Rapid Evidence Review:

Outreach and public engagement interventions to increase ethnic diversity in geography and environmental science pathways

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This review brings together the available evidence on outreach and public engagement activities, which aim to increase ethnic diversity in geography and environmental science pathways. Through summarising literature, reviewing existing frameworks and practices, we identify routes that that can be used by university outreach and public engagement teams to improve ethnic diversity in school and University pathways.

Introduction

CONTEXT

This rapid evidence review was conducted as part of the ONE Planet Diversity Project, a collaborative project between Newcastle University and Northumbria University funded by the National Environment Research Council (NERC) under the Diversifying the Talent Pipeline call.

The 'ONE Planet Outreach Network' aims to address the low engagement of minoritized ethnic groups across the North East of England in the natural and environmental sciences, by:

1. Mapping and critically evaluating current outreach initiatives (Workstream 1),
2. Strategically developing a framework for effective co-ordinated outreach delivery (Workstream 2), and
3. Piloting the delivery of an outreach programme that challenges the perceptions of Higher Education and career opportunities within the natural and environmental sciences (Workstream 3).

This review was conducted to support workstreams 1 and 2. It critically evaluates current outreach activities from outside the partner institutions in terms of engagement with diversity, equity and inclusion (DEI) practices and uses learning and recommendations to develop a framework for effective outreach delivery.

WIDER CONTEXT

Data from UK national funding bodies highlights a clear under-representation of students from ethnic minority backgrounds in undergraduate, masters and doctoral programs[1].

Black, Asian and minority ethnic students studying Geography and Environmental Science (GES) subjects in the UK may experience isolation in their learning environments, as they may be the only students of colour in their department and lack access to visible role models[2]. Non-white students are more likely to perceive their department environment as being less tolerant, equitable and diverse, and less likely to perceive their working environments favourably[3].

There are many ways that University departments could, and do, support diversity. Outreach has been named as an important and valuable route for Universities to increase diversity in their qualification pathways[4]. However, increasing diversity will require efforts across multiple dimensions, and cannot be detached from the historical and structural, psychological and behavioural dimensions.[5]

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[1] Dowey, N., Lawrence, A., Raji, M., Jackson, C., Williams, R., Fernando, B., ... & Souch, C. (2024). The Equator Project Research School and Mentoring Network: evaluated interventions to improve equity in geoscience research. Earth Science, Systems and Society, 4, 10123.
[2] As above.
[3] Solem, M., Lee, J., & Schlemper, B. (2009). Departmental climate and student experiences in graduate geography programs. *Research in Higher Education*, *50*, 268-292.
[4] Bloemendaal *et al*., 2020, Raising Our Voices for Diversity in Geosciences
[5] Schlemper, M. B., & Monk, J. (2011). Discourses on 'diversity': Perspectives from graduate programs in geography in the United States. *Journal of Geography in Higher Education*, *35*(01), 23-46.

ABOUT THIS REVIEW

This evidence review provides a narrative review of the relevant quality studies in this field. It focuses on 3 key research questions:

1. What are the characteristics of outreach and public engagement aimed at increasing representation of Black and Minority Ethnic people in geography and environmental courses?
2. What existing theories and frameworks support the design of outreach to increase ethnic diversity in geography and environmental science pathways?
3. What learning comes from outreach or public engagement initiatives aimed at increasing participation from non-white pupils in geography and environmental science pathways?

The studies included in the review represent the best of relevant studies in this area. They are commonly reports of outreach projects, or reflections on delivery of outreach and progression projects, which sometimes include evaluation data.

However, the studies included are small-scale (sample sizes: 27-320), without the rigorous evaluation of outreach activities against intended outcomes that is needed to determine effectiveness. Initiatives used multiple approaches, with a variety of audiences, and considered different outcomes of importance, which means that comparison of findings based on outcomes hasn't been possible (Appendix 2).

Some studies reported lessons learned from initiatives, but did not always include details of initiatives themselves, such as sample size and duration of initiative. Insights however can be gleaned from lessons learnt in these projects, and from the theories and models that support them.

The report therefore contains learning to inform the development of new outreach initiatives, rather than recommend a specific outreach approach. The review of studies, the frameworks, models and theories used in them, and the learning from them is presented against the three research questions above, and a summary of key findings are presented at the end of the report. The references can be followed to read the papers in full (Appendix 2).

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Summary of Key Findings

1. The lack of diversity in Geography and Environmental Science is a 'wicked problem[6]' and cannot be detached from systemic and historical factors.

Outreach is often cited as a useful approach to support participation in Geography and Environmental Science. However, increasing diversity will require efforts across multiple dimensions, and cannot be detached from the historical and structural, psychological and behavioural factors. Outreach on its own cannot hope to address the lack of diversity.

2. There is no clear evidence of what works to improve DEI through outreach.

The lack of studies concerning outreach and DEI is concerning given this is a widely acknowledged and reported challenge. Evaluation of outreach activities is rarely reported at all, and even more rarely with rigour.

The lack of studies looking at outreach with children is problematic, given it is a commonly used activity to support diversity in geography and environmental science. The three outreach studies showcased use a variety of different approaches, indicating there is not a common model in use.

Activities to support progression commonly use similar methods, such as mentorship, and research schools. Evaluation here is more rigorous, with some evidence of success.

3. Individuals are undertaking outreach and public engagement activities, but this isn't coordinated or joined up.

Outreach is often undertaken by individuals with a passion or a vested interest. When outreach is not included in an individual's planned workload this can unduly impact on those involved.

The studies provide evidence that some institutions, and sector bodies are taking a co-ordinated and strategic approach to tackling under-representation in geography and environmental sciences, beyond the work of individuals. In these instances, wider groups of people are coming together to work on address these broad challenges, taking part in activities such as collecting data, mapping activities, establishing working groups and making action plans.

[6] Rittel, H.W. and Webber, M.M., 1973. Dilemmas in a general theory of planning. *Policy sciences*, *4*(2), pp.155-169.

Summary of Recommendations

OUTREACH DESIGN AND DELIVERY

Theme	Recommendations
Use mentors wisely	Think carefully about mentoring activities and who is chosen to be mentors. Ensure they have the resource to support mentees appropriately.
Work with key influencers	Consider extending outreach activities to include engagement of parents, families or teachers.
It doesn't always have to be about feeding the academic pipeline	Consider outreach activities that support children to develop meaningful connections based on their own interests and experiences.
You can't solve a diversity problem without involving people from ethnic minorities	Include voices or perspectives of ethnic minorities in outreach or program design. Deliver outreach in spaces used by ethnic minority communities, this could be through youth groups, religious groups, as well as schools.
Avoid deficit thinking	Avoid mindsets and language which makes minority students responsible for the under-representation problem.

INSTITUTIONAL SUPPORT FOR OUTREACH

Theme	Recommendations
Recognise and reward time invested in outreach	Minoritised individuals (including participants for longer-term commitments) should be compensated for their time and labour when doing DEI work.
Acknowledge building institutional knowledge for outreach takes time and effort	Provide institutional investment and support e.g. a paid position, to sustain partnerships with schools and communities and to ensure institutional knowledge is retained. Institutions should support academics to build outreach to marginalized groups into the "broader impacts" components of their research and grant applications.
Avoid deficit thinking	Look to understand the wider structural and historical barriers to participation for minority students.
Outreach doesn't always have to be about feeding the academic pipeline	Consider outreach for the investment in individuals, rather than always as a route to addressing pipeline challenges.

Methodology

Database search

Three databases were searched for relevant papers (ERIC, Scopus, Web of Science). Additional searches were conducted using Google Scholar and by following the references and citations of the included studies.

Inclusion criteria

To be included in the review, papers must:

- Present frameworks, models or theories for outreach or intervention findings
- Include recommendations or a call to action
- Have a specific focus on ethnic diversity or conduct differential analyses by ethnic diversity categories
- Have a specific focus on geography and environmental science, rather than Science Technology, Engineering or Maths (as STEM more generally) or University outreach more generally

The review also sought to include papers from the perspectives of non-white authors within the review.

Screening strategy

A total of 44 papers were identified through an initial search. The titles and abstracts were screened, and irrelevant or duplicates were removed. The remaining papers were read in their entirety, and those that failed to meet the inclusion criteria and/or met the exclusion criteria or were of poor quality were excluded. Additional relevant studies were discovered by searching the references and citations of the selected papers, leading to a final review of 8 papers. Appendix A contains full details of the screening strategy.

The number of papers in the review is low. Many papers were excluded as they were opinion pieces, covered school or undergraduate teaching more generally, or were focused on professional-development and practices of teachers or environmental organisations.

Synthesis of key findings

The final papers were read to extract information about the delivery, evaluation, frameworks, and recommendations from each initiative. This data was summarised in a table to facilitate comparison of the interventions and outcomes.

Reporting findings

Studies were grouped into themes based on the age of audience and the delivery methods of the initiatives. The key learnings and recommendations were distilled and extracted to help those planning and delivering similar approaches. Some insights are drawn directly from the conclusions and recommendations of the reviewed papers, while others reflect learning from across the studies. The findings are presented in reference to the three research questions. At the end of the report, a summary of key findings is presented.

Research Question 1

What are the characteristics of outreach and PE aimed at increasing representation of BME in participation of geography and environmental courses among BME?

CHARACTERISTICS OF INCLUDED STUDIES

The majority of the published literature on outreach initiatives for geography and environmental science come from the USA (8), with the remaining coming from the UK (2). In the US outreach and public engagements were funded by the National Science Foundation (3), Association of American Geographers (1) or University funded (2). In the UK the outreach and public engagements project were funded by NERC (2).

Outreach covered audiences across the Geography and Environmental Science pipeline, with a wide variety of different types of outreach initiative including short-term outreach to longer-term partnerships.

Context	Count
Pupils	3
Undergraduates	3
College students	1
Other	1

Context	Count
Outreach	2
Intensive research programme	2
Curriculum collaboration	1
Summer school	1
Internship	1

Outreach and PE with children and young people

Three of the studies present initiatives aimed at children of school age. Two are traditional outreach in primary or secondary school environment, and one in a youth work setting.

- Climate Explorers (Adamson et al., 2021)
  A schools outreach programme in primary schools (9-12) aimed at maximising available time of academics and school children, by using co-production philosophies and storytelling components to increase engagement.
- Nature Kids Jovenes de Naturaleza (Byle, 2022)
  An informal education programme that encourages Latino children (11-18) and their families to connect with the outdoors, including environmental career exploration. The study tests two novel frameworks (Stewardship Identity through Dimensions of Nature Connection, and Head, Heart, Hands and Feet Framework for Teaching to the Whole Child) for designing and assessing culturally responsive learning opportunities.
- Geosciences camp (Cisneros and Guhlincozzi, 2023)
  Two Latina PhD students describe the challenges they experience within the University to establish a Geosciences camp for secondary school children (11-13).

Supporting Undergrad Progression

Three of the initiatives were programmes aimed at supporting undergraduate progression. A variety of different initiatives were introduced including via research schools, mentoring, and developing co-designed teaching.

- Equator Project Research School and Mentoring Network (Dowey *et al*., 2024)
  A six-month NERC-funded project that developed three evidence-based interventions targeting different barriers to racial and ethnic diversity in GEES research: a doctoral training working group, a ring-fenced research school for ethnic minority undergrads, masters and doctoral students, and a targeted mentoring network pairing students with mentors from both industry and academia.
- Interdisciplinary Graduate Education (Denham *et al.*, 2021)
  An interdisciplinary undergraduate course at Portland State University that provided space for graduate students to build their interdisciplinary teaching and pedagogical capacities by co-designing an interdisciplinary curriculum. Using methods of translational and action research, the authors developed a pedagogical praxis in a co-facilitated course, via reflection on their own training in an interdisciplinary program to address today's most pressing socio-ecological challenges.
- NSF Research Experiences for Undergraduates (Blake *et al.*, 2013)
  The program is composed of three primary components: Structured Learning Environments: Preparation and Mentorship, Student Support and
  Safety Nets, and Vision and Impetus for Advancement. Firstly, undergraduates are embedded within a research team to learn research skills, then a structured holistic learning environment is provided. Lastly students are guided to look at geoscience in a wider context, including related jobs.

Partnership Programmes

One study looked at partnerships between two-year colleges and Universities in the US.

- Integrated Geoscience Research, Coursework and Outreach Internship Programme (Stofer *et al*., 2021)
  A three-way partnership between a two-year college, a 4-year comprehensive research-intensive University, and an informal science learning institution. Two-year or community colleges are public, open-access post-secondary institutions that have a dual mission to prepare students for the workforce and provide an alternative pathway to enrolment at a 4-year university. They commonly serve groups under-represented in GEES, who face additional barriers such as work, caring responsibilities, geographic and financial constraints. A year-long programme offered a cohort of under-represented students in GEES from a two-year college exposure to mentoring, internships, undergraduate research experiences, and cohort-building.

Institutional/Sector-wide Efforts

One study looked at how institutions and departments could support DEI participation as a coordinated and joined up effort.

- Action Strategy for Geography Departments as agents of change (Darden *et al*., 2006)
  An action strategy by the American Association of Geographers Council to enhance diversity of the most underrepresented groups in geography by using departments as Agents of Change. The Task Force surveys diversity and action to support diversity across geography departments. It has identified 10 'doable' actions of departments that would

result in progress towards enhancing diversity in school, undergraduate, graduate and faculties, which includes outreach.

ACTIVITIES UNDERTAKEN IN OUTREACH AND PROGRESSION

Activity Type	Description	Studies Using Activity
Working Group	Establishing a working group focused on identifying and removing barriers to diversity that exist within University structures.	(Dowey *et al.*, 2024) (Denham *et al.*, 2006)
Research School	Providing outlets for students to showcase their work and to participate in the wider community of scholars. Invited guests and speakers. Can create access to broader community networks, and safe networking space for participants.	(Blake *et al.*, 2013) (Dowey *et al.*, 2024) (Stofer *et al.*, 2021)
Mentorship	Matching students with a mentor. Some programmes matched based on shared lived experiences. Value found in increasing a sense of belonging and inclusion, increased likelihood of retention into research, and the development of a body of experienced mentors to support future students.	(Blake *et al.*, 2013) (Dowey *et al.*, 2024) (Denham *et al.*, 2006)
Role-models	Ethnic minority students and staff become role-models used in outreach and progression activities.	(Darden *et al.*, 2006) (Cisneros and Guhlincozzi, 2023)
Career Planning	HEIs offer career-focused activities that help to inspire students to see themselves as part of the future STEM workforce.	(Blake *et al.*, 2013) (Dowey *et al.*, 2024)
Summer Internships	Paid internships were offered to students in the summer before they begin studies.	(Stofer *et al.*, 2021)
Co-collaborating teaching	A model for encouraging progression by exposure to, and co-collaboration, in teaching practice. The course presented an opportunity for four graduate students to co-learn how to facilitate and create an interdisciplinary course grounded in social and environmental justice.	(Denham *et al.*, 2021)

Research Question 2

What existing theories and frameworks support the design of outreach to increase ethnic diversity in geography and environmental science pathways?

THEORIES FOR OUTREACH AND ENGAGEMENT DESIGN

This section considers the guiding theories that support the organisation and design of outreach and engagement, and for activities that support progression.

Head, Heart, Hands and Feet (Byle, 2022)

Byle is interested in developing environmental identity, that is the interest, agency, and motivation for participating in environmental stewardship as a citizen, scholar, and/or professional. Byle argues there should be multiple avenues for experiencing the various dimensions of personal nature connection.

Head, Heart, Hands and Feet (HHFH) is a framework for designing and assessing culturally responsive learning opportunities. It is derived from work with indigenous communities in the US to counter western narratives of how learning takes place. Greater opportunities for learning can be afforded by teaching to the whole child through this HHFH approach. Teaching aims to be holistic and more inclusive by involving the head (subject literacy), the heart (social-emotional learning), the hands (service learning), and the feet (place-based learning). However, it can be difficult to create activities that teach the whole child at once, and so different activities may address different elements at different times.

What?	Description
Head (academic skills and knowledge)	Students develop skills to investigate and think critically about concepts rooted in academic standards. Students develop the literacy to engage in topics.
Heart (social emotional learning)	Represents social-emotional learning, affective needs, sensitivity, attitudes, and self-efficacy. Students develop a sense of belonging to both their local, immediate communities and the larger global community as they progress through their learning
Feet (place-based)	The process of using the local community as a starting point to teach subjects across the curriculum, emphasising hands-on, real-world experience.
Hands (action and service-learning)	Students gain their civic voice through the development of a positive sense of self and the power of their contributions to serving communities.

Funds of Knowledge (Byle, 2022)

Byle also uses the theory of Funds of Knowledge - culturally developed bodies of knowledge - as a guide for developing outreach to support DEI. Funds of knowledge challenges deficit thinking, by viewing individuals are competent and carriers of knowledge that has been gained through their life experiences. Recognising and honouring these funds of knowledge, and understanding which cultural dimensions are salient to specific communities and individuals will offer guidance for designing

programmes that are culturally responsive. For example, traditional knowledge systems have been said to use a holistic approach that does not separate observations into different disciplines as Western science does, and non-western systems do not interpret reality based solely on a linear conception of cause and effect, but through a lens of constantly evolving multidimensional cycles where all of the elements are part of a complex web of interactions. Byle argues that education must be designed to perpetuate and enrich the culture of the people you are working alongside and to equip them with the tools to become functional participants in society.

THEORY TO SUPPORT PROGRESSION ACTIVITIES

Tinto's theory of STEM persistence (Stofer *et al.*, 2021)

Tinto's (1993) model of student attrition seeks to explain understanding degree attainment and persistence at the undergraduate level. It suggests that students enter college with a set of background experiences that influence their initial commitments to the institution, that will shape the extent to which individuals become socially and academically integrated within the college environment. Students who have successful academic and social integration experiences make deeper commitments to the institution and are more likely to persist, whereas those who have negative academic and social integration experiences do not become committed to the institution and are less likely to persist. Academic integration is characterized by experiences such as interacting with faculty, academic administrators, and peers on academic-related tasks that ultimately lead to intellectual development and a strong connection to the institution. Social integration is characterized by engaging in social aspects of the environment that also leads to developing a connection with the institution. Such experiences include involvement in campus organizations and interacting socially with peers and faculty.

Students, particularly under-represented minorities and non-traditional students, leave college when they do not feel fully integrated into an academic or campus community. Stofer argues student engagement opportunities are vital to integrate students into an academic or campus community (2021).

THEORY TO SUPPORT INSTITUTIONAL ORGANISATION OF OUTREACH

Disinvestment (Cisneros and Guhlincozzi; 2023)

Disinvestment is a term for the lack of interest within a University environment for DEI initiatives. This has led to historically marginalised scholars taking on the bulk of outreach work at the expense of furthering their research and career progression.

Two Latina PhD students theorise the challenges encountered in establishing a summer camp in a Geoscience camp for children (11-13) in a University disinterested in DEI: into detours, road blocks and alternative routes.

Barriers faced in outreach are exemplified in situations where disinterest and disinvestment is experienced, i.e. institutional support, lack of access to campus and tech resources, recruitment routes. In alternative routes, the authors utilise community provided resources rather than University resources, to make summer camp viable.

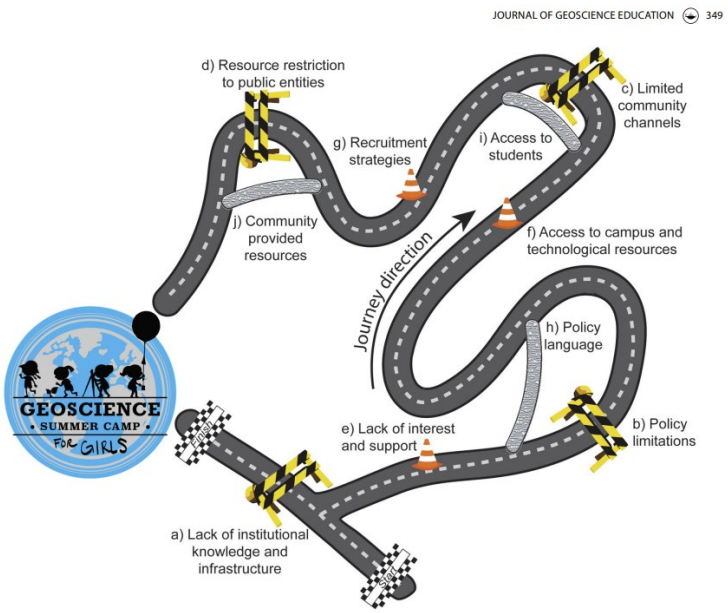


Fig. 1: A schematic detailing the journey of building the geoscience camp for middle school girls, highlighting roadblocks (a-d), detours (e-g), and alternative routes (h-j). (Cisneros and Guhlincozzi; 2023)

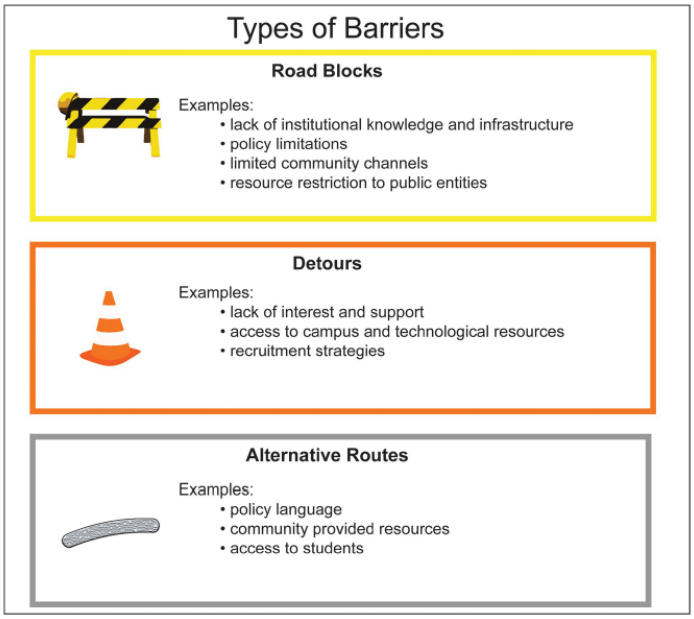


Fig. 2: The suggested typology of barriers. Examples of barrier types with the coinciding barrier icon including roadblocks, detours, and alternative routes (Cisneros and Guhlincozzi; 2023)

FRAMEWORK TO SUPPORT OUTREACH AND ENGAGEMENT DESIGN

This section outlines frameworks used to support the organisation and design of outreach, and progression activities.

Four Ingredients for Successful Communication (Adamson *et al.*, 2021).

Adamson and colleagues introduce four key ingredients for maximising the outcomes of academic outreach through the use of engaging techniques for communication. Developed models for outreach design draw on co-production philosophies and storytelling components: narrative arcs, lenses, interests and narrative hooks, and phrases and terminology. These are intended the complement and extend the existing curricula and be applicable to others delivering outreach activities.

The projects' series of best-practice templates are designed to be flexible for different topics and outreach scenarios, including both face to face and virtual interactions, while taking account of the time pressures and logistical considerations involved in science–school interactions.

The project includes models for different length engagements and what they could look like, in different contexts and environments.

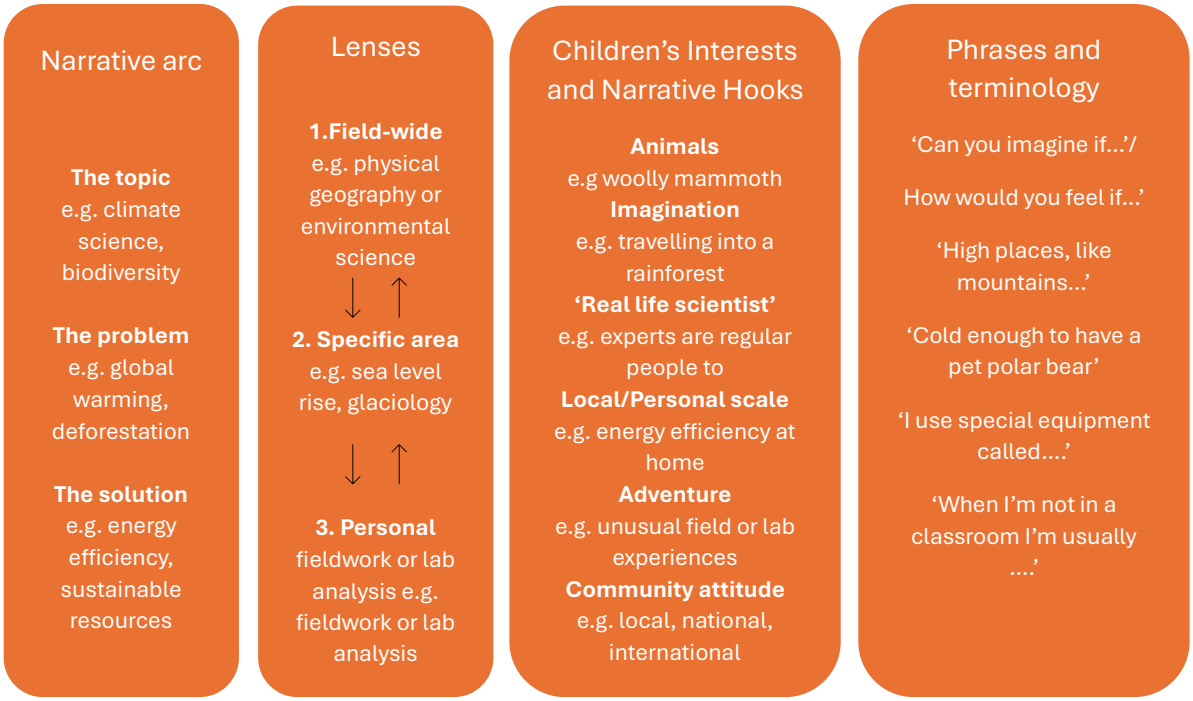


Fig. 3: Recreation of image. A 'recipe' of narrative and co-production elements in physical geography science communication identified across the Climate Explorers schools' workshops. Elements can be combined and edited as appropriate to tailor communication strategies to the audience (Adamson et al., 2021).

FRAMEWORK TO SUPPORT PROGRESSION ACTIVITIES

This section outlines framework used to support progression from school and through University study.

The Shrinking Diverse Pool (Darden *et al.*, 2006)

The Association of American Geographers Diversity Task Force reviewed the state of diversity in American geography departments and existing efforts to enhance diversity. Surveys of geography departments indicate the severe under-representation of racial and ethnic minorities in their faculty and student populations. The study offers a framework that identifies different opportunities for departments to intervene to support progression at each entrance point.

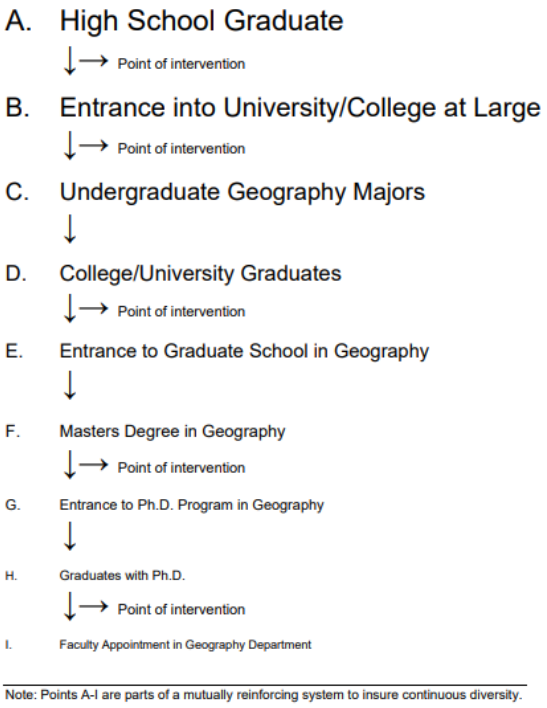


Fig. 4: The Diversity Challenge: The Shrinking Diverse, Opportunities to Intervene to Support Progression (Darden et al., 2006)

FRAMEWORK FOR INSTITUTIONAL ORGANISATION FOR OUTREACH

This section offers a framework used to consider the spectrum of institutional actions to address inequity.

Potential Actions to Improve Equity in Geoscience (Dowey *et al.*, 2024)

This NERC funded project identifies a number of possible actions that could be undertaken to improve equity in geosciences.

The Equator project developed a Theory of Change, and a programme of three evidence-based interventions to address different barrier to racial and ethnic diversity in GEES research.

Fig. 5: Potential actions to improve equity in geoscience (Dowey et al., 2024).

Research Question 3

What learning comes from outreach or public engagement initiatives aimed at increasing participation from non-white pupils in geography and environmental science pathways?

This section identifies themes which support increased participation that have been found in two or more of the studies reviewed. Evidence from these studies is used to generate recommendations for outreach and public engagement initiatives.

Recognise and reward time invested in outreach

Partnerships with communities serving high numbers of ethnic minority students must be established and maintained for outreach to work well. Reaching under-represented groups cannot be done from a standing start, contacts need to be found and partnerships built and maintained (Cisneros and Guhlincozzi; 2023). Outreach can be difficult and time-consuming to conduct. Where EDI is not a primary commitment of the University, individual's time is spent at the expense of advancing their careers.

Adamson and colleagues (2021) acknowledge the challenges for University outreach in schools, where outreach generally takes place in already busy school curricula and typically only lasts one class period. By thinking about outreach design well in advance and working out key messages, the available time can be used effectively to maximise outcomes for students and teachers.

Dowey *et al*., (2014) and Stofer *et al*., (2021) pay participants for their time and expenses taking part in outreach activities, as this is time taken away from work or study.

- ✓ RECOMMENDATION: Minoritised individuals (including participants for longer-term commitments) should be compensated for their time and labour when doing DEI work.

Work with key influencers

One important factor in thinking about participation of ethnic minority students is parents and families. According to Cisneros and Guhlincozzi (2023) and Darden and colleagues (2006) parents of ethnic minority students will need more convincing that geography degrees can provide financially rewarding careers. There may be an increased sense of anxiety because they worry their children may face cultural challenges in their careers.

Byle (2022) suggests that intergenerational learning between families aids in having a shared vocabulary to discuss the topic. When children teach parents and communities environmental science topics that they have learnt they can inspire older generations.

- ✓ RECOMMENDATION: Consider extending outreach activities to include engagement of parents, families or teachers.

Use mentors wisely

Mentoring is a popular activity for supporting the development of identity and inclusion (Denham *et al.*, 2006). Feedback from the Equator project identified the importance of having role models with shared lived experiences (Dowey *et al.*, 2024). However, mentoring is not without challenges. Stofer and colleagues describe challenges in creating authentic mentoring matches, and that participants often felt their mentors were disinterested, "*the researchers were more interested in their research and giving us the task and getting it done and did not really connect with us beyond this*".

- ✓ RECOMMENDATION: Think carefully about mentoring activities and who is chosen to be mentors. Ensure they have the resource to support mentees appropriately.

Acknowledge building institutional knowledge for outreach takes time and effort

There is currently a lack of institutional knowledge about how to engage more ethnically diverse students in geography and environmental science. When outreach is undertaken by individuals, knowledge gained can be lost when individuals leave (Cisneros and Guhlincozzi, 2023).

Improving participation cannot happen with rushed efforts that aren't joined up or are well thought through (Dowey *et al*., 2024). Time and space for conducting EDI efforts needs to be dedicated and preserved (Cisneros and Guhlincozzi, 2023). Time is needed to build trust with stakeholder communities before embarking on project work (Dowey *et al*., 2024).

- ✓ RECOMMENDATION: Provide institutional investment and support e.g. a paid position, to sustain partnerships with schools and communities and to ensure institutional knowledge is retained.
- ✓ RECOMMENDATION: Institutions should support academics to build outreach to marginalized groups into the "broader impacts" components of their research and grant applications.

You can't solve a diversity problem without involving people from ethnic minorities

Dowey and colleagues (2024) argue that having conversations and co-creating with those with lived experiences of the barriers being addressed is crucial for designing interventions that create meaningful change. This is because responsive education cannot progress smoothly unless its foundation is laid from the cultural perspectives of the group of people for whom it is designed (Byle, 2022). Authentic collaboration with communities will often involve organisers to step outside of their comfort zone and take risks (Byle, 2022).

Challenges will be faced when this happens from a deficit perspective, and without engaging communities themselves in design (Stofer *et al*., 2021). When creating events and opportunities it is important to think about who is invited to be the speakers and

leaders of an event because they are important for creating a sense of belonging (Dowey *et al*., 2024). Outreach design should collaborate with departments and programmes serving high numbers of ethnic minorities (Denham *et al*., 2006).

Delivering in partnerships with organisations and groups that serve ethnic minority communities can also aid University outreach in reaching the right people, forging contacts and supporting with communication strategies (Cisneros and Guhlincozzi, 2023).

- ✓ RECOMMENDATION: Include voices or perspectives of ethnic minorities in outreach or program design.
- ✓ RECOMMENDATION: Deliver outreach in spaces used by ethnic minority communities, this could be through youth groups, religious groups, as well as schools.

Avoid deficit thinking

Some of the studies reviewed provide examples of departments using deficit thinking when thinking about improving participation. Deficit thinking is the idea that students, particularly those from low-income or racial/ethnic minority backgrounds, don't progress because of internal deficiencies in themselves or their families, such as limited intelligence, lack of motivation, or inadequate home socialization. In Denham *et al*. (2006), department staff felt representation was difficult because of a lack of interest in geography by minority students compared to non-minority students. Meanwhile Stofer *et al*. (2021) reported that ethnic minority students were unable to change their mindsets or build relationships with mentors. Deficit thinking can be a barrier to reducing educational inequalities.

There is value in delivering engagements focused on creating meaningful connections for minority students on their own terms, rather on supporting participation more directly (Byle, 2022).

- ✓ RECOMMENDATION: Avoid language which makes minority students responsible for the under-representation problem
- ✓ RECOMMENDATION: Look to understand the wider structural and historical barriers to participation for minority students

Outreach doesn't always have to be about feeding the academic pipeline

Many Universities view EDI under-representation solely as a pipeline problem. Experiencing geography and environmental education though outreach (Adamson *et al.*, 2021), informal education (Byle, 2022) or through university education (Denham *et al.*, 2021) can be valuable to individuals more broadly. It can support people to develop an emotional connection to the environment (Byle, 2022), to understand and connect to society' socio-ecological challenges (Denham *et al*., 2021), and to create meaningful connections with existing knowledge and experiences, the barriers they face and what needs to change in their environment (Cisneros and Guhlincozzi, 2023; Byle, 2022).

Progression into research careers is not the only valid pathway. Mentees in the Equator project appreciated being given information on non-academic pathways and shown careers away from formal structures of academic where some students may feel less comfortable (Dowey *et al.*, 2024).

- ✓ RECOMMENDATION: Outreach activities do not always need to be focused on feeding the pipeline. Consider outreach activities that support children to develop meaningful connections based on their own interests and experiences.

Appendix 1: Methodology

DATABASE SEARCH

Three databases were searched for relevant papers (ERIC, Scopus, Web of Science). Additional searches were conducted using Google Scholar and by following the references and citations of the studies included.

Inclusion Criteria

To be included in the review, papers must:

- Present frameworks, models or theories for outreach or intervention findings
- Include recommendations or a call to action
- Have a specific focus on ethnic diversity or conduct differential analyses by ethnic diversity categories
- Have a specific focus on geography and environmental science, rather than STEM or University outreach more generally

To review also sought to include papers from the perspectives of non-white people within the review.

Scoping Criteria

Search results were narrowed down based on the following scoping criteria

Scope	
Location	OECD Countries
Language	English
Date	2004 onwards (20 years)
Setting	Formal and informal outreach with school/college settings, University settings
Outcomes	Increased interest, motivation or intention to study geography and environmental science at University level Increased representation or participation in or geography and environmental science past Undergraduate level
Population	Ethnically diverse students (14 +)

Search Terms

The databases were searched using the following search terms

Concept	Search terms used
Intervention	(Outreach OR "public engagement" OR "informal learning" OR Interven* OR Project)
Field	(Geograph* OR "environmental science" OR geoscien*)
Ethnicity	(ethnic* OR inclusi* OR "non-white" OR BME OR BAME)
Outcomes Measured	(participat* OR representat* OR diversi*)
Context	(student* OR pupil* OR degree OR graduate)

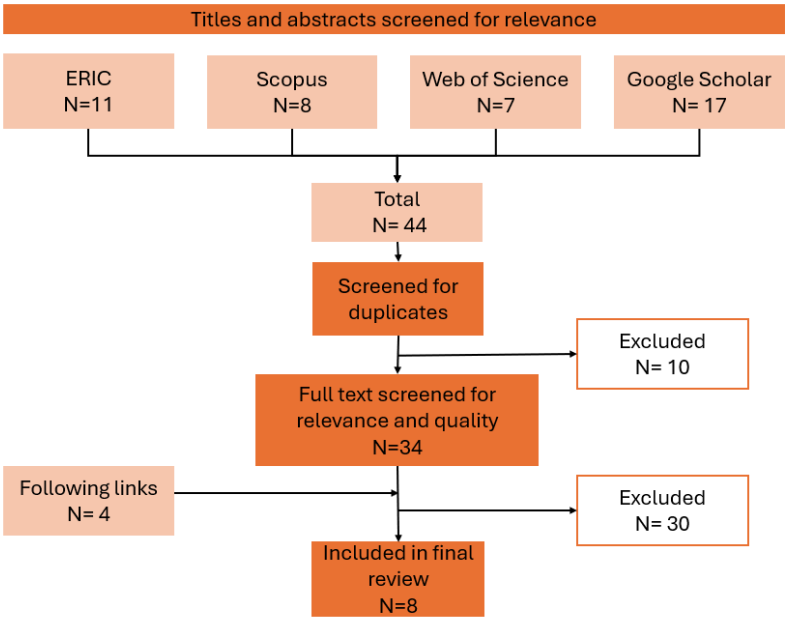
Exclusion Criteria

The following exclusion criteria used to narrow down papers. Papers were excluded if they focused on:

- citizen science with a general public audience
- the teaching geography or environmental science in school
- the diversity strategies of environmental organisations
- the professional development of teachers or environmental organisations
- opinion pieces by interested parties.

SEARCH STRATEGY

The search strategy outlined in the diagram below was used to identify relevant papers and grey literature for the evidence review. After an initial screening of abstracts, papers that did not meet the inclusion criteria were excluded. Further scrutiny of the remaining papers was conducted to ensure they were relevant and of reasonable quality. Finally, the papers that met the inclusion and quality criteria were synthesised and analysed. Papers that did not meet the inclusion or quality criteria or that that met the exclusion criteria were excluded. A summary of all the papers included in the final review can be found in Annex A.



Synthesis of the final papers

Key features of the methodology and evaluation of the outreach or public engagement, and frameworks used were extracted from the final papers, as well as key findings and discussion points. This information was synthesised into a table which allowed the different initiatives and their outcomes to be compared and contrasted. They key learnings from the discussion sections of the paper were summarised to provide insights. These insights are summarised in the 'learnings' throughout the report.

Appendix 2: Papers Reviewed

Authors	Country	Discipline	Delivery Model	Education Phase	Sample	Outcomes Measured	Methods
Stofer and others (2021)	USA	Geoscience	Internship for two-year college students	College students	40	Belonging Perceptions	Interviews
Blake and others (2013)	USA	Geoscience	Research experience for undergrads	Undergrads	47	Participation Research skills	Participation tracking, testimony
Cisneros and Guhlincozzi (2023)	USA	Geoscience	Summer camp	Pupils 11-13	-	Barriers to effective outreach	Personal reflections
Denham and others (2021)	USA	Environmental Science	Co-design course with undergrads	Undergrads	-	Social justice perspective	Reflections
Adamson and others (2021)	UK	Physical Geography	Schools outreach	Pupils 9-12	320	Interest and knowledge	Co-design survey
Dowey and others (2024)	UK	Geoscience	Residential workshop	Undergrads	88	Belonging, knowledge, confidence	Surveys
Byle (2022)	USA	Environmental Science	Informal learning project	Pupils 13-18	27	Hollistic development connection to nature	Interviews Ethnography Worksheets
Darden and others (2006)	USA	Physical Geography	-	Various	-	Various	Review of studies

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