

On the Cutting Edge: Teaching Help for Geoscience Faculty

A place is described for faculty to share their teaching expertise and to remain current with advances in geoscience.

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In contrast to science, which makes progress at the level of the community and where individual work builds on all that has come before, teaching science has often been an individual enterprise. Typically, faculty create courses in isolation, without the benefit of knowledge of others' classroom experiences or research on how students learn (1, 2). Building a culture of sharing and communal improvement in support of undergraduate geoscience teaching is the goal of the On the Cutting Edge professional development program.

To this end, On the Cutting Edge has offered a series of professional development workshops for geoscience faculty and graduate students since 2002. Participants share their teaching experiences, learn from leaders in geoscience and other disciplines, and develop new online resources in support of teaching geoscience (3) (see the figure, right). Many of the workshops focus on specific topics in geoscience education. Emerging themes, such as teaching with visualizations and data; core courses in the undergraduate major, such as structural geology; and rapidly changing content areas, such as climate change, are all included. Other workshops, repeated each year, help faculty design or revise a course, pretenure faculty manage their careers, and postdoctoral students and graduate students prepare for an academic career. This range of workshop topics has been successful in engaging a wide spectrum of geoscience faculty in learning more about geoscience teaching.

To date, ~1400 geoscience faculty from more than 450



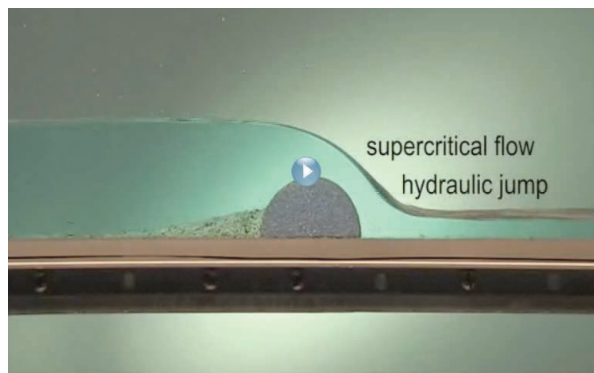
Workshop participants generate much of the Web site content. Here, participants in the 2008 Teaching Introductory Geoscience workshop work together to improve their contributions to the teaching activity collection.

geoscience departments have participated in On the Cutting Edge workshops. Participants from research universities, comprehensive universities, liberal arts colleges, and 2-year colleges are selected on the basis of scientific and educational expertise, as well as to provide a diverse array of viewpoints.

The On the Cutting Edge Web site (<http://serc.carleton.edu/NAGTWorkshops/>) is one of the program's most important innova-

tions for allowing faculty to learn from one another about teaching. The Web site is a key resource for workshop participants as they prepare for their workshop experience; it provides tools for interaction, sharing, and collaboration during the workshop and records insights gained at the workshop. After the workshop, the Web site provides information and resources and supports changes in instruction for both participants and the larger community. The Web site also illuminates the linkages between science content, pedagogical strategies, teaching activities, assessments, and research on learning.

The Web site is a joint creation of the workshop participants and the project team of On the Cutting Edge. The conveners work with staff to create pages that introduce the topics of the workshop and build a foundation for workshop discussions. For example, before a workshop on the role of the affective domain in geoscience teaching, pages reviewing the definition of the affective domain, a framework for its application to teaching, and an introduction to the literature were developed. Workshop participants prepare for the workshop by reviewing materials on the Web site and contributing examples from their own teaching. In another example, participants from a 2009 workshop on teach-



Many Web site users are searching for video or other visualizations. This video of a flume study of water flowing over a dam is part of a collection of videos for teaching river geomorphology developed by Little River Research and Design, with funding from the Missouri Department of Natural Resources. From this page, users can easily explore other related materials and ideas for teaching geomorphology, including a collection of teaching activities and syllabi.

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ing paleontology submitted descriptions of their courses and two activities that they have used in the classroom. These examples are collected through a structured Web-based format in advance of the workshop, which allows participants to learn about their colleagues' work before they meet at the workshop and automatically produces a valuable, easily searched collection for use by all interested faculty (4).

During the workshop, participants document the results of their discussions and work together via the Web site. For example, participants in the affective domain workshop described dilemmas that they had faced in teaching and discussed a variety of possible responses, based on the presentations and information gained at the workshop. They developed these discussions into a set of Web pages that they can use for their own reference and that are available to others. Increasingly, workshops also provide opportunities for participants to review and improve teaching activities submitted before the workshop, enhancing the quality of the materials shared through the Web site.

Following the workshop, the On the Cutting Edge project team reviews materials generated by the workshop and creates a topical site designed to present this information to geoscience faculty who did not attend the workshop.

The On the Cutting Edge site now has 33 topical sections based on the workshops offered to date. These include more than 1200 community-contributed teaching activities ranging from in-class activities that make lecture interactive to designs for laboratory activities. Web statistics show that 16,000 users returned to the site six or more times last year to find ideas or materials for teaching, to learn about a new method or topic, to find out what their colleagues are doing in their teaching, to find geoscience visualizations, or to obtain information to assist with career planning or advancement (see the figure, page 1095, bottom). We estimate that ~25% of these users are geoscience faculty, including roughly equal numbers of workshop participants and other geoscience faculty. Other users include faculty in other disciplines, teachers of elementary through high-school pupils, students, and others.

Workshop participants use the Web site to refresh their memory, to make use of resources discussed at the workshop in their teaching, and to expand their knowledge in areas addressed by workshops other than the one they attended. For example, one participant in the Introductory Geoscience workshop developed a dinosaur course

About the Authors



Authors Macdonald, Mogk, and Tewksbury are full-time geoscience faculty, in addition to leading the On the Cutting Edge program. Cathryn Manduca (left) is the executive director of the National Association of Geoscience Teachers and the director of the Science Education Resource Center (SERC) at Carleton College, which uses workshops and Web sites to help faculty to be better teachers in all disciplines and engages in projects that support geoscience education at all levels. All the authors have received national awards for contributions to geoscience education and have served as leaders in geoscience professional societies. As SERC's technical director, Fox has developed the content management system that supports community development by the On the Cutting Edge Web site. Iverson, SERC's evaluation director, leads the data collection effort for the Web site and workshops. Kirk, McDaris, Ormand, and Bruckner manage the Web site, steward the content, and create a coherent resource from the contributions of community members.

by combining ideas learned at the workshop with materials from the online course design tutorial available from a workshop he did not attend. The result was a course that used a student project as a central element to tie together concepts addressed throughout the course. Similarly, geoscience faculty who have not attended workshops are using the Web site to learn about different aspects of geoscience teaching and to find out more about what their colleagues are doing in their courses. This combination gives them confidence to try new methods in their teaching.

We know less about use by those outside geoscience, but use patterns suggest that they are also learning about pedagogy, finding visualizations, and exploring teaching examples. Of intensive sessions (those viewing 10 or more pages), 38% include views of activity pages. Learning does not stop with the activities, however; 20% of intensive sessions include visits to a module describing a pedagogic method.

The combination of workshops and Web sites has influenced the practice of individual geoscience faculty in the classroom (5). Multiple surveys indicate that 80% of respondents have made specific changes to their teaching practices with a measurable shift toward active-learning techniques. Interviewees can identify specific changes and trace them to lessons learned at the workshop or from the Web site. Critical to supporting these changes is a student-centered view of learning (6), which is developed at the workshops. Past participants use phrases such as "eye-opener" or "seismic shift" to describe this change in viewpoint.

Beyond the impacts on individual faculty, the On the Cutting Edge program has created a new culture; faculty learn from one another and share resources to improve teaching. The workshops encourage discussions about

teaching, whereas the Web site allows faculty to quickly discover what others are doing. We are beginning to see spontaneous contribution of teaching materials through our online submission forms, actions that reflect the beginnings of a self-sustaining community of sharing.

In the future, On the Cutting Edge will offer several workshops in 2010 on topics central to improved teaching in the geosciences: teaching complex systems, using the Geographic Information System and remote sensing in geoscience, and teaching through fieldwork. We continue to work to engage a larger fraction of geoscience faculty in this community and, this year, will expand our virtual workshop series by offering workshops on service learning, teaching about the deep earth, designing effective courses, and teaching online courses. All will yield new additions to the Web site, which we invite you to explore and enjoy.

References and Notes

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6. S. Loucks-Horsley et al., *Designing Professional Development for Teachers of Science and Mathematics* (Corwin, Thousand Oaks, CA, ed. 2, 2003).
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