

Bringing Research on Learning to the Geosciences

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My primary interest in this topic is a practical one. We know lots of things from research on learning that, if implemented, could radically improve geoscience education. In addition, there is lots more we could learn about learning specific to the geosciences that would have application not only in geoscience education, but in the way we do our research, and how we communicate results to those who need to use them (including public presentations on controversial issues, and work with policy makers). I am most interested in

1. gaining a better understanding of what we know now
2. figuring out how to help the broad geoscience community learn with understanding about these results
3. building collaborations that will take us to the next step of understanding learning in the geosciences.

From my point of view, in most cases today, faculty are developing their instructional techniques based on their intuition about what works in the classroom. In some cases, they have great intuition or work hard to make observations to guide their intuition. However, it is only in rare cases that faculty move beyond what they think works well to a model where they build their instructional techniques on a foundation of research on learning and use data from formative evaluations to refine their teaching. I would like to move geoscience instruction to the place where this is the norm. Further, I would like the geosciences culture to develop in such a way that geoscientists, when faced with a question about how to best teach or present some topic or information (in research or education), immediately think of looking to the learning sciences for guidance. This of course would require strong collaborations between geoscience and learning science to enable joint understanding of critical issues in geoscience learning and to enable research to be fully integrated with current practice.

I have great hope that geoscientists can come to value the contributions of learning scientists, collaborate with them and apply their results. We share a common culture of asking questions, collecting data, and drawing rigorous conclusions. Geoscientists are used to working with complex systems, limited data collection opportunities, proxy data, and complicated inferences—we share this in common with much of learning science. Geoscientists tend to be great observers as well, seeking pattern and questions from complex interwoven types of observations. It should be possible to adapt this training to observing our students, collecting data, and drawing more rigorous conclusions about the impact of our teaching on their learning.

The first issue in bring research on learning broadly to the geosciences seems to be one of motivation. From my viewpoint, anecdotal observations suggest that most faculty members believe that they are doing the best they can with their students. They care about their students' learning to the maximum extent they believe is appropriate and

believe they are doing their best to help students learn. Many are frustrated by difficulties in teaching students, particularly when they observe that they are not successful in engaging the students in the material or in raising their level of understanding. However, often they feel that circumstances that result in poor student achievement are beyond their responsibilities and are due to time constraints, financial constraints, or institutional policies. Further, they are following in the footsteps of their role models and those who successfully taught them the science that they know. In this circumstance, where faculty feel they are doing their best, how can their attention be turned to research results that might help them do better? Certainly the examples from physics of providing faculty a clear example of what is being learned (or not learned) is one approach. Other approaches might build on helping faculty address problems that are frustrating them, for example, making them more successful in teaching large enrollment introductory classes or helping them be more effective in teaching complex quantitative skills.

I am struck by Edelson's discussion of motivating learning on the immediate scale. How are students motivated to learn, not about a topic in general, but at a particular moment or in a particular instance? In addition to raising a general interest in using research on learning, how do we motivate the faculty member or teacher to take the time to learn what is needed to more effectively teach their class tomorrow, to make a change in their class this semester, to engage with a particular set of issues or materials, or to learn about one particular result. For successful transfer of research results to the classroom, I think there is tremendous power in thinking about motivating learning at the level of an individual paper (Redish has a fine example in our essay collection), conference proceeding, or workshop. So often, we have good intentions to learn or act motivated by a general interest in a topic, but in the trials of everyday life, this piece of learning or implementation slides off the table. Thinking about motivating learning or action on the particular scale will also help us organize available materials in ways that they can be more easily accessed and used by geoscience faculty, teachers and curriculum developers.

An idea of interest to me as we approach this workshop is the notion of engaging geoscientists in doing research on learning. I haven't worked out all of the motivation or logistics, much less figured out an appropriate project, however, for some teachers, faculty and curriculum developers, I think the appeal of being involved in a real research project that would provide a useful result that they are interested in might be a sufficient hook to engage them in a project. Thinking further out on a limb, I can imagine a project looking at an aspect of data visualization or modeling where the research question would be sufficiently compelling to a research scientist in the geosciences that it would capture their interest, particularly if the question addressed a problem that was inhibiting their ability to interpret their own research results (or in a positive voice, where the research result would enhance their ability to do their own scientific research). If it was possible to engage the geoscience community in an experiment that required their participation in such a way that they learned about the nature of research on learning, and led to a result that they used to the benefit of their own teaching or research, I believe they would become more motivated to use research on learning throughout their work. Helen's

work with geoscientists on the role of field studies in learning provides one example of this type of process. All of those who have worked with faculty and teachers in doing disciplinary research can comment on the extent to which those educators have learned about and implement research on learning in their classrooms beyond the range of the experiment.

A second area of interest to me is the application of research on learning to how faculty learn in the course of their professional development. Heather Macdonald, Barb Tewksbury, Dave Mogk and I are in the first year of a five year CCLI-national dissemination grant to provide face to face and on-line faculty professional development workshops addressing both content and pedagogy in geoscience education. While we plan to use research on learning to guide our development of workshop materials, this also seems to provide a natural opportunity to learn more about how faculty learn.

Lastly, I am very interested in the use of digital libraries and web-technologies to enable learning. Thus I am both interested in the research on learning that guides activities in distance-learning both in informal and formal contexts, and in the application of this work to web-resources that engage geoscientists, and science educators more broadly, in learning about research on learning with understanding and supports their transfer of this learning to their teaching.