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Towards More Fluid Inclusion: Making Geoscience Undergraduate Degrees a Place of Belonging for All

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Geosciences are central to addressing many of the challenges facing our society and environment today, and geoscience undergraduate degrees can lead to influential and lucrative careers in a range of fields. However, geosciences are one of the least diverse of all STEM subject areas. We present results from a series of workshops held in 2022 focused on understanding the experiences of current or recent undergraduates from under-represented groups on UK geoscience degrees. The workshops focused particularly on the participants' sense of belonging in their degree programmes. Factors that reduced participants' sense of belonging can be broadly grouped into *unfamiliarity of geosciences amongst family and friends*, *lack of representation in the discipline*, *lack of representation among/exclusion by peers*, and *structural barriers*. We present and discuss the recommendations made by participants for strategies to tackle each of these barriers to belonging. These strategies are intended to be practical actions that individual educators can take to enhance belonging in the geosciences.

Keywords: diversity, geoscience, inclusion, belonging, geography, undergraduate, widening participation

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INTRODUCTION

Geosciences, taken here in a broad sense to include geology, geography, environmental science, and disciplines like oceanography and atmospheric science, are central to addressing many of the challenges facing our society and environment today (Scown, 2020; Gill and Smith, 2021). A degree in geosciences can be a gateway to influential and often lucrative careers that shape our physical and social infrastructures and environments (Young People Collective et al., 2021) and future research directions (Gill and Bullough, 2017). Geoscientific questions affect everyone in society, and it is vital that the breadth of our society is represented in addressing these questions. However, geosciences are one of the least diverse of all the natural sciences at all levels from school through to senior professionals (Dowey et al., 2021; Breetzke et al., 2022; Berhe et al., 2022). The exclusion from geoscience of minoritised groups[1] means potential exclusion from opportunities for stimulating and well-paid careers, and from decision-making on issues that

[1]We use the term "minoritised" here to put the onus on the relations of power (e.g., racism, ableism) that make groups become a "minority" within the geosciences. Within our workshops we used the term "under-represented," and in the remainder of this paper we use minoritised and under-represented.

may, in turn, disproportionately affect minoritised groups. In addition to the disadvantages to minoritised groups excluded from geoscience careers, arguably a lack of equity and diversity is a disadvantage to the sector as diversity has been shown to contribute to problem-solving capability, creativity and innovative thinking by bringing together ideas from different life experiences, cultures, expertise, etc. (Hong and Page, 2004; Nathan and Lee, 2013). However, this view risks seeing diversity as a coveted "commodity" rather than a just end. Beyond "tolerance" or "accommodating" the other, drawing on *ubuntu* philosophy, we argue that diversity is necessary in helping us all become more human: it is only in diversity that we complement our incompleteness (Nyamnjoh, 2017).

Recently, geoscientists have increasingly begun to call for a focus on equity and social justice in the geoscience disciplines. While the experience of women in geoscience has been the subject of a number of studies over several decades (e.g., Holmes and O'Connel, 2003; St. John et al., 2016; Hernandez et al., 2020), in the last few years race and ethnicity in the geosciences have come into sharper focus. Recent studies have highlighted the fact that geosciences are the least ethnically diverse of the natural science disciplines in countries such as the US, the UK, Canada, and even South Africa, where only 7.3% of the population is white (e.g., Wilson, 2018; King et al., 2018; Marín-Spiotta et al., 2020; Dowey et al., 2021; Breetzke et al., 2022), with little progress despite years of intervention (Bernard and Cooperdock, 2018). Much of this literature focuses on the situation in the US, although there are several recent exceptions (e.g., King et al., 2018; Dowey et al., 2021; Breetzke et al., 2022). A smaller number of studies focus on sexuality and gender identity (e.g., Le Bras, 2021; Downen and Olcott, 2022; Kamran and Jennings, 2023) or disability[2] (Carabajal et al., 2017; Mol and Atchison, 2019; Stokes et al., 2019; Kingsbury et al., 2020), and statistics on these groups are less readily available, leading Núñez et al. (2020) to call for increased attention to these axes of oppression and to intersectionality in geosciences. We are not aware of any studies focusing on the socioeconomic background of geoscientists specifically. However, a recent study found that first-generation university students are heavily under-represented in geoscience degrees at US institutions (Carrera et al., 2023). While bodies such as the US National Science Foundation have been calling attention to the issue of (particularly) gender and race in geosciences for some time (e.g., Posselt et al., 2019; Marín-Spiotta et al., 2020), explicit self-reflection on practices and attitudes has become much more widespread among disciplinary bodies in recent times, and especially since the events of 2020 (e.g., Fernandes et al., 2020; Behl et al., 2021; Lloyd et al., 2023).

Undergraduate degrees are a key step in training geoscience professionals. For many students, undergraduate degrees are the first experience of geosciences, such as geology or meteorology, that are rarely taught in schools. The importance of undergraduate degrees as a stepping stone into the profession was highlighted by Holmes and O'Connel (2003), who found that positive undergraduate experiences were one of the three "attractors" which led people into geoscience professions (including postgraduate studies). Similarly, Riggs et al. (2018) call for increased attention to the lived experiences of under-represented students in undergraduate geosciences.

In this paper we centre lived experiences and recommendations shared by UK undergraduates in the geosciences who identified as coming from "under-represented" groups. For the purposes of this project we had an open definition of "under-represented" groups, including but not limited to: Black, Asian and minoritised ethnicity backgrounds[3]; LGBTQIA+; disabled students; first in family to go to university; those from low-income households; in care or a care leaver; and "non-traditional" and international students.[4] 34 students attended one of three workshops as part of the Geoscience Access, Inclusion and Attainment project (GAIA), funded by the Natural Environment Research Council, which ran for 7 months in 2021–22. The project aimed to investigate both the question of perception of geoscience among under-represented groups and the barriers to a sense of belonging that members of these groups encounter before, during and after embarking on geoscience undergraduate degrees. In addition, the participants were asked to provide practical recommendations for improvement that could be implemented by individual geoscience lecturers.

[2]Disability is in itself a complicated category, given the wide range of different ways different disabilities may affect individual experiences. See Atchison and Libarkin (2016) for a consideration of the different perceptions of various disabilities among geoscience professionals.

[3]This category has historically been used by the UK government to group a range of ethnic minorities. As of 2022, the UK government discontinued its use of this term; however, it was still current at the time of our workshop planning, and we considered it was likely to be familiar to potential workshop participants. In terms of the UK 2021 census categories, we consider all ethnic groups other than White British, White Irish and White Other to fall under the umbrella of "minoritised ethnicities." This includes two groups considered by the census to be White, i.e., Roma and White gypsy or Irish Traveller. Census categories and a demographic breakdown of the UK population by ethnic groups can be found at https://www.ethnicity-facts-figures.service.gov.uk/uk-population-by-ethnicity/demographics/age-groups/latest/ (accessed July 2024).

[4]Although women are still under-represented at higher levels in geoscience, there has been significant progress on increasing the proportion of women taking geoscience at undergraduate level in the UK, with women outnumbering men in the HESA subject group Geography, Earth and Environmental studies (natural sciences) in the academic years 2019/2020 to 2021/2022 (https://www.hesa.ac.uk/news/19-01-2023/sb265-higher-education-student-statistics/subjects) and so for the purposes of this project we did not include women as an under-represented group. Non-binary students are included under the LGBTQIA+ heading.

BACKGROUND

"Diversity" and "Belonging"

A significant body of literature exists on social justice in higher education (see, for example, McArthur and Ashwin, 2020; Arday and Mirza, 2018; Swartz et al., 2018), and it falls beyond the remit of this paper to provide a comprehensive review. In the UK, such literature has historically been grouped under "widening participation," since many of the policies arose in response to the Robbins Report (Committee on Higher Education, 1963) while elsewhere it has historically been tagged with labels such as transformation[5] (South Africa), or Affirmative Action[6] (United States). Many of these studies were concerned with increasing "diversity" in the HE student body, rather than merely increasing student numbers of "traditional" students (see, for example, the discussion in Burke, 2012). In the context of our study, these "traditional" students would be white, middle class, cis heterosexual students without disabilities, born in the country in which they are studying and home language speakers of the language of instruction. More recently attention has shifted to the experience of "non-traditional" students (Reay et al., 2009), often using a Bourdieusian lens to consider congruence or otherwise of *habitus* between students and institution (see, for example, Thomas, 2002). Student movements such as Why is My Curriculum White (UK), #RhodesMustFall (South Africa and UK), and the broader demands for decolonising the curriculum which have arisen out of these and similar movements reflect a growing dissatisfaction with the increasing mismatch between a curriculum designed for an imagined "traditional" student (usually full-time, not simultaneously employed, white, middle-class, non-disabled, cisgendered heterosexual, domestic, without dependents) and the increasingly divergent student body actually enrolled.

Use of the term "diversity" by higher education institutions has been criticized by feminist and anti-racist scholars for weakening and replacing moves towards social justice and deeper institutional change (Ahmed, 2012). A simple focus on increased representation is not sufficient without an understanding of the barriers to belonging and access that occur both at compulsory education and at undergraduate level. Moreover, increasing diversity through inclusion is itself problematic, since this relies on assimilation of the "other" through retaining a focus on the dominant "imagined student" which paints under-represented groups as needing to "achieve" this norm, and relies on "reasonable accommodations" to help them assimilate (Harrington, 2019). The language of "diversity" can also be a side-step to avoid naming and tackling racism in particular, as well as other, compounding, forms of oppression. While we recognise that significant, sustainable improvement for students, staff and others requires both institutional and structural change, our focus in the project, and thus in this paper, was on what we – as "specific intellectuals"[7] (Foucault, 1980) – could ourselves do or influence to improve the situation. In choosing this approach, we are refusing the easy, "academic" option which analyses and ascribes accountability and responsibility for change elsewhere: while we recognise that we work and live in a capitalist social order, sustained by social structures and processes (such as patriarchy, white supremacy, neocolonialism, etc.) which direct and constrain our thinking and agency, we recognise that even within this hegemony we have spaces for contestation and dissent. Relative to our students we have some power within our contexts, and therefore a responsibility to exercise our agency to bring about positive change where we can. Thus, while this paper does not focus on the level of institutional or structural change, it does go beyond "diversity" as "lip-service" (Ahmed, 2012) or simply as enhancing representation.

As opposed to a "leaky pipeline" metaphor, which simply seeks to boost representation, theorising undergraduate journeys as "chilly climates" (Palid et al., 2023) or a "hostile obstacle course" (Berhe et al., 2022) emphasises the need to foster *belonging* by identifying and mitigating the obstacles in the course (Walton and Cohen, 2007; Huntoon et al., 2015; Berhe et al., 2022). Belonging has been identified as critical to student "retention"[8] and success (Thomas, 2012; Ahn and Davis, 2020), and a growing body of literature unpacks this construct critically (see, e.g., Carruthers Thomas, 2015; Tett et al., 2017; Taylor and Harris-Evans, 2018; Trowler et al., 2019). Like Guyotte et al. (2019: 3), we understand belonging to be "shifting, processual and multi-dimensional," mobile, dynamic, and relational, rather than a binary of "belonging" vs. "not belonging" (Hunt et al., 2023). Our conception of belonging draws on Yuval-Davis's (2006; 2011) notions of belonging as constituting a reciprocal relationship between "emotional attachment . . . feeling 'at home' (invested) and 'feeling safe' (mattering, valued, accepted, included)" (Yuval-Davis, 2006: 197). This conception also invokes the dual elements of "belonging" and "the politics of belonging" (Yuval-Davis, 2006), which concerns the question of who is *seen to have the right* to "belong".

A useful framing to consider the processes encountered by these increasingly divergent students is provided by Avtar Brah's concept of diaspora space, which "brings together the simultaneity of social categories (such as gender, racialisation, sexuality, and social class) in which we are all located ('intersectionality') and of experiences of being

[5]See, for example, Waghid (2003); Naidoo and Ranchod (2018); Reddy (2004); Seepe (2017).

[6]See, for example, Featherman et al. (2009); Ibarra (2001); Baez (2003).

[7]According to Foucault (1980:126), "specific intellectuals . . . (work) within specific sectors, at the precise points where their own conditions of life and work situate them" and derive political importance through complicity in institutional power/knowledge regimes.

[8]"Student retention" is a contentious construct since it centres the institution, with students seen as assets to retain and "student success" equated with graduation. While we prefer terms such as "persistence" which centre the student and their agency, we recognise that for some students success does not equate with graduation, and that "persistence" may be a negative rather than a positive choice in their circumstances.

positioned in location." Here, "diaspora" is conceptualised as "a representational signifier of the ways in which we all live with difference." (Phoenix, 2020: 69). Brah (1996) uses the construct *diaspora space* to denote the space where the *indigene*[9] (in our study context, this would be those geoscience students considered "traditional") encounter the *diaspora* (in our study context, these would be students who differ in some way from those described as indigene – students from marginalised groups in the context of studying geosciences in the UK). In diaspora space, identity and belonging are contested and negotiated, which – with time – can allow for change to who is seen to belong, and how identity is understood. Thus, when students from marginalised/under-represented groups come in to study geosciences and thereby challenge hegemonic perceptions of what a "geoscience student" is like, with contestation, negotiation and time these perceptions will change and students from these marginalised groups will gain a greater sense of belonging. Our focus in this paper is on the experience of contestation and negotiation of these "diaspora" students in the "diaspora space" that is undergraduate geoscience studies.

"Diversity" in Geoscience at School and Undergraduate Level in the UK

Higher Education Statistics Agency data indicate that Geographical and Environmental Studies is one of the least diverse of all subjects surveyed (HESA, 2021). According to HESA statistics BAME[10] students made up 27% of all science undergraduates in the academic year 2019/2020, 28% in 2020/2021 and 29% in 2021/2022. In geography, earth and environmental studies, the corresponding figures are 10.2%, 10.7% and 10.9%. While the proportion of BAME students studying geoscience and related subjects has increased over these 3 years, the gap between the proportion studying geoscience and the proportion studying science overall has widened. (For reference, the overall UK population as at the 2021 Census[11] comprised 81.7% identified as white and 18.3% identified as BAME, while for 18–24 year olds – from which the majority of students are drawn – the proportion identified as BAME was 24%. Students identified as BAME are thus overrepresented in science, but under-represented in geosciences.) For the same years, by contrast, HESA statistics show a somewhat higher proportion of disabled undergraduate students in geoscience compared to the proportion in science as a whole. However, these statistics do not provide any information on the nature of the disabilities experienced by these students.

The lack of diversity in UK geoscience is characteristic from early in the progression from school to the profession (Vidal Rodeiro, 2009; Gill, 2018). Research from Cambridge Assessment (n.d.) indicates that students from "high social class groups" (based on parents' main occupation, as classified by the National Statistics Socio-economic classification) are more likely to study geography at AS and A2 level (age 16–18), and boys are slightly more likely to take Geography at AS level and more likely to persist with it at A2 level. Geography was one of the top 10 most popular AS and A2 subjects chosen by students who identified as "white" but did not feature among popular AS or A2 subjects chosen by students who identified as having minoritised ethnicities. Geography was also a more popular choice among students with higher, or medium, prior (GCSE, age 14–16) attainment, and uptake of the subject was more common in Comprehensive, Grammar and Independent Schools compared to 6th Form or FE/Tertiary colleges.[12] Students were influenced in their subject choice by expectations of interest or enjoyment and by their perception of the usefulness of the subject for careers or further study. While parents were the main source of advice on subject choice for A level students, this was not the most useful advice according to these students, and the amount and usefulness of advice was also mediated by social class and the kind of school/college attended (Cambridge Assessment, n.d.). For example, parents who did not attend university are less able to give their children detailed advice and schools with more resources can provide a more comprehensive careers advice service. Of additional concern, Geography ranked in the bottom 10% of perceived importance to the students who took the subject at A2 level.

Our preliminary research (full results are in progress to be published elsewhere) with students at the University of Huddersfield points towards the disproportionate "whiteness" of Geography (Geography, Physical Geography and Human Geography). At the University of Huddersfield's School of Applied Sciences (SAS) between the academic years 2015/2016 and 2021/2022, 26.42% of students who declared a "race"/ethnicity[13] were white; however, between the academic years 2018/2019 and 2023/2024 89% of students on undergraduate Geography degrees in SAS were white.

The "whiteness" of geography may also be a factor in students of colour not considering geography as a degree choice. In 2021 we surveyed students on the School of Applied Sciences' Science Extended (SED) degree

[9]Brah uses the term to denote those who are seen as the original occupiers of space. This is distinct from the more specific use in certain contexts, e.g., North American settler colonialism, where it is reserved for First Peoples.
[10]We use the term BAME (Black, Asian and Minoritised Ethnicity) here as this is the descriptor used by HESA, although we recognise the fundamental problems with the term. We consider it to be a "chaotic conception" and elsewhere in this paper use terms that are more appropriate for our purpose.
[11]Source: https://www.ethnicity-facts-figures.service.gov.uk/uk-population-by-ethnicity/demographics/age-groups/latest/(accessed July 2024).

[12]In Comprehensive, Grammar and Independent schools, Geography was one of the top ten subjects, taken by 16.3%, 15.3% and 11.9%, respectively. In 6th Form and FE/Tertiary colleges, Geography was not among the 10 most popular subjects taken.
[13]93.7% of undergraduate students declare an ethnicity. These data are routinely collected to monitor differential outcomes by factors including race/ethnicity, gender, socio-economic factors, etc. Most students who do not declare are international students, from whom this data is not required.

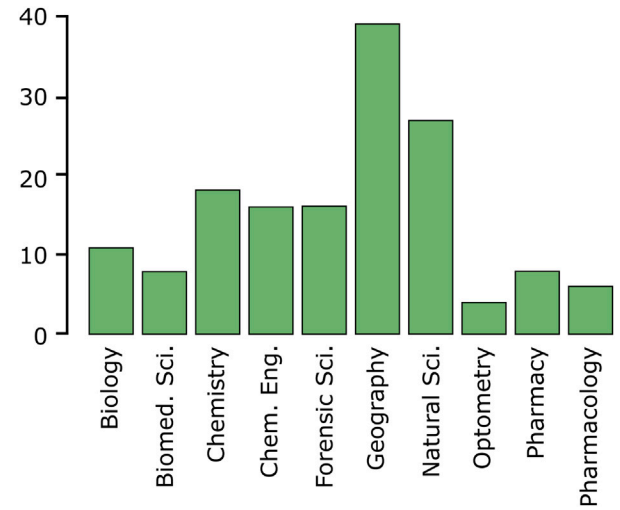

FIGURE 1 | The number of times each degree programme in the School of Applied Sciences appeared as one of the programmes SED students would definitely not consider for future study. Biomed. Sci., Biomedical Sciences; Chem. Eng., Chemical Engineering; Forensic Sci., Forensic Science; Natural Sci., Natural Sciences.

programme, the majority of whom are British Asian (70% on average between 2016/2017 and 2021/2022) about their attitudes towards geography as a potential degree subject. The SED is a foundation year programme for students wishing to go on to study science subjects at university, but who do not yet have the required qualifications. At the beginning of the SED course, around 70% of students on the SED plan to go on to study either optometry or pharmacy. However, since these two programmes have limited intakes, many SED graduates ultimately go on to study other science subjects offered within the School of Applied Sciences at Huddersfield. Geography is offered as an option to SED students, but very few choose to take it up (4 students total over the period 2018/2019–2022/2023). The majority (3 out of 4) of those that have were from the white population of SED students. In total, 48 students completed the survey in full, out of a cohort of 182 (26%). Geography was selected most often as a subject students would "definitely not" like to study (see **Figure 1**).

METHODS

Building on our survey (as discussed above) we wanted to understand the experiences of students from under-represented groups who had undertaken undergraduate study in the geosciences at UK universities. In March–May 2022, the GAIA project ran a series of three workshops with current and recent geoscience undergraduates from under-represented groups. Our definition of under-represented groups (see above) was deliberately broad in order to allow us to address intersectional questions. However, it should be borne in mind that this breadth may act to hide intergroup differences in experience.

The first workshop was held in Manchester during the day at the weekend and the second two were held online, one on a weekday afternoon and one on a weekday evening. Participants were compensated for their time at the national living wage and reimbursed for transport where relevant. Catering was offered at the Manchester workshop. Bursaries were also offered for childcare to allow participants to attend, although no participants took up this offer. It was hoped that these arrangements would lower the barriers to access for as many potential participants as possible.

Participants were recruited through UK university geoscience departments and geoscience-related student societies. We used university and students' union websites along with lists of universities offering geography and geology degrees accredited by the Royal Geographical Society and the Geological Society of London to produce a list of departments, programmes and societies who might be able to disseminate information about the workshops to current and recent geoscience undergraduates. We also passed on the information via the British Sedimentological Group emailing list (primarily consisting of UK geology professionals) and asked contacts to pass the information on to their networks. Finally, we advertised the workshop at the Equator School (Dowey et al., 2022). These sampling strategies relied on members of staff and student societies to pass on the information, and in most cases we received no confirmation as to whether the information was passed on.

In all, 34 participants attended the three workshops. Degree programmes represented included geology, geography, physical geography, human geography, environmental science and geochemistry. Participants were drawn from a range of universities including Oxbridge, Russell Group, pre-92 non-Russell Group and post-92.[14] The majority of the universities were in Northern England, although participants came from a much broader geographical spread, including overseas. No participants attended universities in Northern Ireland.

Table 1 shows which under-represented groups participants were drawn from. Most participants identified as members of more than one group. Participants gave informed consent for workshops to be recorded. All participants were asked whether they wished to be named in any subsequent publications, and if so, what name they wanted to be used. Those participants who asked to be named are listed after the conclusion of this article.

Within the research team, one researcher identified as Black African, one as South Asian, two as person of colour or BAME, and three as white. Two were current or recent undergraduates of geoscience degrees at the time of data collection and three others were academics in geoscience/geography. Two members of the team identified as falling under the LGBTQIA+ umbrella. One member of the team was born outside the UK and two identified as first-generation

[14]For details of these categories of UK university, see, for example, https://www.ukstudyonline.com/types-of-uk-universities/.

TABLE 1 | Numbers of workshop participants who identified themselves as belonging to particular under-represented groups.

Group	Number of participants (out of a total of 34)
Black, Asian or minoritised ethnicity or religion	29
From low-income household	17
LGBTQIA+	13
Disabled	13
First in family to attend university	15
Non-traditional educational background and international students	4
Caring responsibility	0

Some groups are amalgamated to avoid any group of fewer than four participants.

immigrants. One member of the team identified as disabled and one as neurodivergent.[15]

The four academics on the research team all worked at the University of Huddersfield, a post-92 institution in Northern England, at the time of the workshops. Three worked in the Geography programme and one in the Science Extended Degree programme (discussed above). In the process of planning the workshops, we paid specific attention to potential power dynamics within the team and between the team and workshop participants. Within the team, we recognised that each member had different starting points and areas of expertise, and all workshop activities were planned and created during collaborative discussions. During the workshops, the geography/geoscience academics only spoke to provide administrative information and did not facilitate any breakout discussions. While a detailed discussion of post-workshop feedback is beyond the scope of this paper, anonymous feedback suggests that participants experienced the workshops as a warm, positive safe space to discuss their opinions and experiences.

The chief facilitator of all workshops was Manju Patel-Nair of Changemakers Unltd, a consultancy focused on racial justice, diversity and belonging. Each workshop had a co-facilitator who was a current or recent geoscience undergraduate from an under-represented group (either Victoria Ayodeji or Francisca Rockey), and other members of the research team also acted as co-facilitators in some instances. The workshops consisted of a series of activities including presentations by student co-facilitators and Mohammed Dhalech of Mosaic Outdoors, mentimeter polls, breakout groups, and whole-group discussion (see **Supplementary Material** for a workshop outline).

[15]Team members were asked to provide a positionality statement and these are summarised here. However, team members did not always provide the same information as each other, but focused on the aspects of their identity that they considered most important with respect to the study. For example, two team members explicitly identified as a first-generation immigrants, but that does not mean that no other team members fall under this umbrella.

Students were asked to address four main questions: 1. On a scale from "inclusion" to "belonging", where would you place yourself in the context of your degree experiences and why (this activity used an inclusion-belonging line, including written comments and a whole-group discussion); 2. How would you describe the culture on your course? (anonymous mentimeter responses); 3. Please describe your experiences getting into, on with and out of your course (breakout room discussion followed by whole-group debrief); 4. Please give some practical recommendations for how geoscience degrees could become a place of belonging for all (breakout room discussion follow by whole-group debrief). In the face-to-face workshop, participants wrote ideas and comments on poster paper, while in the remote workshops we used Google jamboards.[16] Where possible, discussions were recorded, and these recordings along with written comments, mentimeter results, and responses to post-workshop feedback surveys were used as the material for this study. Thematic analysis was conducted by the research team using an inductive thematic approach.

Below, we present some headline findings from the workshops and particularly from the two breakout sessions: the first where participants were asked about barriers they experienced before, during and after their geoscience degrees, and the second where they were asked for practical recommendations to make geoscience degrees "a place of belonging for all." The recommendations were created by workshop participants and prompted and organised by the research team, in a process we consider a co-creation. In the interests of space, we have not included supporting quotations from our participants, but these can be found in our report *Making geoscience degrees a place of belonging for all*, available on our website,[17] or in the **Supplementary Material** associated with the present paper.

RESULTS

"Getting in, Getting on, Getting Out" - Experiences Before, During and After Geoscience Undergraduate Degrees

A wide range of comments were made by attendees of the workshops when asked about experiences before, during and after their geoscience undergraduate degrees. We have focused here on contributions that focus on barriers to belonging. These comments largely fell into four main themes: unfamiliarity of geosciences on the part of family, friends and community; lack of representation in the discipline (among lecturers and in industry); lack of representation and exclusion among their peer group, including microaggressions and in some cases active exclusion; and structural barriers.

[16]http://jamboard.google.com
[17]http://geoaccess.org.uk

Unfamiliarity With Geosciences on the Part of Family and Friends

Participants repeatedly stated that their families and/or communities had little awareness about the content, skills or job prospects of geoscience undergraduate degrees. A perception of geoscience degrees as lacking in value was particularly discussed by students from minoritised ethnicity and/or low-income backgrounds.[18]

Lack of Representation in the Discipline

Participants noted the whiteness and lack of diversity ("straight, white, upper class") in both teaching staff and guest lecturers as well as in some of the careers and companies employing geoscience graduates. Neurodivergent participants and participants with (invisible) disabilities and/or mental health concerns mentioned a sense of isolation at times, particularly when disability and neurodivergence was not openly discussed in relation to coursework or adjustments. This led to a sense of alienation for the participants and a sense that staff sometimes lacked understanding of, or sensitivity to, the problems specific to particular under-represented groups. However, many participants also commented on how individual staff were welcoming and inclusive. One aspect that was mentioned by multiple participants was a lack of case studies and examples from outside the UK/the Global North in lectures and assignments.

Lack of Representation Among and a Sense of Exclusion by Peers

A number of participants reported a culture on their courses that left them feeling alienated in relation to their peers, with lack of opportunities for meeting and socialising with other members of under-represented groups. This was reported by participants across all our under-represented groups. This situation was exacerbated by the COVID lockdown which affected most of our participants at some point. Students discussed, and made notes about (see **Figure 2**), the dominance of some exclusionary practices within the geosciences (e.g., going to the pub after fieldwork) and racist, ableist or homophobic microaggressions that affected their sense of belonging.

Structural Barriers

Participants identified a number of structural barriers leading to increased hardship for geoscience undergraduates from under-represented groups. These included: difficulties in getting appropriate accommodations for disabilities; the cost of field trips and field equipment; field trips to locations that were unwelcoming to members of particular minoritised groups; lack of accessible field trip alternatives; the assumption that geoscience undergraduates would be experienced in outdoor activities and would own and know how to use all the necessary clothing and equipment.

Recommendations to Help Make Geoscience Undergraduate Degrees a Place of Belonging for All

Participants were asked to make practical recommendations which could be implemented by individual lecturers or course teams to increase the sense of belonging on geoscience undergraduate degrees. There were a wide range of recommendations, which we have categorised according to the problem they are designed to address. Although some of these recommendations do require buy-in at a level above the course team, most can be implemented at course or lecturer level.

The Reputation of Geoscience

Problem: family, friends and community need more awareness of geoscience as a discipline.

Recommendations:

- A programme of outreach to under-represented communities, especially parents of school-age children, preferably working with ambassadors from those communities (both undergraduates and graduates) who are fully remunerated for their work
- Encourage current students to talk to their family and friends about the subject
- Provide detailed information about possible career paths at university open days and during outreach with schools and colleges; provide schools and colleges with information about the concrete career options available with a geoscience degree

Lack of Knowledge of the Application Process

Problem: students from under-represented groups may not be able to attend open days and may not have the knowledge to navigate the applications process.

Recommendations:

- Provide alternative virtual open days and tours
- Provide information about the application process at open days and on course websites
- Have visible student role models from under-represented groups be part of widening participation programmes and open days
- More information provided by schools and colleges about alternative routes rather than just Russell Group or Oxbridge (other universities, apprenticeships etc.)
- For international students, step-by-step guidance on visa applications

Financial/Resource Equity

Problem: the costs involved in field trips and associated outdoor clothing and equipment can be a barrier.

[18]Because most of our participants identified themselves as members of more than one under-represented group, we have only linked comments to specific group identities when the commenter explicitly made those links in their comment. For example, "as someone who had no family member who had attended university . . . " We made this decision to avoid speaking for our participants in terms of which combination of axes of marginalisation was most salient to any given experience.

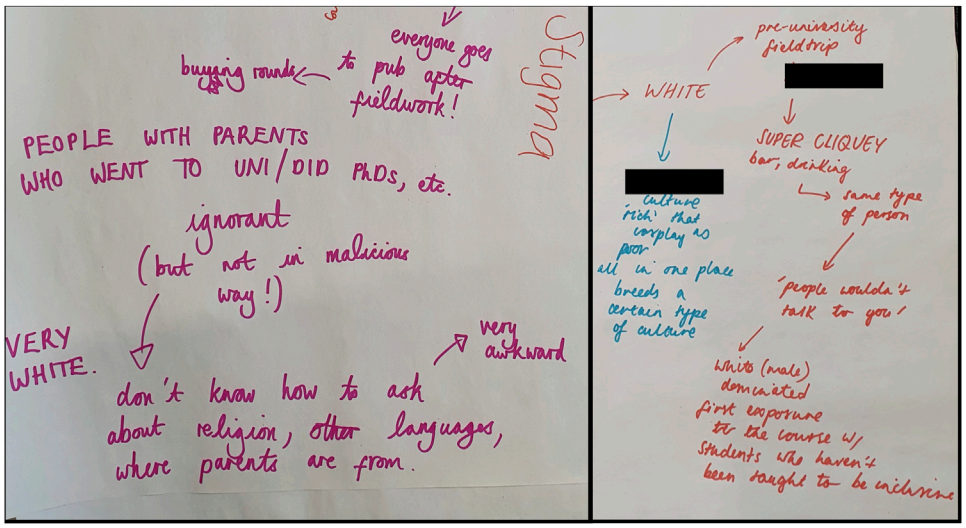

FIGURE 2 | Two examples of comments by participants in the GAIA workshops. Some identifying details are censored.

Recommendations:

- Free field trips or bursaries to cover field trip costs for low-income students
- Provide or lend outdoor clothing to those who do not have it
- Bursaries to cover cost of getting a passport for those who do not have one
- Be clear up-front about extra costs associated with a course or with specific modules – make this clear on course website, in prospectus etc. with plenty of notice to allow students to budget and save
- Ensure that group work takes place on campus rather than, for example, in a pub or restaurant which some students may not be able to afford or may not feel comfortable visiting
- Advertise available scholarships during open day talks and induction (where appropriate)

Accessibility of Field Trips

Problem: field trips may be inaccessible or daunting to students, for example, those with disabilities, those who are not used to being away from home, those with caring responsibilities, or field trips to places or areas where LGBTQIA+ and/or minoritised ethnicity students may face violence and/or discrimination.

Recommendations:

- Consider field trip locations from the point of view of specific student groups
- Provide detailed information about arrangements and dates well in advance of the trip
- Allow for room/group allocations to be changed with clear justification and make this explicit rather than waiting for students to ask
- Provide alternative field trips (or virtual field trips) for students that cannot access particular trips
- Be clear and transparent about any barriers to access and proactively approach students who may find themselves excluded to discuss solutions
- Explicitly factor in (bathroom) breaks and supply information about the timings for these in advance
- Consider all field trip venues (including social venues) in terms of accessibility
- Offer spaces and opportunities for socialising on field trips that do not automatically involve alcohol

Including More Voices

Problem: students from under-represented groups do not see themselves reflected in teaching staff or guest lecturers.

Recommendations:

- Actively seek out geoscience professionals from under-represented groups to give guest lectures
- Provide opportunities for members of under-represented groups, including present and past students, to be part of the planning and feedback process for courses and modules
- Have an EDI panel/forum with student membership in each department
- Offer a BAME mentoring scheme to students throughout their studies, but particularly in their first year

More Global Perspectives

Problem: examples and case studies tend to be drawn from UK, resulting in a narrow range of perspectives and possible solutions to environmental problems.

Recommendations:

- Seek out case studies from around the world, particularly showcasing different approaches to geoscience issues

- Be explicit about how environmental and geoscience issues affect minoritised and global majority populations
- Tailor examples to student body to foster belonging. This can be effective even if it is just the brief mention of a place with which a given student has an affinity
- Allow students to choose assignment case studies from outside the UK
- Integrate discussions of equity and justice, the colonial histories of the geosciences, and opportunities to decolonise the geosciences into the degree programme early on (rather than an optional module in the final year)

Fostering Belonging

Problem: students from under-represented groups may experience alienation from peers and feel isolated.

Recommendations:

- Provide or signpost opportunities for socialising outside lectures, especially events that do not involve alcohol
- Practical and compulsory education/training for both staff and students on equity and justice and the barriers that exist, not just limited to optional academic modules
- Compulsory early module concerning decolonisation
- Mentoring programmes for first-year students with mentor matching based on protected characteristics
- Encourage mixing of groups in seminars and field trips from day one
- Make an effort to pronounce people's names correctly, e.g., use of #MyNameIs tools and inclusion in email signatures[19]
- Acknowledge and make accommodations for cultural/religious events such as Eid
- Consider cultural/religious events when planning assignment deadlines
- Staff to be aware of religious practices and proactively inform students about prayer facilities
- Acknowledge explicitly that higher education can be lonely and difficult
- Overall, a call for more flexibility, guidance, and support.

Networks and Opportunities

Problem: students from under-represented groups often lack networks and are unaware of internship opportunities that may be available to them for networking, internships, scholarships, volunteering, etc.

Recommendations:

- Signpost opportunities, including opportunities targeted at specific groups, during induction and repeat announcements at several points throughout course
- Have a central repository where students can find information about targeted opportunities and networks
- Collaborate with more diverse departments in the university to have a larger diversity of student ambassadors at open days and induction weeks who can give students from under-represented groups more general information about what it is like to study at university
- Direct students to larger university and extra-university support networks that may not be specific to geoscience. UK examples include the Sutton Trust, Social Mobility Foundation, upReach, 93% Club, Rare Recruitment, SEO London, Career Ready, Black Geographers Network, and The Social Mobility Commission

Careers Advice

Problem: students from under-represented groups often lack experience in how to pursue particular careers or do not know what careers geoscience degrees can lead to.

Recommendations:

- Tailored, practical advice on interview practices and dominant organisational cultures and expectations
- Transparency on how accessible careers and specific companies are for under-represented groups – for example, whether a company has a good mental health policy
- Actively seek out industry professionals from under-represented groups to be involved in careers sessions and placement support[20]
- More guidance on the types of careers available, given the breadth of directions which geoscience degrees permit – university careers services may not have as much knowledge as geoscience teaching staff or *vice versa*
- Many graduate programmes use fairly generic automated testing systems as a first round qualifier – provide practice with these
- Advice on the employment rights of people with protected characteristics and links to groups and resources that can provide support

Collaborative Action

Many of our participants emphasised the need for collaborative action across schools, departments and universities and between universities and geoscience employers in order to address the issues raised here. This may help address the difficulties of finding appropriate mentors and speakers within individual departments/institutions.

DISCUSSION

In what follows, we discuss the experiences recounted, and recommendations made, by our workshop participants in the

[19]https://mynameis.raceequalitymatters.com/

[20]For a list of geoscience graduates from under-represented groups, see www.geoaccess.org.uk/role_models

context of extant literature and elaborate on the recommendations.

Wider Awareness of the Geosciences

The experiences of our participants suggest that the negative perception or lack of knowledge of geosciences among their wider communities may pose a barrier to access. Positive family influence has been found to be an important determining factor in attracting students to geoscience degrees and further study (e.g., Holmes and O'Connel, 2003; Stokes et al., 2015). Stokes et al. (2015) found that familial factors were more important for Hispanic students than white students in a sample of undergraduate geoscience majors from the US. Similar results have been found in studies of STEM disciplines other than geoscience (e.g., Martin, 2000).

Degree-level educators in the UK are generally involved in outreach such as open days for prospective students (who often bring their parents), community events, school visits, etc. These events are generally focused around school-aged children, with particular focus on 16–18 year olds as the next group of prospective students. For many programmes and institutions, a focus on reaching parents specifically might require significant research or alternative strategies of outreach. However, STEM interventions aimed at parents have been shown to have some success (e.g., Harackiewicz et al., 2012). As part of the GAIA programme, we ran a series of geoscience taster workshops where students from under-represented groups were invited to bring their parents or other family members, and post-workshop feedback indicated parents were particularly enthusiastic about the workshop content (and especially the careers information). We propose that geoscientists who are interested in making geoscience a place of belonging for all focus on larger community interventions rather than purely focusing on school-age children.

Changing the Geosciences From Within

While wider awareness of the geosciences could foster student engagement and sense of belonging in the discipline, our participants emphasised the responsibility of geoscience staff to consider what is taught and learned, the pedagogical practices used and who is doing the teaching and demonstrating. Previous studies in other STEM disciplines have highlighted the importance of role models from the same groups in encouraging persistence and retention of members of under-represented groups in STEM degrees (e.g., Newman, 2011; Hernandez et al., 2018). In addition, some evidence suggests that STEM role models from under-represented groups may also increase a sense of identification with STEM in members of non-matching groups (e.g., Conner and Danielson, 2016; Steinke et al., 2021). Gladstone and Cimpian (2021) offer a detailed discussion of research on role models in STEM and their effect on motivation and belonging of students from various groups.

Asking minoritised staff and students to engage in mentoring and role-model work, however, can be problematic. There is a risk of "equality and diversity" and pastoral work, which tend not to be remunerated or valued for career progression, falling disproportionately on already marginalised staff and students (Esson and Last, 2020). Possible mitigating strategies, as mentioned in the recommendations above, include paying students for their time and sufficiently workloading and recognising pastoral work. Where the existing geoscience staff and student body does not have any members of specific under-represented groups, students from other departments could assist on open days, or there could be collaborations with other institutions with a more diverse staff/student body.

There has been increasing discussion of what it means to "decolonise" the discipline, particularly from the humanities and social sciences end of geography (e.g., Noxolo, 2017; Esson et al., 2017). Bearing in mind the risk of abstracting the term "decolonise" from its meaning of "giving back Land" (Tuck and Yang, 2021), it may be more appropriate to speak of how the discipline can be "anti-colonial" (Liboiron, 2021) and anti-racist (Esson and Last, 2020) and face, reckon with and organise reparations for its continuing imbrication in institutional racism, (neo)colonial and imperial violence. As recommended by our participants, a start is for courses to include core modules on (de/anti)colonisation. However, as has been argued (e.g., Rai and Campion, 2022; Esson and Last, 2020), adding content into the curriculum is not enough without also rethinking everyday (political) praxis, pedagogies, ontologies, epistemologies, and research methodologies. Importantly, this means challenging institutional racism (Esson, 2020) in the geosciences and refiguring how science is done.

Introducing students to "subaltern" and global majority methodologies and theoretical perspectives and amplifying their use in the discipline and their application in practice can potentially be of use here. For example, Black placemaking (Hunter et al., 2016; Tichavakunda, 2020) can provide a useful conceptual lens in how to support and amplify physical and other spaces for marginalised groups in undergraduate geoscience contexts. Another approach to increasing a sense of belonging that has been applied particularly in the USA is the use of place-based learning (Semken et al., 2017; Yemini et al., 2023). In the undergraduate education context the literature suggests this has been particularly applied in a context of Indigenous land relations (e.g., Reano and Ridgway, 2015; Wooltorton et al., 2020; Semken and García, 2021). In the UK, a similar concept of strengthening belonging for minoritised groups through connection to place can be found in the founding philosophies of a number of walking and outdoor groups aimed at racially minoritised populations (e.g., Black Men Walking,[21] Muslim Hikers,[22] Dadima's CIC;[23] see also

[21]https://www.semcharity.org.uk/wp-content/uploads/2018/10/11434-Landscape-Summer-2018.pdf
[22]https://muslimhikers.com/
[23]http://www.dadimas.co.uk/

Holliman et al., 2024). A greater attention to these kinds of place-based and placemaking practices could be a fruitful avenue for geoscience educators wishing to foster a sense of belonging for all in their degree programmes. Inclusion of such practices in PhD or pedagogy training and certification programmes for higher education professionals (such as those run by Advance HE, formerly the Higher Education Academy, in the UK) would help to embed a concern for belonging from the earliest stages of a geoscience educator's career.

Fostering Belonging Amongst Geoscience Students

There is a wealth of literature that demonstrates the importance of social and interpersonal factors for students from under-represented groups in STEM degrees persisting in their studies, with feelings of isolation and experience of microaggressions cited as major factors leading to decisions to leave STEM (see Ong et al., 2018, for a review). There is a growing body of literature that offers accounts of racism, inequity and oppression on varying axes of difference in geography (e.g., Tolia-Kelly, 2017; Desai, 2017; Kinkaid et al., 2022) and geoscience (e.g., Marín-Spiotta et al., 2020; Morris, 2021; Marín-Spiotta et al., 2023).

Ong et al. (2018) note that many interventions to increase a sense of belonging in STEM focus on a "deficit model," i.e., they assume that the way forward is to "fix" something about the students experiencing negative social and interpersonal factors rather than the system producing them. This is by its nature an unjust solution. Furthermore, students taking geoscience undergraduate degrees are the geoscientists of the future, and if some proportion of those students are perpetuating a hostile environment for members of marginalised groups, they are likely to go on to do so at the higher levels of the profession. If geoscience educators truly wish to make the profession a place of belonging for all, the problem must be addressed rather than mitigated.

Field trips, including residential field trips, are a defining feature of most geoscience degrees, and could represent an opportunity to enhance belonging amongst undergraduate students. Lawrence (2022) calls for the application of an intersectional lens to make fieldwork more inclusive. This can mean reconsidering what comprises "fieldwork" and introducing students to analyses of the whiteness of fieldwork and its imperial histories, as done by Abbott (2006), Hughes (2016) and Hughes (2022). When planning and conducting field trips, organisers and facilitators need to proactively plan and mitigate for risks of harm to students and staff with minoritised identities (Lawrence and Dowey, 2022). As Anadu et al. (2020) highlight, this requires a shift in geoscience fieldwork cultures. This can be initiated with a set of practical steps, including discrimination risk assessments; re-considering field trip locations; and paying attention to exclusionary practices and language[24] (Pickrell and Pennisi, 2020; Anadu et al., 2020).

[24]http://field.berkeley.edu

Fieldwork can also offer opportunities for geoscience educators to be role models and to plan and structure formal and informal fieldwork activities to facilitate access and belonging. It would be easy to suggest that educators, especially at university level, are not responsible for the social behaviour of their students. However, we argue that the value of fieldwork lies also in learning that occurs from place-based, embodied, experiential and – often informal and unplanned – encounters and events (Hope, 2009; Arnold et al., 2023). As such, a commitment to justice in our discipline means staff taking responsibility to foster social and informal spaces in which, as Esson and Last (2020) put it, our "shared humanity" is recognised. This could include providing anti-racism or "allyship" training to staff and students and/or addressing discriminatory incidents and making a record of these (see Anadu et al., 2020; Lawrence and Dowey, 2022 for further steps to take).

Fostering an actively anti-racist, anti-oppressive geoscience department needs to mean going beyond "valuing diversity" and to actively require staff and students from over-represented groups (in terms of "representation," but also power held) to recognise and give up their privileges. More than "not being hostile/racist/homophobic/transphobic," this means, as our workshop participants emphasised, being *proactive*, with interventions such as compulsory training for both staff and students on, for example, social justice, oppression and recognising microaggressions. This may be more straightforward in geography programmes, where many students will be taking human geography modules in which they are exposed to concepts around structural racism, class, racial capitalism, whiteness and feminist, disability and queer theory. Anecdotally we have seen how our own students change in attitude and understanding after taking such modules. However, for disciplines such as geology, environmental science, etc., such subjects are generally not included. The creation, implementation and inclusion into the timetable of such material would require political will, investment of time by programmes and individual educators, and potentially also resources by institutions. While many of the recommendations by our participants are relatively simple to implement, creation of a truly welcoming environment for all requires commitment and resources.

CONCLUSION: TAKING RECOMMENDATIONS FURTHER

In considering questions of identity and belonging, Nyamnjoh (2021) draws on African *ubuntu* philosophy ("a person is a person through other people") and relates this to *conviviality,* which he defines (Nyamnjoh, 2017) as recognition of our incompleteness. Conviviality, he argues (Nyamnjoh, 2017: 262-3) "implies a sense of accommodating togetherness beyond mere tolerance," embracing difference and diversity, trust, equality, inclusiveness, etc., because we recognise our

incompleteness and the relevance and importance of interdependence. Rather than striving to accommodate students from marginalised groups, to tolerate them or include them, according to this argument, those from non-marginalised groups should embrace them as equals, because difference complements our incompleteness and helps us all to become more human.

It is in this vein that our workshops and the recommendations outlined above focus on "belonging" of under-represented groups, rather than "inclusion" or enhancing "diversity." In this respect our paper joins several pre-existing recommendations for the experiences of under-represented groups in geoscience disciplines (e.g., O'Connel and Holmes, 2011; Stokes et al., 2019; Kingsbury et al., 2020; Fernandes et al., 2020; Dowey et al., 2021; Dutt, 2021; Ali et al., 2021) and geography (Esson and Last, 2020). Our contribution is valuable for the following reasons: 1. It takes an intersectional, open and self-defined understanding of "under-represented." 2. It is specifically located in place (UK) and time (undergraduate degrees), a combination which is understudied, and therefore provides guidance tailored to a particular group of geoscience educators (although we hope it will also be of use to other geoscience professionals). 3. The recommendations are based on the lived experiences of geoscience undergraduates from under-represented groups. 4. The recommendations are co-created with undergraduates from under-represented groups. 5. Recommendations are designed to be practical and achievable by individual educators or small groups of educators.

Because we asked participants to focus their recommendations on proposals that would be actionable and within the remit or sphere of influence of academic departments (rather than, for example, requiring intervention at a global or national level), most of these recommendations can be implemented with relative ease and affordability. These principles of justice, equity, and belonging might be adopted as a charter by disciplinary bodies within the geosciences, with individual academic departments invited to subscribe in a manner similar to the Race Equality Charter and Athena SWAN in UK universities. However, this means that these recommendations do not generally address structural or institutional barriers. These recommendations should therefore be seen as an immediate step for positive change that can be taken alongside continual work to tackle the deeper changes required to achieve belonging for all in the geosciences.

Those of us who are social scientists expend considerable analytical energy considering the interplay of structure and agency in the contexts we study, particularly as concerns the possibilities for, and constraints to, change (see Archer, 1982, for a useful discussion of this). While it is necessary to identify and understand the structures (e.g., capitalism, patriarchy, white supremacy, etc.) shaping and constraining the contexts in which we teach and practice geography and geosciences, invoking our "geographic sensibility" also compels us to consider the temporal and political scales involved. Change at the structural level can take mass mobilisations and time orders of magnitude longer than the few years of a typical student's undergraduate career. While we should identify and critique those structures, in our teaching, research and professional practice, bringing about change that can benefit our students while they are still students requires also intervening at more "micro" levels, with greater immediacy. There are actions we can take directly in our contexts, such as those we have identified above, and then there are processes, discourses and institutions we can influence from within our own particular contexts as "specific intellectuals." From our own positions, examples we have identified include: making our research accessible to policymakers to influence policy, for example, around the centring of student voice, amplifying those voices from marginalised groups; working with colleagues in the compulsory education sector to influence practice so as to enhance belonging; championing progressive funding models for higher education; and challenging neoliberal concepts of a "higher education market" and the legitimacy of institutional rankings. Readers are encouraged to reflect on their own contexts and identify opportunities for similarly exerting influence beyond the sphere of their own teaching, research and professional practice.

Finally, it is vital to foreground the voices of students that are "minoritised" within the Geosciences (Esson and Last, 2020). We hope this paper offers one avenue to bring these experiences and recommendations to a wider audience of academics able to implement them. As one workshop participant said, "I would really love for universities to act on any results that were collected from the workshop. If these bodies just say they're inclusive but do not act on it then it's just seen as performative."

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because the data consist of video and audio recordings of workshops and discussions. To protect the anonymity of participants, the data cannot be provided in full on request, but redacted transcripts may be made available. Requests to access the datasets should be directed to b.fox@hud.ac.uk.

ETHICS STATEMENT

The studies involving humans were approved by University of Huddersfield School of Applied Sciences Ethics Committee. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

BF, AD, VT, and RD designed and implemented the GAIA project and co-designed the workshops with MP-N. MP-N facilitated the workshops and all other team members acted as co-facilitators. BF collated and summarised the data. All authors contributed to the article and approved the submitted version.

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CONFLICT OF INTEREST

MP-N is founder of ChangeMakers UnLtd, and was hired as a consultant for purpose of this research.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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SUPPLEMENTARY MATERIAL

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