FIGURES 1, 2, AND 3 (clockwise from far left): Placed-based modules use Sunset Crater, Meteor Crater, and the Nevada Test Site to reinforce concepts from pre-algebra through pre-calculus. (Public domain photos courtesy of the National Park Survey, U.S. Geological Service, and the National Nuclear Security Administration/Nevada Site Office, respectively)

MATH AND GEOSCIENCE "PLACED" IN CONTEXT

Have you longed for new approaches to interest your students when learning the core math concepts needed for success in your geoscience course? Perhaps approaching the subject from a place-based, culturally connected perspective would help. That is what we did in the Kéyah Math Project (KM; http://keyah.asu.edu), funded by the National Science Foundation under the Opportunities for Increasing Diversity in the Geosciences program. Our team of university and K-12 educators and cultural experts developed 13 free, place-based, mathematically infused online modules for use in a range of geoscience and environmental science courses (Schaufele et al., 2006). Although we developed KM with a specific population in mind (Native American students in the Southwest U.S.), the modules and the design concepts are much more broadly applicable.

KM's overarching premise is that targeted students will be more interested in and engage more thoroughly with a geoscience topic if it is exemplified by means of landscapes, features, or culturally significant localities in or near their homelands (Cajete, 2000; Riggs and Semken, 2001). The word Kéyah means "homeland" in the Diné (Navajo) language, and each module refers directly to a place situated within the Southwest U.S. Starting with local or regional examples such as those provided by KM makes it simpler for an educator to integrate indigenous knowledge of places and Earth processes (e.g., Semken and Morgan, 1997; Palmer et al., 2009)

We subdivided each of the modules into four levels that reinforce concepts from pre-algebra through pre-calculus using design principles in place-based and mathematics education. This gradation enables introductory and more experienced students alike to engage with the modules at the appropriate level and build quantitative expertise. Students are introduced to core concepts that can lead to improved interest and capabilities needed for the geosciences workforce of the future (Manduca et al., 2008).

Learning activities in each module are structured around a core geology-related concept or problem and include actual data or imagery. Some modules are focused on analysis of a particular landform or process whereas others use places to situate more global calculations. At introductory levels, students practice basic algebra, graphing and dimensional analysis as they explore the age of the universe or streamflow in the Animas River, a tributary of the Colorado River, which supplies most of the surface water to the Southwest. Students solve simple equations and practice graphical analysis as they estimate the size and age of the Earth and locate earthquake epicenters.

At higher levels, more advanced treatment is given to topics such as seismic wave propagation, radioactive decay and determining data relationships using linear regression. For instance, the Sunset Crater volcano in northern Arizona (Figure 1), which last erupted less than a millennium ago and directly influenced the lives of Native Americans living in the vicinity (Ort et al., 2008), is used to motivate a learning activity that reviews the quantitative physics of tephra ejection from a volcanic vent, including the velocities of and distances traveled by volcanic bombs. Another module, on the Meteor Crater impact site in northern Arizona (Figure 2) is used to motivate a learning activity that reviews the circumference of a circle, basic geometry and volume of a sphere. In that exercise students learn about and manipulate the kinetic energy equation. They compare energy to crater size using linear regression and predict meteor sizes for various impact events. Cultural and environmental significance are reinforced by connecting these analyses to collapse craters (Figure 3) formed by nuclear testing on Nevada desert lands taken from Native Americans during the Cold War.

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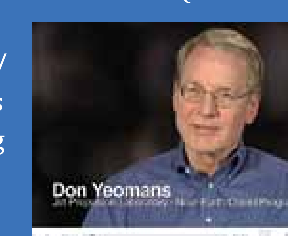
WHAT ON EARTH ?!

There's little evidence to indicate that the world will end this year and plenty to suggest that it won't (see "12-21-2012: Just Another Day," http://www.jpl.nasa.gov/video/index.cfm?id=1065). But there is no doubt that the 5,125-year-long "Mayan calendar" upon which the prediction has been made was based on some incredibly good observation of Earth and the heavens. It also used innovative mathematics, including the concept of zero.



A number of online resources offer ways to capitalize on the interest generated by pop culture references and examine how the schedule of our lives is shaped by movements of the earth, moon, and sun. **Calendars Through the Ages** (http://www.webexhibits.org/calendars/index.html) offers a good overview of calendars *per se*, including the Maya/Aztec calendar and those of many different cultures. A service of the Institute for Dynamic Educational Advancement, it is funded in part by the U.S. Department of Commerce, National Institute for Standards and Technology, Time and Frequency Division, as a complement to www.time.gov. **SERC** (http://serc.carleton.edu/index.html) offers numerous lunar and planetary science activities at all levels in its **Pedagogy in Action** resources (http://bit.ly/IyMcV7).