

“GC Insights: Diversifying the Geosciences in Higher Education: a Manifesto for Change” by Hall et al.

Preprint link: <https://egusphere.copernicus.org/preprints/2022/egusphere-2022-116/>

RC1

Thank you for taking the time to read this manuscript, and for providing helpful and specific feedback for how to improve this work. Below we have responded to all comments and have indicated how we have changed the manuscript (which, for ease of use, we have written in blue text) as a result of these suggestions.

RC1.1: While the abstract is clear and concise, it leads the reader to expect a more robust discussion about specific recommendations for increasing diversity within geoscience academic programs. However, the article is scattered and attempts to cover too much ground in the limited amount of space allowed, especially with regards to couching the recommendations within the context of bias, racism, ethics, and barriers to inclusion. As a result, the recommendations are not as strong and well-formed as they could be, and the depth of discussion needed for explaining clearly how those recommendations fit within and solve the issues of bias, racism, ethics, and barriers to inclusion is lacking. Furthermore, the strength of the recommendations is significantly diminished by the adversarial tenor of the article and the dearth of robust support for the assertions cited by the authors as the causes for low diversity within geoscience academic programs. While diversity continues to be a long-standing issue for the geosciences, the drivers are more complex than what the authors assert.

Response: We agree with the reviewer that a more holistic perspective of diversity more accurately reflects the complexity of topics within geoscience contexts that our paper addresses. To address this, we have made the complexity of on-going issues more explicit and have added additional references to expand the breadth of diversity. However, we are not intending to provide a robust analysis of the “causes of low diversity within geoscience academic programs”, and we would not be able to do so in the limited word count of the GC Insights format. We are simply providing examples of scholars who are leading discussions on how we, the geoscience community, might begin to develop solutions to the complex issues of bias, racism, etc. we are more interested in sharing a forward-looking perspective that recognizes the history, but focuses on what geoscientists today have the power to change.

Our primary goal, in this manuscript, is focused on offering opportunities for geoscience educators to improve their curricula by using specific strategies to diversify their teaching behaviors, sources of technical expertise, and how they interact with their institutions to work towards a more diverse and inclusive geoscience. The intent of this article is also to assert that there is a substantial body of knowledge about both the drivers and solutions that needs to be bridged into practice. However, we recognize that these comments from the reviewer are an

important perspective on the communication and we will work to focus on the benefit that change can bring than come from a critical perspective of the impacts of what happens when this is not done. In the revised version of the manuscript, we have taken these comments into consideration by making the main contribution more clear in each section through reorganization and more explicit communication, explaining the work that we believe can be done now, and the limitations of our article given the format.

RC1.2: Overall, the strength of the article is in the recommendations for improving higher education by:

1. advocating for institutional change through investing in the recruitment and retention of educators and learners from under-represented communities.
2. incorporating diverse perspectives and authors in curricula by prioritizing the use of a wide array of publications and information sources
3. including the historical, cultural, and sociopolitical contexts of geoscience information discovery in curricula.
4. connecting geoscience principles to more geographically diverse locations, especially more local and regional sites across the world.
5. implementing different communication styles that improve student engagement and learning and empower learner transformation and agency.

Response: Thank you for your comments, this will be greatly helpful in addressing RC1.1 to ensure that our intentions are clear and straightforward.

RC1.3: Development of operational approaches to these recommendations would strengthen the article as would inclusion of examples that have shown measurable improvements in increasing diversity, equity and inclusion within geoscience academic programs.

Response: We have worked to include more examples and references throughout the article about the strides made. However, due to the manuscript word limit, we will need to use our reference list to point readers towards answering how we can leverage these advances to continue making change.

Specific comments:

RC1.4: In the Introduction, the authors assert that the geosciences is “entangled with prejudiced practices, making it an inequitable and exclusive field” but do not provide any supporting references, and in the next sentence, the reference to the Marin-Spiotta et al, 2020 is not included in the list of references.

Response: We have included the full citation for Marin-Spiotta et al., 2020 in the end references. The full citation is:

Marín-Spiotta, E., Barnes, R. T., Berhe, A. A., Hastings, M. G., Mattheis, A., Schneider, B., & Williams, B. M. (2020). Hostile climates are barriers to diversifying the geosciences. *Advances in Geosciences*, 53, 117-127, <https://doi.org/10.5194/adgeo-53-117-2020>

RC1.5: In the Champion Meaningful Transformation section, the arguments are scattered over two paragraphs between a brief overview of the need to build community relationships, ethics, and the need to recruit and retain educators and learners from underserved communities. This section would be strengthened by better organization of the content and a deeper discussion about the key agents, such as ethics training, recruitment and retention of educators and learners from underserved communities, and frameworks for building and maintaining community relationships. References to programs and initiatives that have shown measurable change would help strengthen these recommendations as well.

Response: This was a valuable comment that helped bring clarity to this section. We did a nearly complete reorganization of this section to focus first on external engagement and then focus second on recruitment and retention as a key part of the way that universities can make progress in addressing societal challenges. In this section, many of the concrete programs are buried in the references. We instead state those explicitly in the text and draw out the key concepts such as reparations for dispossession (Land Grab Universities), programs that advance equitable engagement, valuing work that scholars do on outreach, community engagement, and equity, and education.

RC1.6: In the discussion about diversification of information sources, the authors discuss search engine use and the prioritization of high-impact journal articles over other types of articles. The authors fail to discuss the self-customizing algorithms of search engines that show search results tailored to the user's browsing behavior, including the country and language of the country in which the user resides. This algorithmic bias is inherent to search engine algorithms and at its best, attempts to help a user find the information they are seeking quickly. The authors do not discuss this algorithmic bias, nor offer any solutions to overcome this bias. Instead, they briefly mention SCImago, a database that only covers journals in the Scopus® database, and of the 240 countries covered by this database, U.S. publications represent 21% of the database contents. While this is a helpful site, recommendations on how to use browsers to find less visible publications, and discussion of the necessary skills for critically evaluating information sources would strengthen this section of the article.

Response: Thank you for this comment. We have integrated algorithm bias in Line XX within the section. This has been very helpful to see that it is a necessary point to include and have made sure these details are included to further illuminate issues with search engines. We have kept SCImago as a database but detailed its limitations as an example to what limitations may exist with these repositories.

RC1.7: The section on integrating historical content, citation of Stefanoudis et al., 2021 does not bring to light the long list of recommendations put forth in that article for including local researchers, but only highlights that local researchers are excluded by many scientists today, thus excluding the important actionable steps that Stefanoudis et al., 2021 detail.

Response: We included an example of an actionable steps included in this section as well as others that have been brought forth. We do note that we are focused on educators as our audience and will focus on applicable steps and Stefanoudis et al. 2021's recommendations have been edited to fit that purpose.

RC1.8: The section on connecting across geographies could be better developed by including a discussion about including local and regional context relative to the location of the academic department. By including local sites adjacent to institution's location, educators and learners would build community within the areas where they work and learn and would begin to integrate the other recommendations put forth in this article.

Response: Thank you for this comment. We will elaborate further on the value of place-based education.

RC2

Thank you for taking the time to read this manuscript, and for providing helpful and specific feedback for how to improve this work. Below we have responded to all your comments and indicated how we will change the manuscript (which for ease of use we have written in blue text) as a result of these suggestions. We worked to include many of the references suggested, but due to word limits for the GC Insight format, we were unable to include them all.

General comments:

RC2.1: In general, this is an interesting piece of work that makes some important reflections on our discipline. It brings together themes such as historical context and diversifying reading lists in a manifesto for change for diversifying geosciences in higher education. This is an important topic, and in my opinion the key challenge geoscience faces. There is a growing body of literature and practise in this space and additional contributions such as this one can strengthen and broaden discussions. This growing body of literature is neither recent nor small, reflecting the long lived and extensive discussions taking place in the community. Some of these conversations are further along than suggested by this manifesto, though in frustration I acknowledge that action and change are less forthcoming. In my review I've suggested a variety or works and thoughts that the manuscript could benefit from acknowledging. There is of course a balance between citing previous works and limits on what is possible within a publication.

Response: One of the key arguments of our manuscript is that many of these ideas are ripe for implementation and we aim to guide researchers and institutions towards implementation. This

could be better fleshed out in the manuscript to make the specific contribution clear and we appreciate the reviewer's constructive and balanced perspective on this point.

RC2.2: There have been a few 'call to arms' papers/communications in geoscience more broadly. Some aimed at organisations, some at research, some more broadly (e.g. Ali et al 2021; Cooperdock et al., 2021; Dowe et al 2021; Kiesling 2020; Quardokus Fisher et al 2019). It may be useful upfront to discuss how this manifesto builds on and/or is different to this other work.

Response: Thank you for your comment. We have worked to be more explicit that our intended purpose and audience is action points for geoscience educators as individuals throughout the article. In the introduction, we have reorganized a couple of sentences to make this more explicit in the context of aligned diversity efforts across the geosciences.

RC2.3: The title suggests that this will be a broad manifesto, but I find that the piece is focussed on race and indigenous cultures. This is fine and important but this focus should be more explicit in the abstract and opening statements if it is the authors intention to be so focussed. Marginalisation in the subject can occur for a variety of reasons, and the geosciences have low diversity by any measure (race, LGBTQ+, disability, gender...) and this is all entrenched and perpetuated by our current educational systems. Of course, these are also intersectional – a really interesting piece in applying an intersectional lens to increasing diversity in geosciences is given by Nunez et al. 2019.

Response: With the expertise of our authors, we focused on racial bias and Indigenous cultures initially. In later drafts, we worked to expand this. But, thanks to this comment, we saw opportunities to include additional references and discussion about diversity more broadly and have worked to include this throughout the piece.

RC2.4: I like figure 1. It is clear and well presented. Some of the key messages here are a bit lost in the sections. Perhaps these could be tied more explicitly to the text by subheadings? Throughout I find myself agreeing with many of the reflection but find the sections fall short of clearly articulating the recommendation and HOW/WHY that will lead to increased diversity in the geosciences. The authors could engage more throughout with the work that has/is already being done and the steps that have been taken. By pointing towards case studies/examples of the actions they propose (which do exist) this could be a much more tangible set of recommendations that educators could pick up and use.

Response: We worked to clarify our sections to be more streamlined to provide 1) background context, 2) actionable steps, and 3) justification to make the change particularly through our citation list. We attempted to distill our points in Figure 1. We also will be editing the figure to make sure that it's succinct and in line with our recommendations and additional considerations for diversifying the geoscience (e.g., creating a more inclusive environment for those with disabilities).

RC2.5: The authors may find it interesting to note that the new QAA Subject Benchmark Statement for Earth Science UK HE now explicitly mentions equality, diversity and inclusivity and includes many of the themes included in this manifesto. As well as GeoContext, another useful resource that could be highlighted here is the growing AdvanceGEO community resources. Some professional organisations such as the Institution of Environmental Sciences explicitly demand EDI as part of their accreditation, including themes that are considered here.

Response: Thank you for bringing these to light! We included GeoContext more explicitly in the document as a reference, as well as highlighted ADVANCEGeo.

Specific Comments:

RC2.6: “Geosciences play an essential role in addressing key societal issues, but it is entangled with past and ongoing prejudiced practices, making it an inequitable and exclusive field.” This is a bold opening sentence. Whilst I do not dispute its truth, others who are not as familiar with the field or literature might. There are a wide range of references that can be used to support this, particularly those that present data to support this fact. For example, Bernard & Cooperdock, 2018; Dutt, 2020; Marin-Spiotta et al., 2020; Pickrell, 2020; Dowey, N., et al, 2021; and there are others. Some of which you refer to, some of which you don’t.

Response: We have some of these references in the current list as you noted, but we have worked to incorporate these references (e.g., Dowey et al., 2021) but are limited by word count.

Championing Meaningful Transformation

RC2.7: This section has some important reflections and suggestions. However, it doesn’t have a clear focus and it is hard for the reader to really pick out its key message. Is it about challenging parachute science? Is it about Land Grab Universities and colonialism? Is it about including marginalised groups? Or is it about demanding that those within the system, and who predominantly benefit from the status quo, challenge and change the systems and institutions in which we operate? I feel like it’s the latter but that message isn’t coming across clearly. There are other works that also demand this from us (e.g. Ali et al 2021; Dowey et al 2021; Kiesling 2020; Quardokus Fisher et al 2019) that could be usefully cited perhaps.

Response: We appreciate this point, which is similar to a point made by reviewer 1. We worked to make use of the references suggested by the reviewer in the revised draft, as word count allowed.

RC2.8: “Extracting knowledge from communities without clear reciprocity has historically benefited dominant groups, while excluding and exploiting oppressed communities.”

Can you point to some of the literature that discusses this in more detail? Perhaps some work on parachute science? There's a wealth of literature on knowledge extraction more generally, perhaps some useful geoscience-focussed references can be found in Rogers et al {preprint}.

Response: We incorporated Stefanoudis et al., 2021 and Keane, 2017 to assert our points here.

Diversify Sources

RC2.9: This is an important section on the use and perpetuation of knowledge in our curricula. I understand that the authors may wish to swerve 'decolonising curriculum' but perhaps they could nod to some appropriate literature and thought here? For example, this section seems to focus on how literature is used by educators in teaching degree programmes – essentially reading lists. Is the recommendation here that reading lists contain works from diverse authors, in a variety of languages, from a range of geographic locations? Could the authors be more explicit about this recommendation? Or is it more that in our teaching, we should consider the very foundations on which our discipline is based and challenge those ontologies? For example, should educators consider the extensive and diverse knowledge systems that are typically excluded from our curricular (e.g. see Hall & Tandon, 2017; le Grange 2007)?

Response: We believe that both diverse sources and being cognizant of the foundation of many of the popular resources we use are built on colonial practices. We will make this more explicit in our next draft and include the recommended citations.

RC2.10: As far as recommendations regarding diversifying reading lists go, I particular like the emphasis on co-production with students. I think this can be strengthened. Working with students as partners and collaborators in increasingly evidenced as a pathway to truly inclusive curricula. You could use Adewumi et al., 2022 and references therein.

Response: Thank you for your note, we included this in the section on Transformative Agency because we see that this is a way to empower students to create, learn, and bring this back to their communities.

RC2.11: The section on authorship could be interestingly linked back to the previous discussion on parachute science. North et al., 2020 might be a useful source here. I'm not sure I see the relevance of "While some journals offer discounted publication rates and fee waiver requests" Line 60. This is a barrier to publication, not a barrier for educators to use that material in their curricula. The argument in this section could be tightened to directly link to how this material is (or is not) used in education and how it should and could be incorporated.

Response: This is an excellent point. Our thinking was that some of the journals that are popular inherently have barriers to many researchers. As a result, educators may be limited on what research and work they incorporate in their curricula. However, we made sure to recenter the emphasis on educator access.

Integrate Historical Context

RC2.12: This section may be better restructured to first explain how local researchers and knowledge was(/is) excluded and then how this is perpetuated by the record not being corrected/highlighted through our teaching. Rogers et al., 2021 has some sources on this that may be useful – again I appreciate that the authors may wish to swerve ‘decolonising the curriculum’. I would argue that many educators do teach geoscience in historical context (c.f. line 73-74) but that the context given is narrow in its view, Eurocentric and dominated by white male discourse that celebrates the science rather than situates it in colonial expansion. Some of this is explored in Dowey et al 2021 amongst a vast literature. Finally, it might be useful to emphasise how teaching historical context will lead to diversifying geoscience.

Response: We have reorganized this section in line with reviewer comments, including reviewing our wording to ensure that when we say “historical context” we mean one that includes those that have been historically excluded and oppressed. Our intention is to explore how limited in view geoscience is currently taught, as the reviewer discusses in this comment. We referenced incorporate Dowey et al. to discuss this matter further.

Broaden Pedagogy, Epistemology, & Communication Styles

RC2.13: This section importantly highlights ways of knowing and recognising the variety of ways of knowing. It focuses on communication and knowledge sharing, which is of course important. A large variety of inclusive pedagogies is nodded to in the reference to Mintz, perhaps too fleetingly. It tends to overlook pedagogies and strategies to be inclusive to other marginalised groups. For example, it doesn’t recommend any of the work on including disabled students in the geosciences (a huge issue particularly with our emphasis on fieldwork e.g. Feig et al., 2019; Stokes et al., 2019, Lawrence & Dowey 2022), neurodiversity (e.g. Kingsbury et al., 2020), LGBTQ+ (e.g. Olcott & Downen, 2020) and gender (e.g. Holmes et al, 2015).

Response: As mentioned in our response to Reviewer 1, with the positionality of our authorship, we realized that we heavily focused on diversity topics like race, non-Western cultures, and Indigenous knowledge. We had some of these topics listed, but have included additional discussion and references throughout the piece to strengthen the breadth of improving diversity.

Support Transformative Agency in Education

RC2.14: This section addresses valuing the student’s learning-teaching-knowledge-experience and how that can be linked to agency and the student’s ability to take on knowledge and pursue action. This is an important and complicated point. The authors focus this in knowledge production and ways of knowing, picking up similar threads in previous sections. Student agency is more than this though and centring students in their education in a variety of ways is an important tool to improving diversity and inclusivity. Students are not only participants in geoscience education but can be valued co-producers and collaborators. The authors touched

on this in the section on reading lists, but this could be taken further here. By giving agency to students, we can together build curricular that is more inclusive to their needs e.g. as explored in Curtin & Sarju 2021 and refs therein; Cook-Sather & Agu, 2013 etc.

Response: As mentioned in RC2.10, we will expand this section further to consider additional ways educators can empower students' transformative agency. Thank you for bringing this to our attention and we will include further discussion about how this can be done, such that it is explicit in our work, not just our reading lists.

CC1, CC2 (same author)

Thank you for taking the time to read this manuscript, and for providing helpful and specific feedback for how to improve this work. Below we have responded to all your comments and indicated how we will change the manuscript (which for ease of use we have written in blue text) as a result of these suggestions.

CC1.1: Thank you for this clean and structured collection of different domains within the field of geosciences where diversity is not only neglected but often actively suppressed. I like that you provide concrete opportunities to promote change.

Response: Thank you for your comment, we wanted to explicitly discuss how this is a point of active oppression and exclusion (even if it is not intentional). We believe that making this explicit and recognizing this is imperative for educators to work towards diversifying the geosciences.

CC1.2: Another aspect which might play a role here could be critical cartography. Especially geosciences deal with phenomena which have a spatial component which is often communicated and via maps, but many maps are still based on principles of the last century. This includes the selection of a suitable map projection (especially global maps tend to underlie a strong colonial notion) , the non-inclusive process of mapping (who creates the maps and who is being mapped), or also the selection of symbology and colors. Especially educators can foster transition towards more diversity-oriented maps, and thereby contribute to a more inclusive way of presenting, teaching and communicating science.

Response: This is an excellent point and when we are talking about references that are biased and diversifying resources, we will make sure to include maps. This is an excellent point that those in power develop maps that can in turn ostracize and exclude others.

CC2.1 (author of CC1): Sorry, I forgot to add two resources which deal with the role of maps in terms of diversity and might be relevant in this regard:

- Perkins, C. (2017). Critical cartography. In The Routledge Handbook of mapping and cartography (pp. 80-89). Routledge.
- Basu, S., Kirby, P., & Shepherd, L. J. (2020). Women, Peace and Security: a critical cartography. New Directions in Women, Peace and Security, 1-25.

Response: We thank the reviewer for their inclusion of these references for us to review. We added the book chapter by Perkins because of its more general discussion of critical cartography, which will have the broadest applicability to our intended audience.

CC3

Thank you for taking the time to read this manuscript, and for providing helpful and specific feedback for how to improve this work. Below we have responded to all your comments and indicated how we will change the manuscript (which for ease of use we have written in blue text) as a result of these suggestions.

CC3.1: The expectation that English is the language of academic writing has the potential to both ignore or simplify the range of knowledge held by those who do not or cannot speak or write in English and can also undermine the depth of knowledge contained within a local language. Allowing greater use of names and concepts held by local language speakers brings critical information into the academic sphere without recourse to sometimes unwieldy translations.

For example: studies by my organisation worked with indigenous peoples to understand the symbiotic ecological relationship between two fish species. Kallunthi when literally translated means 'stone turner' in the tongue of the Kuruma people of northern Kerala. However, contained within that name is an understanding that the fish is turning stones to clean them for later spawning by the hump-backed mahseer. Kallunthi does not simply mean 'stone turner', it also means 'fish that turns and cleans stones for our God fish to use for breeding during a different season'.

By allowing greater use of local or regional languages and making the effort to understand the broader concepts a simple translation may ignore, we help to enrich the whole process of academic writing.

Response: We thank the reviewer for their discussion of the importance of work and research in all languages. We have included a discussion about barriers stemming from language, as well as the complexity of language and how words cannot easily be translated. We will certainly cite the Helsinki Initiative on Multilingualism in Scholarly Communication (<https://www.helsinki-initiative.org/>) as a justification and guide for working in all languages (as well as not translating phrases that cannot be directly translated, but including discussion and context) to improve diversity.