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GC Insights: Diversifying the geosciences in higher education: a manifesto for change

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Abstract. There is still a significant lack of diversity and equity in geoscience education, even after decades of work and widespread calls for improvement and action. We join fellow community voices in calls for improved diversity, equity, inclusion, and justice in the geosciences. Here, in this manifesto, we present a list of opportunities for educators to bring about this cultural shift within higher education: (1) advocating for institutional change, (2) incorporating diverse perspectives and authors in curricula, (3) teaching historical and socio-political contexts of geoscience information, (4) connecting geoscience principles to more geographically diverse locations, (5) implementing different communication styles that consider different ways of knowing and learning, and (6) empowering learner transformation and agency.

1 Introduction

While geoscience plays an essential role in addressing societal issues, it is an inequitable and exclusive field because of its complex entanglement with past and ongoing prejudices (Dowey et al., 2021; Berhe et al., 2022). While advances have been made, geoscience education that does not interrupt prejudice contributes to the hostile climates and structural problems that hinder diversity (Marín-Spiotta et al., 2020).

Many resources and calls to arms have come from communities and leaders for decades, but change is slow (e.g. Huntoon and Lane, 2007; Bernard and Cooperdock, 2018; Gates et al., 2019; Liboiron, 2021; ADVANCEGeo, 2022). In this manifesto, we call for six specific points of reflection and action that individual higher education geoscience educators can undertake to recognise and unlearn their biases and to support geoscience education diversity (Fig. 1). Furthermore, we hope to continue the momentum and establish a community-built framework for implementing and strengthening diversity, equity, inclusion, and justice in geoscience education.

2 Champion meaningful transformation

Foundational geoscience knowledge and resources extracted from excluded and exploited communities have historically benefited dominant groups (Keane et al., 2017; Stefanoudis et al., 2021; Wight, 2021). To combat extractive mindsets,

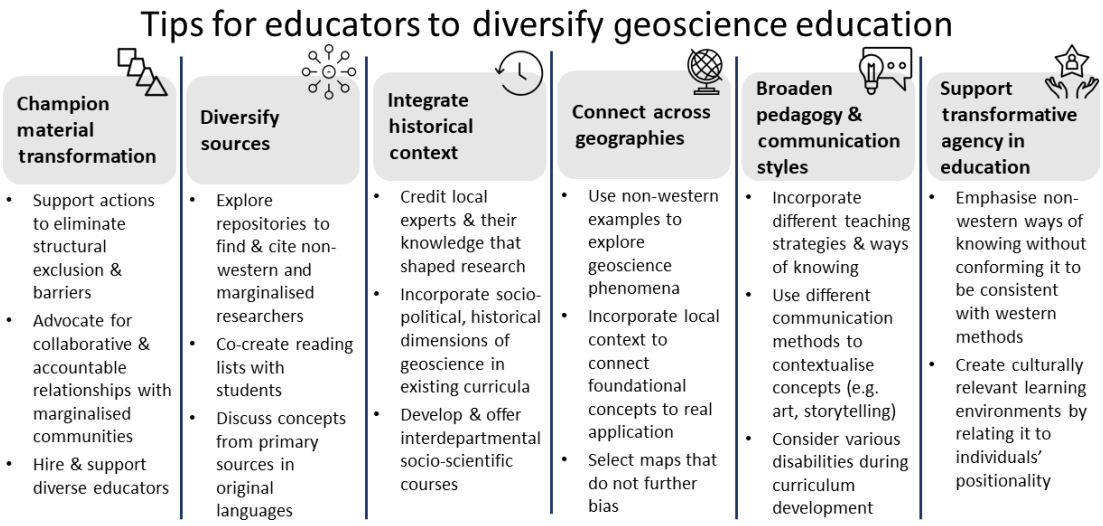

Figure 1. Summarised recommendations for educators to diversify their geoscience curricula and education.

geoscientists outside of a community must not presume that said community are required to provide access to knowledge, opportunities, or resources. Educators can advocate for investing resources in communities and experts that contribute to understanding and diversity in geoscience to help build trust and repair the legacy of injustices (e.g. colonial transfer of land and resources) that has led to the institution's success. For the sake of systemic change, educators must challenge the status quo, commit to action for equity, and develop accountable relationships built on respect, reciprocity, and trust with communities (La Paperson, 2014; Powell and Kelly, 2017; Squire, 2019; Jones, 2021; Ali et al., 2021; Lewis and Sadler, 2021; Liboiron, 2021).

Educators should examine institutional factors leading to the lack of diversity in the geosciences and their role in perpetuating them while calling for the prioritisation of recruiting and retaining educators and learners from marginalised communities (Land Grab Universities, 2022; Carbajal and Atchinson, 2020; Ormand et al., 2021; Cooperdock et al., 2021; Ranganathan et al., 2021). Cultural, structural, and individual interventions and accountability systems are required to lower barriers and power imbalances while supporting diverse individuals and groups across all measures (Núñez et al., 2019; Kingsbury et al., 2020; Olcott and Downen, 2020).

3 Diversify sources

Not diversifying one's sources when developing curricula can perpetuate structural and unconscious biases regarding the value of specific research sources and types, leading to a structural system of exclusion that proliferates unconscious bias.

Most search engines decrease the visibility of research published in smaller and regional journals by directing users to often-referenced work in high-impact journals, often due to search algorithm biases based on a user's history (e.g. current location, language). These biases result in an erasure of non-western authors that may rely on local or regional journals because of the inaccessibility and exclusivity of high-profile journals (even after considering publication discounts) (Jeater, 2018). Therefore, publications by western scientists carrying out research in non-western regions are valued and cited more widely than their local, non-western counterparts (Wight, 2021).

Repositories offer a diverse selection of resources to reduce strain on educators looking for work by marginalised researchers, though these databases are often biased. For example, SCImago (2022) lists journals from over 200 countries but is still heavily influenced by the United States.

Language barriers from diverse sources may constitute an additional barrier in English-dominated academic settings, but this may result in limited consideration of diverse expertise (Federation of Finnish Learned Societies et al., 2019). Providing primary resources, including phrases in the original language that have no direct translation, is an opportunity to discuss diverse geoscience perspectives while considering context and complexities.

Co-creation of reading lists by educators and students that centre diversity can empower students and improve curriculum inclusivity (Schucan Bird and Pitman, 2020). Diversifying sources must also include author acknowledgement and reciprocity to reduce further othering and exploitation (Keane et al., 2017). For example, many sustainability efforts extract information from Indigenous practices without considering Indigenous science's complex, holistic origin and implications (Tsosie, 2019). For guidance on incorporating Indigenous knowledge into curricula, refer to the CARE (Collective Benefit, Authority to Control, Responsi-

bility, Ethics) principles (Global Indigenous Data Alliance, 2022).

4 Integrate historical context

Many scientists have downplayed and continue to downplay marginalised researchers' and participants' contributions to their research, which leads to exclusionary curricula (Dowey et al., 2021). Educators support diversity and equity by including discussions of socio-political contexts in curricula (GeoContext, 2022); through this inclusion, learners can develop and practise more inclusive, diverse, and culturally sensitive approaches to science. By highlighting historical, cultural, and socio-political dimensions of geoscience discoveries, we can bring value to those historically marginalised groups by emphasising the meaningfulness of their contributions. For example, local Indian Pandits helped the British during their colonial land survey project, the Great Trigonometrical Survey, by sharing their critical knowledge of their homeland. While this project helped establish the concept of isostasy, the Pandits receive little acknowledgement in western education (Sarkar, 2012; Cartier, 2021).

Educators can mitigate the erasure of marginalised populations by integrating historical contexts during lessons in order to illustrate the concept and research process while meeting learning objectives. While this can be incorporated in fundamental or advanced geoscience classes, offering socioscientific courses (e.g. geoethics) can lead to deeper understanding and interdisciplinary collaborations.

5 Connect across geographies

Place-based learning introduces different ways of exploring geoscience concepts through geographically and culturally relevant practices and by diversifying geographic case studies and including local expertise surrounding the institution (Johnson et al., 2014; Semken et al., 2017). It allows educators to bridge the disconnect between foundational principles, global-theoretical frameworks, and local-practical applications, such that phenomena may impact different locations and communities. This practice amplifies local experts and supports diverse student learning by diversifying examples that consider non-western regions. For example, many textbooks use western examples to illustrate ocean–atmosphere dynamics, like the Gulf Stream, but omit details about the Somali Current and its impact on monsoon behaviour (Schott, 1983).

Map selection can further perpetuate unconscious biases, because scales, symbology, and colour can emphasise western regions and ideology (Perkins, 2018). When educators use diverse and equitable geographical contexts and resources, learners can develop a broader understanding of geoscience globally, resulting in a more robust contextualisation of concepts learned in courses with what is happening in their environment.

6 Broaden pedagogy, epistemology, & communication styles

We can diversify the geoscience curriculum by broadening our approaches to communication, teaching, and epistemology (or ways of knowing) (Le Grange, 2007; Hall and Tandon, 2017). When educators embrace diverse teaching approaches, student motivation grows and can lead to better engagement and retention (Tremblay-Wragg et al., 2021). Embracing these approaches helps educators create inclusive learning spaces, be respectful of diverse audiences, be culturally sensitive, and support the full inclusion of disabled learners and educators (Feig et al., 2019). Educators can also develop inter-institution classroom collaborations to co-develop virtual exchanges and course-based collaborative learning projects (Stefanoudis et al., 2021).

We can diversify our communication styles by utilising different strategies in teaching (Mintz, 2020; Illingworth, 2020) to encourage learners to diversify how they communicate knowledge. Methods of knowledge sharing (e.g. storytelling, oral histories) by the communities may not conform to western teaching practices and tend to be excluded as references and from academia. Academic citations and curricula should be adapted to bring academic recognition to all ways of knowing, learning, and relating (MacLeod, 2021; Kornei, 2021). This diversity will enable educators to practise place-based learning and to honour the knowledge and communities of a more diverse student population.

7 Support transformative agency in education

Educators can support transformative and critical science agency by valuing the connected and holistic facets of learning–teaching–knowledge–personal experience grounded in students' diverse social, emotional, and cultural needs (Rodriguez, 1998; Durlak et al., 2011). Agency refers to a learner's ability to create knowledge and to translate lessons learnt into pursuable actions with tangible benefits for themselves and/or their communities, strengthened by collaborative learning opportunities among learners and educators (Schenkel and Calabrese Barton, 2020; Adewumi and Mitton, 2022).

Pedagogy that places western scientific knowledge as the ultimate source of knowledge and epistemology prevents the development of agency among learners, especially those from historically excluded communities (Smith, 1999; Masta, 2018; Alexiades et al., 2021). Diversifying knowledge systems in curricula (e.g. traditional ecological knowledge, western science) can lead to stronger education overall rather than weakening previously centred systems (Virkkunen, 2006; Reano and Ridgway, 2015; Smythe et al.,

2017). Multiple epistemologies can be considered and valued in geoscience without being broken down, othered, or changed to be consistent with one another (Alexiades et al., 2021).

Education scholars have begun implementing strategies demonstrating how transformative agency and actions support educational equity while serving individual learners' community interests (Atwater et al., 2014; Bang et al., 2017; Miller et al., 2020). Reano (2020) describes how a co-created climate change adaptation plan with the Confederated Tribes and Bands of the Yakama Nation (Yakama Nation, 2022) supported the transformative agency of Indigenous students.

Data availability. This paper contains a literature overview of the current conversations surrounding diversity in the geosciences in higher education and the author's views and guidance for individual educators and the broader higher education geoscience community. Other than the sources cited in the references, we did not create or use data to produce this work.

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