of important environmental processes related to the movement of arsenic compounds in the environment and the dissolution of natural organic matter. It will also allow us to compare the efficacy of the in-person and online professional development programs. Its broader impact is the demonstration to the educational community that already available computers and digital cameras, along with online data, can easily and effectively serve as hands-on scientific instruments, adding a new dimension to the way STEM subjects are taught.