The topic of earthquakes appears in virtually all introductory undergraduate geoscience courses. Most students entering these courses already have some knowledge of earthquakes and why they occur, but that knowledge often derives from the most recent event in the news and can therefore be biased toward the most destructive earthquakes (1). In addition, students arrive at college with misconceptions (2, 3), perhaps picked up from erroneous or poorly presented media coverage. These misconceptions can go unchecked or even be reinforced by introductory textbooks, most of which contain errors and oversimplifications about earthquake processes (3, 4).

But we need not rely on the news media and textbooks in teaching. Earthquakes happen every day, and an exciting thing about earthquake science is near-instantaneous access to data collected by a global network of seismometers. The U.S. Geological Survey’s (USGS) Earthquake Hazards Program hosts a Web site that serves data from that network in real time (http://earthquake.usgs.gov). Anyone can access and explore the data, which are available in both raw and interpreted form with supporting information. During 9 years of teaching introductory geoscience courses, I developed and refined an inquiry-based module called “Seismicity and Relative Risk” to take advantage of this reliable resource to engage students in learning more about earthquakes.

The refining part was instructive. Initially, I asked students to explore a static map of earthquakes (such as shown in the map) and then to write an essay that related earthquakes to plate boundaries. The results were disappointing. Students did not know how to describe patterns in the distribution of earthquakes or even seem to understand what “relate earthquakes to plate boundaries” meant. I realized that I was not giving them all of the tools they needed. Recent research shows that students often do not recognize that these static maps consist of data collected and analyzed by scientists; instead, they see them simply as “pictures” (5). In addition, about half of the students in introductory geoscience courses are not prepared for the level of abstract thinking that this assignment required (6). There are many learning benefits to be gained from incorporating data into classroom teaching (7); I needed my students to get their hands on these data so that they would become real for them.

Over the next few years, I tried different ways of incorporating data from the USGS site in class. In one version, pairs of students examined different regions and presented what they found in a few slides. This helped with describing patterns, but was tedious and repetitive for both me and the students, and it never got them beyond their descriptions. In the next version, students answered a series of questions that guided them through the USGS site. This helped with describing patterns, but was tedious and repetitive for both me and the students, and it never got them beyond their descriptions. In the next version, students answered a series of questions that guided them through the USGS site. This was better, but students worked at very different paces; it was hard to

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**Engaging Students in Earthquakes via Real-Time Data and Decisions**

Anne E. Egger

Earthquakes displayed. Global distribution of earthquakes greater than magnitude 3 from 2002 to 2011. Color represents the depth of the earthquake origin: red, 0–33 km; yellow, 33–100 km; green, 100–400 km; blue, >400 km.
A major advantage to this writing assignment is that each paper is unique, making them far more fun and interesting to grade than earlier versions of the assignment. I use a rubric for grading that emphasizes content, analysis, and coherence of the argument (8).

The final part of the module takes place in class after I have read their papers. I compile their decisions and show them the results. One location is never chosen unanimously, and the choices are often quite evenly spread, which prompts a discussion about which factors students weighed differently and why. Students gain a new appreciation for how different people interpret and weigh risk, as well as the inherently incomplete nature of the geologic record. I use this as an opportunity to lecture briefly on the complex role that science plays in policy and decision-making and about ongoing research on earthquakes and how students can get involved if they are interested.

One of my goals for this module is to empower students to use data to satisfy their own scientific curiosity, so they may be engaged in the scientific process beyond this introductory course. Many students have contacted me after the end of course to tell me that they looked up an earthquake that they felt, or pointed someone else to the Web site to see just how many earthquakes occur in the Bay Area every day; sometimes they have pointed out errors that they have heard in the news reports about earthquakes. By allowing students to work with real data in real time, they develop a personal connection and positive affect that motivates their future learning.

References and Notes
8. A complete description of the module, including learning outcomes, guided exploration questions, slide presentations, writing prompts, and rubrics is available in the supplementary materials.

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About the author

Anne E. Egger is an assistant professor at Central Washington University, jointly appointed in Geological Sciences and Science Education. The development and refining of this module took place while she was teaching at Stanford University, where she was a lecturer and the undergraduate program coordinator in the School of Earth Sciences. At Stanford, she extensively revised the introductory geoscience course to include more hands-on and inquiry-based activities such as this one. Egger’s research involves combining the tools and techniques of geology and geophysics to better understand the geologic history of tectonically active regions. She is the codirector of Visionlearning (www.visionlearning.com), where she has authored modules for students in introductory science courses and coauthored a book titled The Process of Science.
Editor's Summary

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