Saving Earth, Saving Geoscience

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INTRODUCTION

Geoscience is crucial for addressing societal challenges arising from interactions between Earth and human systems. Ironically, a gap exists between the pivotal role of earth science in achieving a more sustainable future and the number of students pursuing geoscience careers. This disconnect is highlighted by closures of geoscience departments and the second-class status of earth science in schools (e.g., Center for Geoscience and Society, 2018; Geoscience on the Chopping Block, 2021). How can geoscience education evolve in both content and pedagogy to address this disconnect?

This question, addressed in a recent report on the future of geoscience education (Mosher and Keane, 2021), inspired us to organize "An interactive walk into the future of applied geosciences education," a roundtable at the 2022 Earth Educators' Rendezvous. Seventeen participants representing diverse institutions answered six questions regarding the importance of teaching applied geoscience at the university level; responses are summarized below and in Figure 1.

RESULTS: EARTH EDUCATORS' RENDEZVOUS ROUNDTABLE

1. Why is it important to incorporate an applied approach into teaching geoscience?

Student motivation was the top answer. Participants noted that students are driven to learn how to address the challenges facing society today. An applied approach to the geosciences can develop career skills and expose students to the issues they care about as well as a broader spectrum of geoscience careers, extending far beyond traditional extractive industry career paths.

2. What are the most important skills we can teach to prepare students for careers?

Respondents identified four essential skills:

Geoethics, which is concerned with the standards and values that guide geoscience research and practice, is of high importance in connecting geoscience to society and providing a sense of humility and respect for local interests and community leadership. A geoscience education must include a foundation in professional ethics, which is required for licensing in many jurisdictions.

Promoting the scientific method and teaching students how to apply it through the various stages of investigation is essential for inspiring curiosity and creativity. Analysis and interpretation of results are other critical skills.

Communication skills were highlighted by many participants, including verbal and written communication as well as interpersonal communication that enables effective teamwork and interdisciplinary collaboration. Effective communication also helps to transcend cultural and ideological barriers and enhance inclusivity.

Specific technical skills, such as GIS and applied mathematics for problem solving, were highlighted as critical. These tools and others are needed to address present demands, continue the evolution of learning, and view problems from the perspectives of others.

3. What are the best practices for teaching applied geoscience?

The respondents mentioned active learning techniques such as **mentorship** to create working relationships with students in an apprenticeship-like capacity. Another suggestion was to **utilize case studies** that highlight real-world problems. Connecting students with issues specific to their

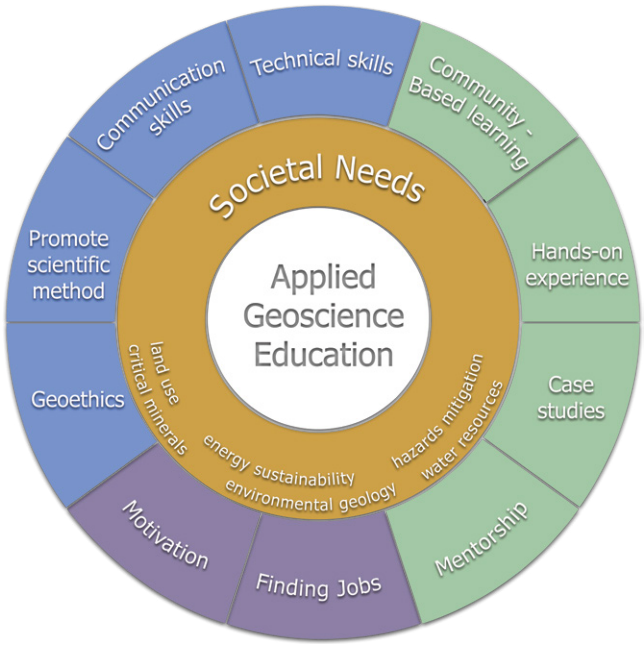

Figure 1. Applied geoscience education is a way to respond to the needs of society (in orange). To achieve this, it is essential to know why an applied education is important to students (in purple), what competencies are needed (in blue), and which teaching practices are most beneficial (in green).

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communities can stimulate interest, make the science feel relevant, and increase awareness and engagement. **Field experiences** greatly enhance engagement. Respondents emphasized that **hands-on experience** with technology and data management is immensely valuable.

4. What resources are the most important and what organizations can supply those resources to help facilitate an applied approach to teaching?

This question resulted in a familiar list of resources and organizations, but several are worthy of comment. First, **alumni networks** are immense sources of wisdom and experience and are often underutilized. Geoscience needs to be considered in the broadest context to include associated disciplines such as economics, ecology, land-use planning, and engineering. Colleges and universities should facilitate networking opportunities by inviting alumni with different perspectives and skill sets to connect and speak with students.

The National Association of Geoscience Teachers Science Education Resource Center at Carleton College has produced an extensive collection of high-quality teaching resources. The Geological Society of America, the American Geophysical Union, and other organizations devote attention to geoscience as a service, as do the American Geosciences Institute, the International Association for Promoting Geoethics, and Geology in the Public Interest.

Government agencies offer a wealth of information, and the U.S. Geological Survey is a vast resource. Most nations have some form of geoscience survey, and the same is true for states and provinces. Many universities host extension services that interact locally in their regions.

Last, the **sharing of experiences** and ideas with those who have "on-the-ground" experience can provide useful resources for educators at all levels.

5. What are the most relevant geoscience challenges that appeal to current students?

Responses to this question were driven by what the educators have been hearing from their students: more than ever, students want to **apply what they learn to solve problems** in the real world. These problems include the impacts of climate change, food injustice, and water availability. They also want to help further energy sustainability and address the need for critical minerals while promoting responsible mining and preserving ecosystems. Students want to balance the need for natural resources with environmental conservation and preservation.

Students are especially driven by salient experiences at home, where they have seen **local challenges** go unaddressed. They understand the need for local action and are ready to put their education to work, which is something that teaching practices should reflect.

Today's students are driven by altruism (Carter et al., 2021) and a desire to hold industry and government to higher standards. They are worried about the future of their children and people far from home. Research shows that highlighting the social relevance of geoscience also may attract more underrepresented students (Carter, et al., 2021).

6. What are the biggest barriers to instituting applied geoscience in our teaching and in engaging with society?

Respondents were nearly unanimous in their primary concern about **having neither resources nor time** to allow any workload changes or additions. Educators are stretched to the limit on all fronts, as was abundantly clear during the pandemic.

They suggested several reasons why change is difficult, including a lack of awareness of the **disconnect between classroom instruction and what graduates will need to know** (Mosher and Keane, 2021). Directly applying geoscience and engaging with society are unfamiliar territories for some instructors. The **momentum needed to overcome resistance to change** was also cited, particularly when applied geoscience is given a lower status in the academic reward structure.

Many respondents agreed that it would be easier to modify course plans if there were more **teaching resources that address the public good,** which brings us back to their primary concern: the need for more support.

SUMMARY AND CONCLUSIONS

There is an urgent need to diversify and strengthen university geoscience departments by reimagining undergraduate geoscience education to meet the needs of today's students and of society. As reflected in the responses above and the Mosher and Keane (2021) report, key barriers include resistance to change, lack of time, and the need for additional resources. Another challenge is the low visibility of geoscience both in K–12 education and among the public, emphasizing the importance of actively promoting the value of geoscience as a viable and societally relevant career path. Ongoing professional development and opportunities to share concerns and exchange resources will help to catalyze change. The annual Earth Educators' Rendezvous provides an ideal forum for open dialog around the future of geoscience education, and we hope you will join us for a three-day "Applied Geoscience Education: Engaging with Society for Sustainability" workshop at the 2023 Rendezvous.

REFERENCES CITED

Carter, S.C., Griffith, E.M., Jorgensen, T.A., Coifman, K.G., and Griffith, W.A., 2021, Highlighting altruism in geoscience careers aligns with diverse U.S. student ideals better than emphasizing working outdoors: Communications Earth & Environment, v. 2, no. 1, p. 1–7, p. 213, https://doi.org/10.1038/s43247-021-00287-4.

Center for Geoscience and Society, 2018, Earth and space sciences education in U.S. secondary schools: Key indicators and trends 3.0.; Alexandria, Virginia, American Geosciences Institute, 24 p., https://www.americangeosciences.org/sites/default/files/SecondaryEdu2018Report_20pgPlusCovers_PrintRes_120618.pdf (last accessed 13 Mar. 2023).

Geoscience on the Chopping Block [editorial], 2021: Nature Reviews Earth & Environment, v. 2, no. 9, p. 587.

Mosher, S., and Keane, C., editors, 2021, Vision and change in the geosciences: The future of undergraduate geoscience education: Washington, D.C., American Geosciences Institute, 176 p., https://www.americangeosciences.org/change/pdfs/Vision-Change-Geosciences.pdf (last accessed 13 Mar. 2023).

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