Closing the Loop: Communication for Transformation of Geoscience Teaching Practice

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The goal of the GER Framework is to improve teaching and learning about the Earth, by focusing the power of Geoscience Education Research (GER) on the set of ambitious, high-priority, community-endorsed grand challenges outlined in this document. This goal has an underlying assumption - that research results are effectively shared with educators and are used to reform teaching practice; consistent with the feedback loop on the strength of evidence pyramid (Figure 1). Closing this loop is intimately tied to research theme 10, Institutional Change and Professional Development. But closing this loop has a broader scope as well. Raising awareness of research results, and then applying the research results, will require engaged, respectful dialogue as well as strategic communication to extend the community of reflective practitioners and gain needed support from administrators.

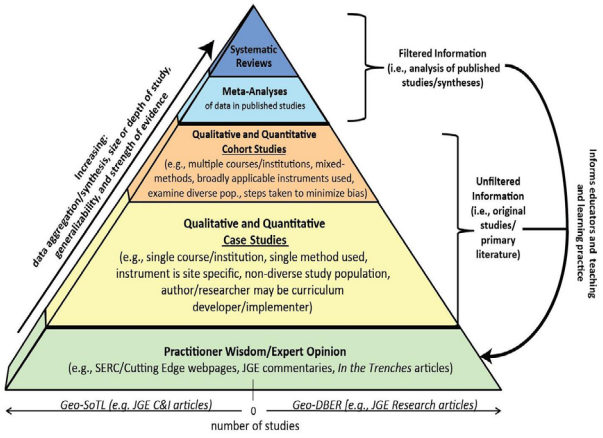

Figure 1: GER Strength of Evidence Pyramid, from St. John & McNeal 2017.

Expanding and Sustaining Dialogue

Many of the characteristics that allow application of research results revolve around dialogue. Reflective practitioners, defined as those educators who are trained or choose to think about how their students respond to their teaching (and external influences on learning), and re-think their own teaching to accommodate greater student understanding, are a desired product of teacher education (Adler, 1991) and professional development; they are also necessary collaborators in fostering progressive dialogue between researchers and educators. Improvement within the research community can be made by enhancing communication of research and access to practitioner-friendly content through published teaching materials (e.g., InTeGrate modules, see Fortner, Scherer, & Murphy, 2016). But a limiting factor is arguably determining the most effective ways to recruit and maintain education research relationships with practitioners. There are lessons

to be learned from K-12 and free-choice (informal) learning settings about the challenges and successes of such dialogue. Situated in a free-choice learning context, an example is found in the Trail of Time Exhibition at the Grand Canyon (Karlstrom et al., 2008; Crow et al., 2011; Frus, 2011), which provides a dramatic opportunity for Park Rangers and informed visitors to interact with research-informed display materials and interested visitors. In the Trail of Time example, Rangers are the practitioners who have interacted with education researchers and geoscientists to maintain an exhibition visited by millions of people each year. Further, the practitioners' influential role in promoting diversity and continuation to higher education must not be overlooked (Bensimon, 2007). Promoting Earth science education nationwide is especially relevant to Earth science literacy among the general population because of a lack of K-12 Earth science teaching practitioners in the U.S., where around 7% of high schools offer such a subject (Lewis & Baker, 2010).

Dagenais et al. (2012) provide a review of educational studies that inquire about how educational research is viewed and implemented in international K-12 education via thorough a literature review of papers published between 1990 and 2010. Their analysis found that the "use of research-based information is hardly a significant part of the school-practice scenario. If such use occurs, it is mainly conceptual and research-based information is a source of inspiration to accommodate or modify the practitioners' frame of reference.... However, the literature reports a variety of factors that may affect the process of research use" (p. 296). These included several positive characteristics of communication between researchers and practitioners: (a) facilities for collaboration, (b) access to research and data, (c) collegial discussions, (d) collaboration with researchers, and (e) sustained collaboration (p. 297, Dagenais et al., 2012). With deeper investigation, it could be determined how and when these characteristics can facilitate or impede the necessary dialogue.

Dialogue between practitioners learning from researchers and researchers learning from practitioners is essential to achieve a shared goal of improving learning outcomes in people involved in any project seeking to inform the public on scientific process and findings. Practitioners from across all aspects of education can offer useful experience to improve understanding of learning, share with other practitioners, and provide information that can frame research questions (Adler, 1991; Wagner, 1997; Bensimon, 2007). Our vision also maintains the importance of practitioners (and administrators) being aware of, and responsive to, research as a discipline and implementing improvements in thinking and teaching that are derived from evidenced-based research results (see review by Dagenais et al., 2012).

Recommended Strategies to Develop and Support Practitioner-Researcher Dialogue

1. Develop and advertise moderated online forums in which K-16 and informal educators can post questions or directly talk to GER experts, and where GER experts can ask questions of educators. Or consider models, such as the K-12 Research+Practice Collaboratory, which is an online space to bring educators and researchers together to "develop more equitable relationships between research and practice' and innovations for STEM teaching and learning.

2. Expand and maintain face-to-face researcher-practitioner forums at geoscience and science-education conferences. These forums could be thematic, (e.g., selecting themes or more

narrow grand challenges from this Framework each year) and follow a similar format as that of the Geoscience Education Research and Practice Forum at the 2017 Earth Educators' Rendezvous (EER) or the Moving from Learning Opportunities to Learning Pathways Forum at the 2018 EER.

3. Encourage practitioner participation as co-developers of new knowledge through SoTL and DBER, especially for local-scale research. This might include local field trips to landscapes or outcrops that are accessible to area schools where researchers collaborate with practitioners to produce research products relevant to practitioners. For example it may focus on misconceptions and the placement of these experiences within a learning progression, or on affect and meta-cognition.

4. Incorporate modestly greater DBER experiences, in subjects of interest or in greatest need, in faculty professional development and teacher preparation programs, so that the dialogue between practitioners and researchers can be initiated more readily.

5. Discuss curriculum with state-level departments of education and local school boards and teacher groups. Approach administrators and teachers with an emphasis on supporting connections between teaching, geoscience education research results, and school standards.

Dissemination and Marketing

Better tested, more effective, and targeted dissemination techniques are necessary to share findings of GER with, and encourage adoption of best practices by, the greater community of geoscience educators and program administrators as well as interested educators in allied disciplines. Compiled across education, Dagenais et al. (2012) report several communication factors that generally contributed to people choosing to use research findings: (1) timely access to research, (2) results communicated in a way that is easy to understand and implement, (3) research foci that are connected to school and classroom context, and (4) a perception that some aspect of the research is relevant (p. 297, Dagenais et al., 2012). These findings help show the important of communicating the relevance and value of the research to the target audiences. Communication and marketing research can help geoscience education researchers make more effective use of in-person (e.g., conferences, colloquia, field trips), print (e.g., journals and news magazines), and online and virtual (e.g., social media, webinars, blogs, list serves, websites, virtual reality) modalities of dissemination.

Recommended Strategies for Expanding Communication to Target Audiences

1. Apply research on effective mass marketing techniques including advertising and social media (e.g., Newsome, 2006; Goske et al., 2008; Bohon et al., 2013) to reach the broader geoscience community.

2. Include science communication training with professional development opportunities online and at professional conferences to science education researchers, both discipline-specific (e.g., Geological Society of America, American Geophysical Union) and interdisciplinary (e.g., American Association for the Advancement of Science; American Education Research Association, Educational Research Association; National Association for Research in Science Teaching).

3. Publish findings and practices in journals that accept geoscience-education papers and also reach into the broader geoscience community, such as *Geosphere and Geological Society of America Bulletin*.

4. Publish findings and practices in disciplinary science-education journals in other fields, such as *CBE-Life Sciences Education* and the *Journal of Chemical Education*.

5. Publish findings and practices in interdisciplinary science-education journals such as *Science Education, Journal of Research in Science Teaching, International Journal of Science Education, and Journal of College Science Teaching.*

6. Target graduate students and postdoctoral fellows, as well as faculty, for dissemination of relevant research findings and best practices in geoscience education, as has been effectively done by in-person and online means by the On The Cutting Edge and InTeGrate programs.

7. Disseminate effective arguments for incentivizing research and publication in geoscience education (SoTL and GER alike) for academic promotion and tenure at a wide range of institutions.

8. Improve access to education research, possibly by supporting publication in open-access journals or by advocating for ways that K-12 and informal educators can gain better access to journal articles if they are not associated with institutional subscriptions.

9. Create translations of research for educators to reduce the gap in language barriers, such as ensuring that GER abstracts (and papers) include sections that address the implications for teaching, or by providing a second abstract or summary specifically for educators that explains the practical uses of the article. These abstracts can be published directly in conjunction with research articles, or summarized in a "practitioner's annotated bibliography" to be disseminated through practitioner journals (i.e., In the Trenches) or through the NSTA Learning Center. This latter platform reaches a broad audience of science teaching methods instructors, who influence the development of new teachers, as well as interface with science content faculty. This could be produced on an annual or biennial basis, and include guest contributing teams of geoscience researchers and geoscience teachers.

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Figures

Figure 1.
Provenance: From St. John & McNeal 2017.
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