Integrating Current Research on Subduction Processes and Records into Learning and Teaching: Potential for GeoPRISMS Knowledge Transfer

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Exactly how should we attempt to transfer the knowledge gained through cutting-edge geosciences research to undergraduates, K-12 students and their teachers, and the general public? What parts of this new knowledge should we attempt to transfer? How can we transfer it effectively to engage non-scientists and communicate the value of the broader scientific endeavor? What has society in general got to gain from improved understanding of science in general, and subduction processes specifically?

The need for a citizenry that understands the importance of science in democratic decision-making processes has been demonstrated (AAAS, 1993; NRC, 1996), but a more challenging task is effectively communicating exactly why we as geoscientists continue to conduct research, how we do it, and how it will benefit society. An additional challenge is engaging science-phobic students and communities in science. Even though the focus of GeoPRISMS is the study of subduction processes, the excitement of new research results can only be communicated if recipients are engaged by, and have an understanding of, the overall context and relevance. For this reason, GeoPRISMS outreach and education programs can simultaneously (a) piggy-back on already existing materials (e.g. plate tectonics; SERC http://serc.carleton.edu/teachearth/index.html ; discovering plate boundaries, http://plateboundary.rice.edu/), (b) leverage general interest in natural hazards, and (c) use GeoPRISMS-specific themes (e.g. the tectonics-sediment-climate interactions theme) to engage its various audiences and build their understanding of the scientific process through aspects that are immediately relevant to them. Below, we present three approaches that could be used, targeting a spectrum of levels and situations.

(1) What specific suggestions do we have for transferring knowledge and connecting Undergraduate Educators to GeoPRISMS?

Research conducted under MARGINS has been transferred into a variety of 'mini-lessons' available through SERC, Earthscope http://www.earthscope.org/eno/handouts, and IRIS http://www.iris.edu/hq/programs/education_and_outreach/resources . We suggest that from this start, a series of scaffolded teaching exercises, based on real research results and focused on tectonic processes and their relevance to society, could be developed for use in the undergraduate classroom. A model for such exercises is those developed for *Reconstructing*

Earth's Climate History: Inquiry-based Exercises for Lab and Class (St. John et al., 2012). Initial identification of core skills and specific content knowledge, use of backward design (Wiggins & McTighe, 2006), and recognition of how we learn (NRC, 2005) incorporated with initial identification of student misconceptions are integral parts of effective lesson design. Dissemination of teaching materials (together with 'plug-and-play' answer-keys) to undergraduate and graduate educators is only effectively accomplished through hands-on workshops.

(2) How can cutting-edge GeoPRISMS research be translated for use in K-12 classrooms?
Effective transfer of knowledge and skills, associated with cutting-edge research into the K-12 classroom, requires a complex partnership and filters. It is essential that teachers are familiar and comfortable with the teaching materials they are using, and that the materials fulfill their curricular needs at an appropriate level. A majority of teachers teaching earth science do not have dedicated training in earth science. We suggest an approach modeled by TIMES (Teaching Inquiry-based Minnesota Earth Science) (Schmitt, 2012), in which a group of middle- and high-school teachers spend two weeks in the field learning fundamental aspects of geology, facilitated by education specialists who act as go-betweens, connecting content to curriculum and teaching; in this instance it would be in New Zealand, and in the context of subduction. Teachers would build their knowledge of geology, how geoscientists *do* science, and as a consequence build their confidence so they can better incorporate geology-related research and topics into their teaching. Mediated access to both research geoscientists and educators assist the teachers in translation of their overall experience into directed, purpose-built teaching materials that are place based (Semken & Brandt, 2010; Pound et al., 2011), address topics relevant to their curricula, and support the Next Generation Science Standards (NRC, 2012). An essential aspect is the continued support of teachers as they implement the materials that they design (Loucks-Horsley et al., 2010); this is provided through online discussions and follow-up sessions attached to regional or national meetings.

(3) How can Indigenous Knowledge (*Mataranga Maorii*) be used to engage science-phobic students to empower them and their communities (*Runanga, hapu and iwi on Marae*)?
Model programs 'Te Ru Tauira' and 'Te Pu Tautahi' are after-school programs established through collaboration between Maori, low-decile high schools and school communities, and the University of Canterbury; the ultimate aim of the program is to engage, encourage and support Maori secondary students to move on to University education, and connect them to careers that will help them become future leaders in their communities. This is accomplished through first building connections and trust with the Marae; then, based on the requests from the Marae, and existing curriculum, a series of Lab-type activities focused on 'The Arrival' (Nga Tapuae o Kupe) are undertaken. These activities are structured around the Indigenous Peoples' skills and knowledge of the natural world. In the context of GeoPRISMS the broad topics of earthquakes, tsunami, and volcanic eruptions would be ideal topics. Activities are designed so that students learn experientially what their ancestors had learned or already knew (Traditional Knowledge), and in so doing they experience 'doing science'. This program provides resources for the students and their teachers, allows them to consider science as a non-threatening

extension of their own culture, using a collaborative approach that values both Mataranga Maori and western science, providing a pathway to higher education.

This model is complementary to the approach used in (2) above. In the context of GeoPRISMS we suggest that this model (a) be further developed and supported for use with the Marae, (b) a similar approach be developed and implemented in the context of Indigenous people of the Pacific Northwest and Alaska, and (c) that collaborations or exchanges between Indigenous peoples of both New Zealand and North America focused on connecting Indigenous Knowledge with Science be supported; similar initiatives have been supported by local Indigenous people in Aotearoa New Zealand.

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