The Need for a Geoscience Education Research Collaborative

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The call to develop a community that is engaged in applying our knowledge of learning science to the geosciences is long over due. For nearly a decade I have been building a geoscience education program that includes elements of curriculum development, teacher preparation and professional development, promoting effective teacher – scientist partnerships, and integrating technology and real data into the classroom learning experience using inquiry methods. After developing and implementing these programs for a few years, I became frustrated that my efforts were not having the impact I had envisioned. While the educational literature had certainly helped me improve the programs that I offered, there were real gaps in my understanding of why students were not learning, teachers were not making reforms in their classrooms etc. It was clear, that I needed to learn how to evaluate specific activities and to learn how to conduct research on how we learn in the geosciences. Unfortunately, I had few places to turn for help. This workshop is a critical first step in developing the educational research expertise needed to move geoscience education and our community forward.

In the past five years, I have initiated several research studies of how students learn with a geographic information system and the impact of GIS-based curriculum on spatial visualization skills. I have also begun to measure the impact of teacher – scientist partnerships on the teaching practices of both partners. As with any research project, there have been false starts due to faulty design of the investigation or uncontrollable / unexpected circumstances but now I believe the research is producing useful results. While my research experience as a geophysicist has provided me with the tools to design experiments and conduct investigations of complex and dynamic Earth systems, I have difficulty at times translating that knowledge and skill set to conduct research on human subjects and learning. It seems that even after combing the educational literature, parts of the puzzle are missing for me.

My greatest challenge has been in getting a handle on the 'best practices' in educational research methods and in identifying those assumptions and norms in research design that are uniformly agreed upon among the broad community of researchers of particular problems. For example, in my geophysical research, there are many assumptions required to build a numerical model of faults and earthquakes. There are analysis techniques that are used broadly by the community to investigate such problems. These accepted techniques and assumptions are documented, often indirectly, in the literature, and are most frequently discussed and communicated informally among scientists within the community. In my work, everyone doing numerical models of Earth agrees upon certain assumptions (e.g. a Poisson's ratio =0.25 unless it is otherwise known), and agrees upon the likely impact of that assumption being incorrect (usually because they can predict the behavior expected using physical or chemical laws).

In educational research, we deal with a system as complex or even more so than Earth — the human mind. To make matters worse, there are few physical or chemical laws that can help us predict how the brain will respond to different learning environments. So understanding the accepted assumptions is even more critical to designing investigations. Yet, divining from the literature the commonly accepted assumptions that one must make to conduct an investigation of learning is no easier than in the sciences. Further, there is very limited expertise in science education research on many university campus', making the transition to this field very challenging. The Physiology Educational Research Consortium (PERC) model is an exciting concept and provides a wonderful example of how we might organize our efforts to build a nucleus of geoscience education researchers.

One outcome of this workshop might be to assemble classic papers on research design in other disciplines so that we can have a basis for developing our own accepted norms and assumptions. This would open the door to more educational researchers in our community and accelerate their learning. On related note, one concern I have in pushing this initiative forward is ensuring that the knowledge gained through this effort is useful and accessible to geoscience educators in K-16. This means that our efforts should be directed at solving problems that have practical application in formal and informal learning environments. It also means that we must translate the results into concrete and accessible forms for the practitioner. Without this step, there will be little or no benefit to the broad geoscience community from the research.