

# 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  
20 calls for improvement and action. We propose an approach and specific opportunities for educators to improve diversity in  
geoscience education 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.

## 25 1 Introduction

While geosciences play 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 some 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).

30 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). Herein, we offer six specific  
points of reflection and action that individual higher education geoscience educators can undertake to recognize and unlearn  
their biases to support geoscience education diversity (Figure 1). Furthermore, we hope to continue momentum to establish a

community-built framework for implementing and strengthening diversity, equity, inclusion, and justice in geoscience  
35 education.

## **2 Champion Meaningful Transformation**

Foundational geoscience knowledge and resources extracted from excluded and exploited communities have historically benefited dominant groups (Keane, 2017; Stefanoudis et al., 2021; Wight, 2021). To combat extractive mindsets, visiting geoscientists must not presume access to knowledge, opportunities, or resources. Educators can advocate for investing  
40 resources in communities and experts that contribute to knowledge and diversity in geoscience to help build trust and repair the legacy of injustices (e.g., colonial transfer of land and resources) that have led to the institution's success. Educators must challenge the status quo, commit to action for equity, and develop accountable relationships built on respect, reciprocity, and trust with communities for systemic change (la paperson, 2014; Powell and Kelly, 2017; Squire, 2019; Jones, 2021; Ali et al., 2021; Lewis and Sadler, 2021; Liboiron, 2021).

45 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; 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;  
50 Olcott and Downen, 2020).

## **3 Diversify Sources**

Without diversifying one's sources in developing curriculum, structural and unconscious bias on the value of specific research sources and types may be perpetuated, leading to a system of structural exclusion that proliferates unconscious bias.

Most search engines decrease the visibility of research published in smaller and regional journals by directing users to often-  
55 referenced work in high-impact journal, often due to search algorithm bias based on a user's history (e.g., current location, language). This results 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 like the work of local scientists are valued and cited more widely than their local, non-Western counterparts (Wight, 2021).

60 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 lists journals from over 200 countries but remains heavily influenced by those in the United States.

Language barriers from diverse sources may constitute an additional barrier in English-dominated academic settings but this may limit consideration of diverse expertise (Helsinki Initiative, 2019). Providing primary resources, including phrases in the original language that have no direct translation, is an opportunity to discuss diverse geoscience perspectives, while ensuring that concept context and complexities are considered.

Co-creation of reading lists by educators and students to centre diversity can empower students and improve curriculum inclusivity (Schucan Bird and Pitman, 2019). 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 practises without considering the complex, holistic origin, and implications of Indigenous science (Tsosie, 2019). Principles such as CARE (Collective Benefit, Authority to Control, Responsibility, Ethics) can be used by educators when incorporating Indigenous knowledge into curriculum.

#### **4 Integrate Historical Context**

Historically to now many scientists downplay marginalised researchers' and participants' contributions in their research, which leads to exclusionary curricula (Dowey et al., 2021). Educators can support diversity and equity by including discussion of socio-political contexts in curriculum (GeoContext). When included, learners can develop and practice more inclusive, diverse, and culturally sensitive approaches to science. By highlighting historical, cultural, and socio-political dimensions of geoscience discoveries, educators can bring value to those historically marginalised. 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 erasure of marginalised populations by integrating historical context during lessons that illustrate the concept and research process while meeting learning objectives. While this can be incorporated in fundamental or advanced geoscience classes, offering socio-scientific courses (e.g., geoethics) can lead to deeper understanding of geoscience concepts and interdisciplinary collaborations.

#### **5 Connect Across Geographies**

Place-based learning introduces different ways of exploring geoscience concepts through geographically and culturally relevant practices, and can be enhanced by diversifying geographic case studies and including local sites 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 can be related to observations of how different locations and communities are impacted. 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).

95 Map selection can further perpetuate unconscious bias because scales, symbology, and colour can emphasize Western regions and ideology (Perkins, 2018). When educators use diverse and equitable geographical contexts and resources, learners can develop a broader understanding of geoscience across the globe that results in stronger contextualization of concepts learned in courses with what is happening in their environment.

## **6 Broaden Pedagogy, Epistemology, & Communication Styles**

100 We can diversify the geoscience curriculum by broadening our approaches to communication, teaching, and epistemology (or ways of knowing) (Le Grange, 2017; Hall and Tandon, 2017). When educators embrace diverse teaching approaches, student motivation grows, resulting in better engagement and retention (Tremblay-Wragg, 2019). This also 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  
105 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). This will in turn stimulate learners to diversify how they communicate knowledge. Knowledge sharing (e.g., storytelling, oral histories) by the communities that may not conform to Western teaching practices and tend to be excluded as references and from academia. Citations and curriculum should be adapted to bring academic recognition to all ways of knowing, learning,  
110 and relating (MacLeod, 2021; Kornei, 2021). This will enable educators to practice place-based learning and honour the knowledge and communities of a more diverse student population.

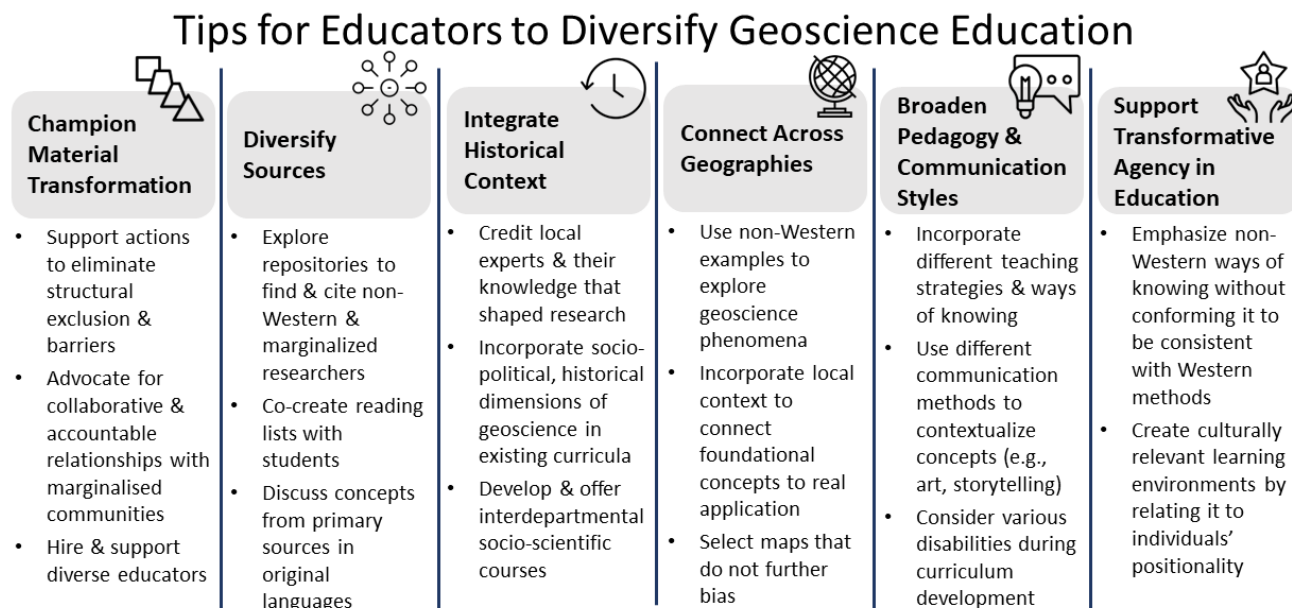
## **7 Support Transformative Agency in Education**

Educators can support transformative and critical science agency by valuing the connected and holistic learning-teaching-knowledge-experience grounded in students' diverse social, emotional, and cultural needs (Rodriguez, 1998; Durlak et al.,  
115 2011). Agency refers to learners' ability to create knowledge and translate their lessons learned into meaningful actions, 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;  
120 Alexiades et al., 2021). Diversifying knowledge systems in curriculum (e.g., Traditional Ecological Knowledge and Western science) can lead to stronger overall education, rather than a weakening of previously centred systems (Virkkunen, 2006;

Reano and Ridgway, 2015; Smythe, 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).

125 Education scholars have begun implementing strategies demonstrating how supporting transformative agency and actions reinforce 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) supported the transformative agency of Indigenous students.



130 **Figure 1: Summarised recommendations for educators to diversify their geoscience curriculum and education.**

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All the authors contributed to the conceptualization of this article and participated in writing the original draft as well as draft review and editing. CAH administered this project and developed the figure.

## Competing Interests

Two of the authors are members of the editorial board of *Geoscience Communication*. The peer-review process was guided  
140 by an independent editor, and the authors also have no other competing interests to declare.

## Data Availability

This paper contains opportunities for geoscience educators in higher education can support diversity. As such, other than the  
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