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Geoscience Education and Global Development

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A fundamental goal of geoscience education is ensuring that all inhabitants of the planet have knowledge of the natural processes that shape the physical environment, and understand how the actions of humans have an impact on the Earth on local, regional, and global scales. Geoscientists accept that deep understanding of natural processes requires an appreciation of the complex Earth system on a global scale. Indeed, since the publication of the seminal document *Earth System Science Overview: A Program For Global Change* (NASA, 1986), teaching about the Earth as a system has become the accepted paradigm in the geosciences. Systems thinking has become fundamental to developing Earth literacy (e.g., Earth Science Literacy Initiative, 2009).

Given that a global approach to the study of Earth processes is the norm, it is unfortunate that the field of geoscience *education* remained relatively segregated by country for most of the last century. This is not entirely unexpected, since educational systems and policies are strongly grounded at the local or regional level. Unfortunately, isolating geoscience education within educational boundaries limits the opportunities for cross-fertilization of ideas and sharing of lessons learned, thereby delaying progress toward the goal of global Earth systems literacy. A global systems approach to geoscience education, which acknowledges that educational practice and policy in one country could have significant influence in another, is a way to reframe our thinking. Increasing interactions across national borders is a powerful strategy for improving the status of geoscience education on a global scale.

Beginning in the 1990s and early 2000s, the frequency of international collaborations increased as geoscience education became firmly established as a field of study, and as researchers and practitioners began to coalesce around core ideas regarding what content is important, which pedagogical approaches are sound, and how learning science theories can be applied to understanding how people learn the geosciences (e.g., Orion et al., 1999; Stainfield et al., 2000). The International Union of Geological Sciences (IUGS) helped facilitate international dialogue on geoscience education beginning in 1990 with the formation of the Commission on Geoscience Education, Training and Technology Transfer (now COGE; 2012). Still, a large proportion of these early collaborations were between researchers and educators in developed countries, and the developing world was all but absent from the conversation. It was not the case that innovations in geoscience education were not happening in the developing world, but rather that poor communication networks to and within the developing world, limited financial resources, and more urgent social and economic priorities inhibited the establishment of developing–developed world partnerships.

In the 2010s, we have reached a turning point and entered a time when the field of geoscience education is moving much more rapidly toward becoming truly global in scope, spearheaded in part by the *Journal of Geoscience Education*'s efforts to internationalize its editorial staff and authorship, and bolstered by growing interactions among geoscience research groups. Voices of educators from developing countries are being heard, and the exchange of ideas about educational practices now crosses the developed–developing world boundary. A recent milestone was the 2010 International Geoscience Education Organisation conference held in South Africa (IGEO, 2010), which marked the first time the conference was hosted on the African continent and by a country within the developing world. Delegates from Africa, South America, Asia, North America, Europe, and Australia shared the results of their work during the main conference, and met for two days postconference to discuss strategies for enhancing geoscience education in their regions.

Concurrent with the expansion of the discipline of geoscience education is the work of the international community at large on the very ambitious United Nations 2015 Millennium Development Goals (United Nations, 2000). The goals are meant to be a blueprint for action by governments and nongovernmental development organizations to ensure that all humans have their basic needs met, regardless of the country in which they were born and live. The Millennium Development Goals are important because they can be a frame for designing and measuring geoscience educational activities within developing countries. Of eight goals, two stand out as deserving attention by the geoscience education community—Universal Education and Environmental Sustainability.

Universal Education is based on the hope that all children will have the opportunity to complete a full course of primary schooling. Because developed countries typically have highly developed K–12 educational systems, it can be difficult to grasp that in developing countries, especially sub-Saharan Africa and southern Asia, even the most basic level of education is unattainable for many. Geoscience educators have a potentially very large contribution to make to universal education by offering place-based, locally relevant science education on topics of critical importance to communities. These topics, such as water, natural hazards, and resource development, bring larger global concerns, such as energy and climate change, to a relevant, local level that can affect individual lives.

Equally, geoscientists bring critical expertise to the goal of Environmental Sustainability, aimed at ensuring the continued existence of environmental resources, biodiversi-

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ty, and safe drinking water. International experiential learning in geoscience undergraduate courses, such as water well construction and repair projects (e.g., Webb et al., 2011; Greenberg et al., 2012), provides immediate assistance for improving environmental sustainability, and in the long term can increase a community's ability to respond to environmental challenges.

It is within this evolving global context that *JGE* has decided to devote a portion of this issue to the theme of geoscience education and global development. The motivation for the theme is threefold: (1) the number of geoscience educators working on projects that contribute to development goals is growing; (2) the unique experiences of educators in developing countries can inform research and practice in the developed world; and (3) a diversity of perspectives from educators across a range of contexts is needed to reach the goal of Earth systems literacy for every global citizen. The five papers included in this section offer a range of perspectives on international geoscience education and serve as an excellent introduction to a broad topic. The papers also serve to highlight opportunities for further discussion and collaboration between the developed and developing worlds.

For geoscience educators who are considering working in the developing world, the perspectives of others who have experienced success are invaluable. Greenberg et al. (2012) describe the processes and lessons learned during a water resources development project involving a group of undergraduate students working in a small Kosovar village. The project is notable for its continuation over a three-year period and for its strong focus on a community-based participatory approach. While tangible improvements to infrastructure occurred as a result of the U.S.-based group's involvement, the results also show the importance of entering into a partnership with local residents, working with them instead of doing something "for" them. As has been noted in other projects, the benefits for the U.S. students were as important as the benefits to the community, both for geoscience learning and personal growth.

Two papers (Chen and Okunlola) describe projects based in developing countries to assess the current status and levels of awareness of the geosciences, and to develop and test educational programs for improving participation and educational outcomes. In many developing countries, the status of geoscience education is poorly understood and, as noted by Okunlola, low levels of awareness can have serious implications for policy development. In countries with natural resource-based economies, geoscience understanding at all educational levels and among decision makers is crucial, and an understanding of areas of critical need is the first step toward designing effective educational programs. As in many developed countries, the geoscience pipeline is at risk throughout much of the developing world, and programs that broaden participation and raise geoscience awareness among precollege to university students are needed.

Meyer et al. and Adentuji address development from a U.S. perspective. Meyer et al. have developed an instructional approach for supporting English Language Learners (ELL). Their research illustrates the idea that the term "development" can be applied to populations within the United States and other developed countries who lag behind national averages with respect to science educational outcomes. Their instructional model is designed to reduce the achievement gap between ELL students and non-ELL students, and although the research is U.S.-based, the model could be adapted to developing world contexts, where it is not unusual for upper elementary and higher students to be taught in English at school while speaking their native languages at home. Adentuji describes the Geosciences Awareness Program, an effort to enhance the participation of underrepresented groups in the geosciences. Their project focuses on changing student attitudes towards, and interest in, geoscience, with interesting evidence to suggest that such programs can be effective mechanisms for increasing diversity within the field.

In sum, the papers point to the possibilities for developing replicable models for effective geoscience educational exchanges and creating opportunities for researchers from developing and developed countries to learn from one another. Rapidly evolving communications technology has made it possible to work collaboratively across wide geographic expanses, and as a result a global geoscience education community is forming. Ongoing technological advances will enable the community to expand and strengthen, as previously isolated geoscience educators have the opportunity to interact with the larger community. These papers are a call to the community to increase dialogue across the developing–developed boundary, catalyzing new advances in the field. An understanding of geoscience teaching and learning that is based on research and practice across the full range of educational contexts will best position us for success in achieving the goal of Earth systems literacy for all.

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