courses. The criteria comprise a list of questions that one can ask about an existing or developing activity to assess its effectiveness in promoting quantitative skills literacy within a geoscience context. This is a work in progress, and contributions to this discussion of what constitutes a good quantitative activity would be welcome. The list of questions includes the following:

1. Are the quantitative and geoscience goals central and important? This question addresses whether the skill and/or geoscience concept being taught in an activity is important for the student to master for a particular discipline. Strong activities promote practice in key quantitative skills in the context of important geoscience concepts.

2. Does the activity lead to better problem solving? This question gets to the heart of whether the activity is likely to lead to an improvement in a student's ability to solve quantitative problems.

Key features of activities that promote problem solving are that they (1) help students identify the knowledge they bring to a problem that is likely to be useful; (2) promote mastery of skills or strategies central to solving geoscience problems typical of those in the discipline being studied; (3) assist students in recognizing when the skill or strategy is likely to be applicable to a problem; (4) draw attention to the types of strategies being used to check for progress toward the solution both in the specific (answer verification) and in the abstract (evaluation of need to switch to a different approach to the problem); and (5) instill in students the confidence needed to approach and solve a quantitative problem.

3. Are the quantitative skills integrated with geoscience concepts in a way that is appropriate for the learning environment and student level, and supports learning quantitative skills as well as geoscience? This question seeks to determine whether the integration of geoscience and quantitative skills is accomplished in a way that benefits both areas. Strategies could range from tight integration by teaching a quantitative skill in the context of a particular geoscience problem, to a sequenced approach in which geoscience data are first used to teach the quantitative skills followed by application of the quantitative skills to a new problem.

4. Does the methodology promote learning? This question looks at whether the activity incorporates effective strategies based on learning theory and research. For example, does the activity motivate and engage students? Does it build on what they know and address any initial misconceptions about the topic? Does it use multiple representations of quantitative and mathematical concepts and data? Does it include opportunities for reflection, discussion, and synthesis? Does it provide opportunities for students and faculty to assess learning and confirm that they are on the right track? Are there opportunities for students to iterate and improve their understanding incrementally?

5. Are the provided materials complete and helpful? This question addresses nuts-and-bolts issues about whether the materials provided to students, either written, oral, or otherwise, are successful in providing the context, motivations, and goals of the activity, and whether or not instructions and questions are clear.

The activities and review criteria can be found on the Teaching Quantitative Skills in the Geosciences Web site. In addition to the activity collection, this site contains a variety of resources to assist faculty with the methods they use to teach quantitative skills at both the introductory and advanced levels; information about broader efforts in quantitative literacy involving other science disciplines; and resources for students struggling with their quantitative skills.

The site is part of the DLESE, and it has been developed by geoscience faculty in collaboration with mathematicians and mathematics educators with funding from NSF (grants NSF-GEO 0085600, NSF-DUE CCLI 0235007, and 0083251). Readers are encouraged to visit the Web site and to submit activities they would like to have reviewed and posted for public access. In addition, feedback is welcome concerning the review criteria, the skills that are central to undergraduate education in the geosciences, and the Web site as a whole.

The workshop, Developing Activities for Upper Level Geoscience Students, was held at Carleton College, Northfield, Minnesota, on 27–29 June 2005.

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—GREGORY HANCOCK, College of William and Mary, Williamsburg, Va.; and CATHY MANDUCA, Carleton College, Northfield, Minn.

FORUM

COMMENT & REPLY

Comment by R. M. W. Musson on "Comparison Between Probabilistic Seismic Hazard Analysis and Flood Frequency Analysis"

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It must be a rare occurrence to see, in the same scientific newspaper in the space of a little over a year, the same errors repeated by the same authors in two different articles, despite the fact that those errors had been refuted in that newspaper in the interim. I pointed out [*Musson*, 2004] the fallacies in a paper by *Wang et al.* [2003]. These errors are now repeated by *Wang and Ormsbee* [2005], who refer back to *Wang et al.* [2003] but not to *Musson* [2004].

This raises questions about scientific method: We expect that science proceeds in some sort of forward direction and that errors are not repeated when identified. To see such a repetition as this raises at least the question of how *Wang and Ormsbee* [2005] were reviewed.

To be brief, it is not the case, in a site at risk from three separate faults, that the probabilistic hazard depends in any way on the simultaneous rupturing of all three. This is a well-known fallacy, which is refuted by *Musson* [2004] and elsewhere, and I do not intend to repeat the refutation here. It is not the case that the hazard value generated from a probabilistic seismic hazard study has no clear physical meaning.

Wang and Ormsbee [2005] back up their assertion on this with a quote ("the aggregated results of PSHA are not always easily related to the inputs") that comes from *National Research Council* [1988]. This was true in 1988. It is not true now. Methods have been developed since then [*McGuire*, 1995; *Musson*, 1999] which make it easy, and indeed routine practice, to relate probabilistic seismic hazard analysis (PSHA) results to the inputs in terms of the expected physical earthquake that most contributes to the hazard. Bolstering a false argument by reference to an obsolete citation is something that should be caught in the review stage of a paper.

It is also not the case that the tail of the lognormal distribution (of predicted ground motions for a given magnitude-distance pair) is unbounded. It is true that the bounds are not presently known and have to be estimated, but this is a source of active research at present [*Bommer et al.*, 2004].

Wang and Ormsbee [2005] make unnecessary problems in their comparison between earthquake and flood hazard analysis; they seem to have difficulty with the fact that the probability of ground motion at a site is the conditional probability formed by the product of the probability of earthquake occurrence (magnitude M at distance R) and the probability of ground motion generation (that given M and R, ground motion A will be exceeded). This obviously does not have a clear analogue for flood hazard, but it is hardly correct to call it confusing.

It was bad enough to see once in *Eos* an article so uninformed by recent developments in seismic hazard analysis, but to see the same material repeated without any sign of progress is remarkable. I hope that so far as *Eos* is concerned, this matter can now be considered closed.

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Response to Comment by R. M. W. Musson

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Musson's comment on our article is a good example of "the inability of PSHA proponents to communicate clearly and directly to anyone but themselves just what it is that they are doing" [*Hanks and Cornell,* 1994, p. I/1-1].

Musson's [2004] comment on an earlier paper by *Wang et al.* [2003] was addressed in a response by *Wang et al.* [2004]. However, it seems that Musson is still sure he is right and Wang et al. are all wrong when he says, "I pointed out [*Musson*, 2004] the fallacies in a paper by Wang et al. [2003]. These errors are now repeated by *Wang and Ormsbee* [2005], who refer back to *Wang et al.* [2003] but not to *Musson* [2004]." Now Musson is trying to impose his self-righteousness on the whole scientific community by asking *Eos* not to publish any paper that contains a point of view different from his.

We demonstrated [*Wang and Ormsbee*, 2005] that "the predicted PGA (peak ground acceleration) corresponding to the total annual probability of exceedance is a statistical measure and does not have a clear physical meaning." This was one of the conclusions reached by the Aki Committee [*National Research Council*, 1988], which noted "the aggregated results of PSHA are not always easily related to the inputs." Musson stated that "this was true in 1988. It is not true now," referring to *McGuire* [1995] and another paper by himself.

I do not know how Musson addressed the Aki Committee's finding. *McGuire* [1995], however, stated, "A disadvantage of PSHA is that the concept of a 'design earthquake' is lost; i.e., there is no single event (specified, in simplest terms, by a magnitude and distance) that represents the earthquake threat at, for example, the 10,000-yr ground-motion level… This disadvantage was recognized by the Aki Committee [*National Research Council*, 1988], which recommended that a "recursive" PSHA be performed to determine the dominant earthquake at any particular hazard level."

McGuire [1995] recognized the Aki Committee's finding and developed a method (deaggregation) to address it. In other words, the Aki Committee's finding was still true in McGuire's paper. So it is still true now.

PSHA was originally developed from the analogous flood or wind problem by *Cornell* [1968]. This directly contradicts Musson's statement, "this obviously does not have a clear analogue for flood hazard." We felt it was logical and beneficial to compare PSHA with flood frequency analysis and to demonstrate how they are being used in risk analyses.

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ABOUT AGU

Congressional Science Fellow

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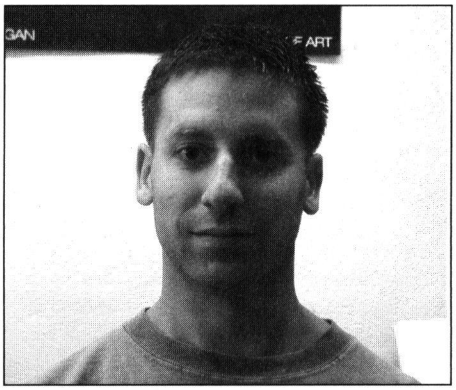

Josh Trapani has been selected to serve as AGU's 2005–2006 Congressional Science Fellow. Trapani is a paleontologist who most recently studied the genetic basis of tooth development in fish as a postdoctoral fellow in the Ecology and Evolutionary Biology Department at the University of Colorado, in Boulder.

"By studying the complexity of genetic differences between species of fish with different dentition patterns, we are able to begin to determine the evolutionary processes—chiefly selection and constraint—responsible for the evolution and maintenance of these differences over geologic time," He noted.

Prior to going to Boulder, Trapani earned a B.A. in anthropology and a B.S. in geology in 1996 from the State University of New York at Binghamton, and an M.S. and Ph.D. in geology from the University of Michigan in 1999 and 2003.

Trapani's research experience in evolutionary and developmental biology is an excellent background for addressing many of the issues facing the U.S. Congress today, including genomics, stem-cell research, and genetic modification of foods.

He recognizes that the atmosphere in Washington, D. C. will be very different from that in academia. In his application letter, Trapani noted, "I look forward to adapting to new conditions and learning about how government works and the role science plays in crafting policy."

After Trapani's participation in a September orientation program in Washington, D.C., organized by the American Association for the Advancement of Science, he seeks placement in the office of a senator, a representative, or a congressional committee for the year.

—Catherine O'Riordan, AGU Public Affairs Manager