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Students of colour views on racial equity in environmental sustainability

Tania M. Schusler[1]✉, Charlie B. Espedido[1], Brittany K. Rivera[1], Melissa Hernández[1], Amelia M. Howerton[1], Kailin Sepp[1], Malcolm D. Engel[2], Jazlyn Marcos[2] and V. Bala Chaudhary[3]

Racial and ethnic diversity in environmental sustainability advances social equity and innovation, solving social-ecological crises. Yet, Black, Indigenous and people of colour (BIPOC) remain underrepresented in sustainability fields despite high environmental concern. Universities provide pathways to sustainability careers and help diversify the field by making programmes more equitable and inclusive for racially minoritized students. Toward this end, we interviewed undergraduate BIPOC students in interdisciplinary environmental and sustainability degree programmes about their experiences. Their observations reflect a legacy of systemic racism that persists today within environmentalism. Many described motivations connecting ecological and social well-being but lamented limited interdisciplinary and global perspectives in the curriculum. Experiences of discrimination, lack of relatability and limited discussions of race led to feeling isolated and excluded. Support networks, extracurricular participation and BIPOC-specific opportunities improved student inclusion and belonging. BIPOC students hold knowledge unapparent to non-marginalized groups that illuminates pathways to racial equity in environmental sustainability.

Global-scale environmental changes driven by human activities are occurring at unprecedented rates, disrupting the Earth's climate system[1], exceeding planetary boundaries[2], threatening biodiversity[3,4] and degrading ecosystem services with negative impacts disproportionately affecting the poor and other marginalized populations[4–6]. Because environmental changes arise from political, economic and cultural drivers[5], transforming political economic systems to advance sustainable development requires cross-sector cooperation characterized by inclusive decision-making that embraces human diversity[6]. Yet in the United States and Europe[7], the environmental movement and related disciplines remain predominantly white[8–10] despite Black, Indigenous and people of colour (BIPOC) demonstrating high environmental concern[11–14] and comprising the majority of environmental justice activists[9,15].

Bridging this racial/ethnic gap matters for both instrumental and normative reasons. Achieving sustainability requires multidimensional thinking suitable to the complexity of socio-ecological systems[16]. Identity diversity contributes to cognitive diversity within groups and teams with greater cognitive diversity produce more successful outcomes in the context of complex problems[17,18]. Thus, racial/ethnic diversity advances sustainability. More important than arguments regarding the instrumental value of BIPOC to environmental sustainability, however, is the fact that the environmental field continues to lag behind other scientific fields with respect to racial/ethnic diversity[19]. Environmental employment opportunities are growing[20]. In an equitable society, people of all races and ethnicities would have access to expanding career opportunities. A racially/ethnically diverse environmental workforce also helps advance environmental justice. Environmental injustices, such as the Flint, Michigan, water crisis[21] and threats to the Standing Rock Sioux Tribe's water quality and cultural heritage from the Dakota Access Pipeline[22,23], arise in part through BIPOC's exclusion from environmental decision-making[15]. Greater racial/ethnic diversity within the environmental field enables BIPOC to influence environmental conditions through management, research, policy, education and other practices in the wide range of sustainability fields.

Interdisciplinary environmental and sustainability (IES) degree programmes offered at colleges and universities are expanding[24]. Yet, despite possessing strong interest in and preparation for environmental careers[25], BIPOC students tend not to select environmental majors due to programmatic attributes. These attributes include curriculum, which signals to prospective students the programme's values and compositional diversity, which suggests to BIPOC students the likelihood of a welcoming climate and academic success[26]. Universities can open pathways to environmental careers for BIPOC by increasing IES programmes' racial/ethnic diversity (compositional race and ethnicity demographics of the student body), equity (ensuring BIPOC access to resources, opportunity and advancement) and inclusion (creating a culture where BIPOC students feel supported, empowered and represented)[27]. Furthermore, diversifying IES programmes can improve learning outcomes for all students by preparing them to participate in an increasingly diverse workforce and society but only when a critical mass of BIPOC are present and IES programmes optimize conditions for cross-cultural interactions[28,29].

Towards the aim of identifying ways to make IES programmes more racially/ethnically inclusive, we investigated the experiences of undergraduate BIPOC students in IES programmes at two private universities in a major metropolitan region of the midwestern United States. We used grounded theory methodology[30] within an action research[31] approach that involved collaboration among stakeholders experiencing a problematic experience (BIPOC students) and professional researchers (faculty) to collect and analyse data supporting action towards a more just situation. We interviewed 24 students with declared environmental majors who self-identified as BIPOC about their motivations for studying the environment, positive and negative experiences within their IES programme and recommendations for making it more diverse, equitable and inclusive. Interview analyses illuminated how racial/ethnic identities

[1]School of Environmental Sustainability, Loyola University Chicago, Chicago, IL, USA. [2]Department of Environmental Science and Studies, DePaul University, Chicago, IL, USA. [3]Department of Environmental Studies, Dartmouth College, Hanover, NH, USA. ✉e-mail: tschusler@luc.edu

influence students' educational experiences and offer transferable insights, while the action research approach provides a model that IES programmes can adapt to generate their own context-specific knowledge and strengthen pathways for BIPOC students to sustainability careers.

Results

Interviewees described varying influences that led them to choose an environmental major (Supplementary Table 1), including encouragement from an influential person such as a college professor, high school teacher, friend or parent; experiences during prior education (for example, field trip, project or course) or involvement with an environmental issue in their neighbourhood. Two-thirds of participants further expressed that their interest in studying the environment arose from recognizing the interdependence of ecological and human well-being. For some, this realization grew from witnessing environmental injustice: 'I have family who live in areas that just feel completely forgotten about. Like trash everywhere, pollution everywhere… I could have the tools to at least try to clean up some of those areas and make them nicer for everyone to live in'. Others emphasized an inherent connection between people, nature and culture: 'I'm a backpacker, and it was more than just being fascinated by nature, I realized how… I care about my ancestors, I care about where my food comes from, I care about understanding the connection of the world'.

Yet, within their IES degree programmes, BIPOC students described observations and experiences that led them to feel isolated and excluded (Fig. 1 and Supplementary Table 2). Multiple students observed little compositional diversity within classes for their major consisting of mainly white students and faculty. Some contrasted this with general education courses where the class composition was more racially/ethnically diverse. Some interviewees also reported that environmental student clubs and internships lacked diversity. For instance: 'I was the only person of colour in [that] club, which at one point had 40 members…. Sometimes I feel I have to be the voice of poor people of colour because they're not in my classes or they're not in the organizations I go to. Not saying that the people that are there are oblivious [but] I feel like you don't think about race as much as someone who is actually affected by their race'. Predicaments like this left several students feeling frustrated, angry or out of place. As one said, 'The most I'm going to see a person of color working at [this university] is probably at [the dining services], and that's really messed up, that makes me really sad'.

Participants also observed limited interdisciplinary and global perspectives, which conflicted with their own understanding that social and ecological issues intersect. BIPOC students described the social implications of science to be understudied in their majors. Although both universities' IES curricula include natural science, social science and humanities courses, students reported that content about how environmental science affects different racial/ethnic groups was often limited to elective courses such as environmental justice. One reflected: 'I feel like some [professors] wouldn't even be able to talk to a student of colour about race… it's like, "This is a science class. We're gonna talk about hard, empirical facts here"…. So if someone were to bring up racism… it's like "I'm gonna hit you with the empirical facts" and deny the lived experiences of these people'. Some BIPOC students recounted examples where faculty and peers purported a 'white environmentalism' by offering solutions to environmental problems that would be incompatible for many BIPOC and portending to fix environmental problems experienced by BIPOC as a 'white-saviour' who knows best. Furthermore, some interviewees expressed dismay that the curriculum emphasized a predominantly white male canon while ignoring contributions by BIPOC to the environmental field. As one said, 'I love Aldo Leopold but if I'm asked to read *A Sand County Almanac* one more time, I'll be a little mad…. The field is dominated by older, or dead, white men from America or Europe, but there are so many people working in this field in other places with different problems and solving them in different ways. And we just don't really talk about it'.

Some participants described experiencing discrimination, more often from peers than faculty or staff. They reported moments where others ignored or dismissed their experiences in class discussions, thereby invalidating their racial/ethnic reality. One reflected, 'I feel like the small microaggressions are more of like, "Really, you've gone through that?"…. Kinda not believing'. Others described sensing an 'us versus them' mentality in the tone of professors or peers who used vague language to refer to groups of people: 'It's like you can tell how someone owns the word. People can say "they" or "Black people" and it feels and sounds totally different'. One student described feeling tokenized: 'There was an instance where my [internship] supervisor referred to me as an African-American student… in an email sent to multiple people. And did not recognize me by name…. And I feel like that's a disservice to the hard work that I put in. And it's very disrespectful, it's very tokenizing'.

These direct observations—little compositional diversity; limited interdisciplinary and global perspectives in the curricula; and/or personally experiencing discrimination—led BIPOC students to feel excluded and isolated (Fig. 2). Some participants reported that peers or faculty seemed unable to empathize with their lived experiences. This lack of relatability left BIPOC students feeling disconnected from their IES programmes. As one said, 'You're not gonna understand my struggle because you don't live it, you don't see it'. Another explained, 'Some people will never know what it's like to live in a food desert, what it feels like to live in a neighbourhood where there are more liquor stores than there are grocery stores…. So there is this disconnect when [peers] talk about some stuff'. A few encountered difficulty making friends. One reflected, 'I wouldn't say I've ever felt like I've been treated differently because of my race or ethnicity, but I definitely think it's harder to create friendships'.

This lack of relatability left some interviewees feeling frustrated or disheartened when it came to participating in class discussions. They described feeling bewildered by white peers' interpretations of events or issues; yet, many felt uncomfortable sharing their own perspectives. These BIPOC students observed that white faculty and peers rarely raised questions about race as it related to course content. One shared, 'For a while I just didn't ask questions…. I was just like, "I'm gonna just sit here and let it go". But definitely my junior and senior year that was when I really was like, "I'm just sick of sitting in these classes and no one questions anything" or they might have questions but they're not the type of questions that I wanna ask'. A handful of interviewees described themselves as outspoken; however, most discussed feeling reluctant to raise questions or offer comments in class related to race, social justice or personal experiences. Several expressed worries about being judged or upsetting others. As one said, 'I sometimes don't say anything on purpose because I don't want to make some people uncomfortable'. These students felt more open discussing race in some contexts than others. One reflected, 'Sometimes if I'm in a class… which is predominantly white… I wait like two or three classes and see, "Am I actually going to speak in this class? Or is this a class where I'm just on my laptop, where I'm quiet?" Another said, 'Am I gonna be judged?" That question always arises in my head. And, sometimes I'm more comfortable than others, but I feel like to be truly comfortable, that shouldn't really be a thought'. This limited discussion of racial/ethnic identities arose from the lack of compositional diversity in the classroom as well as white students' and professors' limited ability and/or willingness to discuss race.

Several participants suggested that little compositional diversity, limited interdisciplinary and global perspectives and lack of discussions about race within their IES degree programmes led to limited social consciousness for all students (Fig. 2). One reported, 'I feel like [white peers] don't want to speak [about environmental racism]

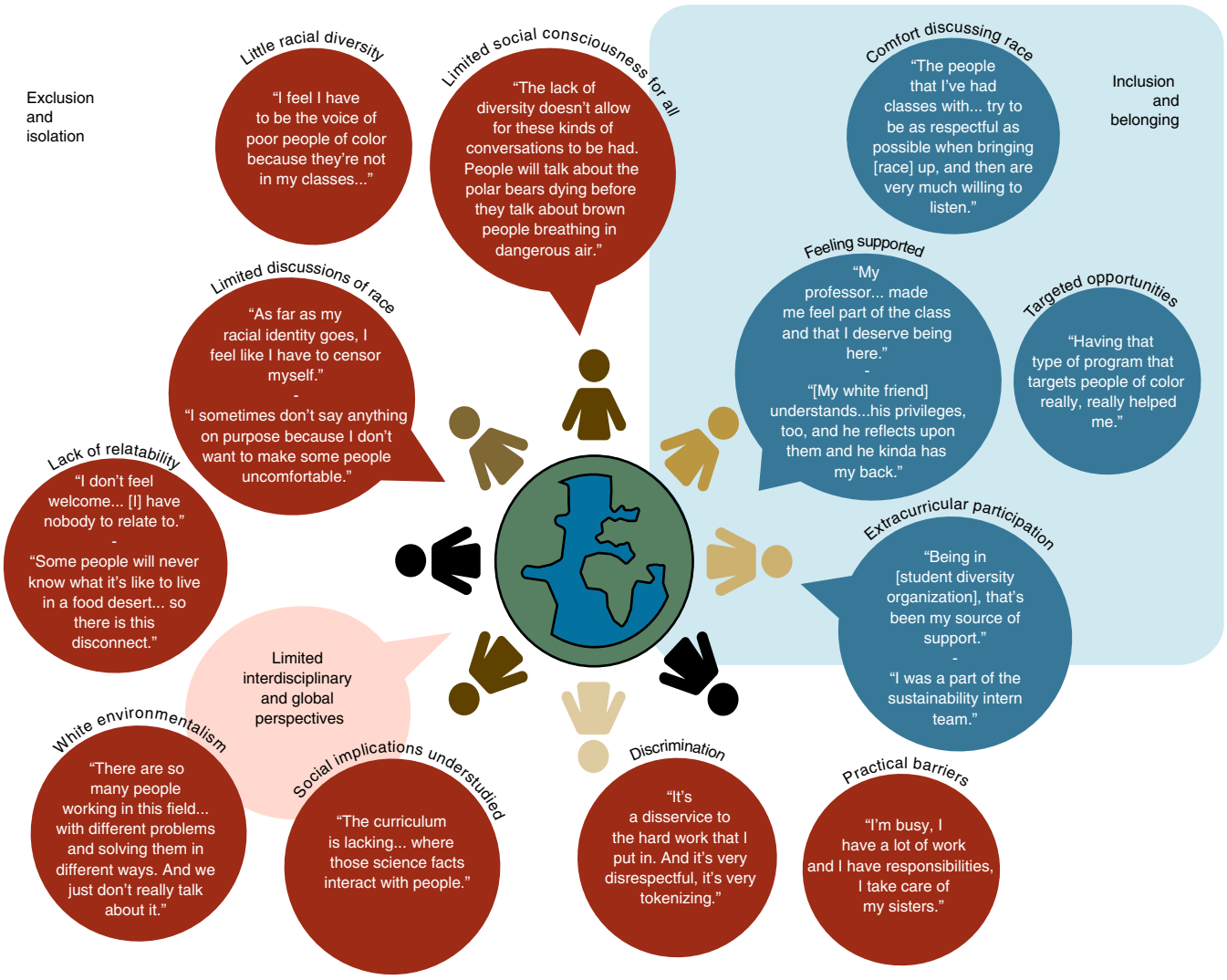

Fig. 1 | BIPOC student experiences of exclusion and inclusion within environmental majors. Key themes that emerged from interviews with BIPOC students reflecting on their experiences as undergraduates in interdisciplinary environmental and sustainability degree programmes indicate that BIPOC students often—but not always—felt excluded and isolated within these programmes. Quotes illustrate each theme.

because there's minorities in the room, so they stay silent and they have no opinions'. Another reflected, '… it's not so much [that white peers] give ideas… that I feel are inherently racist but the fact that there are [not] any ideas that are outside of their race…'. A lack of racial/ethnic diversity restricts learning for all students; yet, the complexity of achieving sustainability requires learning across diverse cultures. One student explained, 'I went to this conference and I was like one of three brown people in a room full of like one hundred. So that's constantly repeated, and… I don't think you can talk about sustainability if you're not getting the issue from all perspectives'.

BIPOC students also reported positive experiences within their environmental majors that fostered some sense of inclusion and belonging (Fig. 1 and Supplementary Table 3). Several received support from faculty, staff or peers who listened to and acknowledged their experiences or assisted them towards achieving their goals. One shared, 'I've grown as a student, in ways that I'm very happy with, and a lot of that has to do with the help that [professors] offered me, and just the fact that they've been respectful of me as a student'. While many interviewees felt supported by faculty or staff, some reported that they had to seek out that support. Others noted that faculty/staff support mainly focused on academics or career development. Participants often felt more comfortable discussing issues related to race with friends. Roughly half described deriving support from friendships with peers. A BIPOC student shared, 'One of [my friends] I have three classes with him and he's one of my other supports. He's white, but he's a white immigrant…. And, he is a minority, too… because he's gay…. And he understands… his privilege, too, and he reflects upon them and he kinda has my back'. Some interviewees simply described neutral relationships: 'I wouldn't say that my peers necessarily want me to fail but I wouldn't say they have overtly cheered me on either'.

Extracurricular participation in student organizations, internships or faculty research within their IES programme or, slightly more often, the university at large helped participants to connect with others and feel comfortable being themselves. One reflected, 'I'm actually trying to start a campaign to increase the number of environmentalists [of colour] on [this] campus, and people in the [student] environmental organizations have been very supportive with that and helping me get that started, but also just listening to the issues that I see when I'm mentioning it and being receptive to it instead of reactive'. Students' involvement beyond the IES

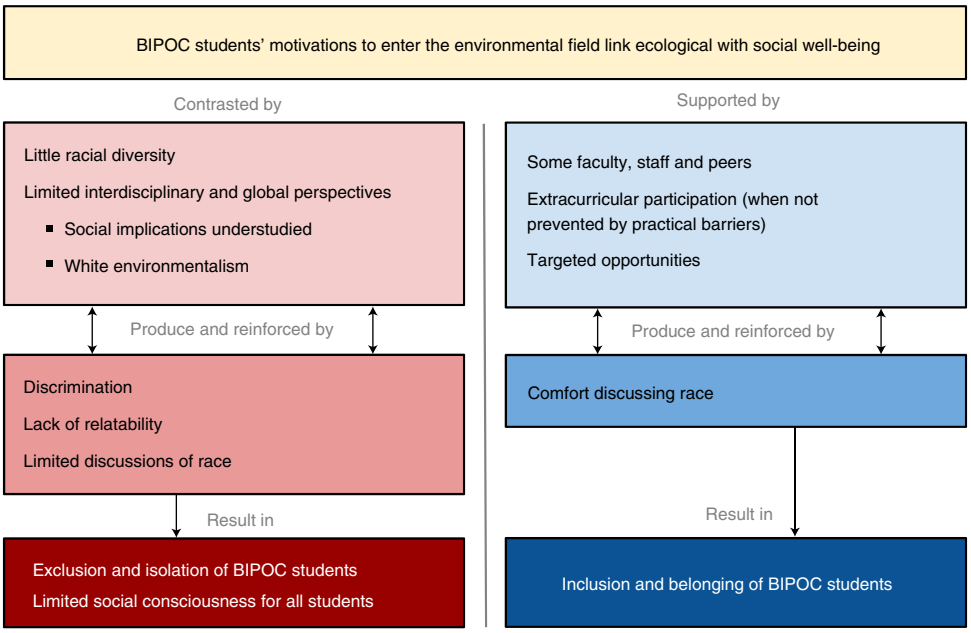

Fig. 2 | Programme characteristics influence BIPOC students' sense of isolation or belonging. BIPOC students' observations and experiences in interdisciplinary environmental and sustainability degree programmes often contrast their motivations for studying the environment and lead to exclusion and isolation, although some supportive experiences contribute to feeling included and a sense of belonging.

programme often, but not always, occurred through cultural organizations. One shared, 'I'm [in] a Filipino student organization. And so, when I'm there, I can speak freely about my experiences'. Yet, not all interviewees felt comfortable or had the opportunity to join clubs, as we describe below.

Several participants benefited from targeted opportunities for BIPOC students, such as scholarships, grants, internships, research positions or organizational membership. Some had not directly benefited but nonetheless valued the existence of such opportunities. One said, 'I've applied for [internships that stated], "We encourage minorities, and women, and people of colour"…. It shows to me that they wanna increase diversity amongst their staff…. Not necessarily like… you're gonna get the job, because you have to be qualified, of course. But… I enjoy [those statements]'.

Stories about feeling supported, engaging in extracurricular activities and recognizing targeted opportunities implied some degree of belonging (Fig. 2). Unlike others who described discomfort discussing experiences related to their racial/ethnic identities, some BIPOC students felt comfortable discussing race in the classroom or with peers. One reflected, 'The people that I've had classes with… try to be as respectful as possible when bringing [race] up, and then are very much willing to listen, and some teachers will actually directly acknowledge and say, "I'm white and middle class, so I may not know the whole situation"'. Notably, students felt comfortable speaking about their racial/ethnic identities most often in courses such as environmental sociology, environmental ethics or environmental justice.

Despite these positive aspects of some participants' experiences as environmental majors, others identified barriers to participation (Supplementary Table 2) that prevented them from realizing support, networks and opportunities. Being a commuter student, working to meet financial needs or fulfilling family responsibilities made it difficult for some BIPOC students to participate as much as they would like: 'I'm busy, I have a lot of work and I have responsibilities, I take care of my sisters…'. A few identified lacking a career-related social network as an obstacle: 'I didn't know about any [opportunities] because you have to know people in the environmental community to do it and if you don't know anybody it's hard'. The discomfort of being BIPOC in a majority white setting, as reported earlier, also prevented some from participating in clubs, internships or related opportunities. Along with reducing these barriers, interviewees offered several recommendations for making their IES programme more inclusive of BIPOC students (Table 1 and Supplementary Table 4).

Implications for IES degree programmes

Our results align with prevailing research on BIPOC students' sense of belonging in scientific, technology, engineering and mathematics (STEM) fields. Belonging, which refers to 'the experience of mattering or feeling cared about, accepted, respected, valued by and important to the campus community'[32], can affect students' academic satisfaction, grades and retention. In STEM, white men are more likely to feel that they belong, while women and BIPOC students are more likely to find scientific fields unfriendly, unsupportive or hostile[32,33]. In the present study, limited racial/ethnic compositional diversity among students and faculty combined with white-dominated curricula left many interviewed BIPOC students feeling excluded and isolated. Their observations and experiences reflect a legacy of systemic racism that persists today within environmentalism[34–37].

Participants offered recommendations to address this racism (Table 1). Among these, hiring faculty of colour will require IES programmes at predominantly white institutions to reconsider every step of the hiring process from crafting job descriptions through candidate selection to actively rejecting biases towards whiteness[38]. Increasing compositional diversity of faculty, staff and students without changing aspects of organizational culture and structure that reinforce white dominance can harm BIPOC. IES programmes also must attend to historical, organizational, psychological and behavioural dimensions that influence the learning environment[39,40]. Toward this end, BIPOC students recommended providing equity and inclusion training for all faculty and staff; integrating the curriculum to acknowledge BIPOC, the worldviews of marginalized groups and the social implications of science; and dedicating resources to specifically support BIPOC students. Faculty, staff and administrators implementing

Table 1 | BIPOC students identify ways to make IES degree programmes more inclusive of people from all races

Recommendations	Illustrative quotes
Integrate BIPOC voices into the curriculum (for example, incorporate literature by BIPOC, include Indigenous people's perspectives, invite BIPOC as guest speakers, address social justice within courses and partner with local communities in course projects).	"One goal is to increase environmental literacy, so if [faculty] were to include minority environmental writers and put it into the lesson plan and curriculum that would be awesome."
	"With environmental science, you talk about environmental justice and you talk about the injustice being done to people of color, and when professors talk about that it seems like they're just reading off the slides. It doesn't seem like they're really going into it…. I feel like [the programme] needs to go deeper into those types of issues."
Train faculty/staff in diversity, equity and inclusion.	"It'd also be great if professors all had some sort of diversity training…. I feel like a lot of people don't recognize… the ways in which people of color have to navigate the world versus someone who is white."
Hire racially/ethnically diverse faculty/staff.	"I definitely wish that there were more professors of color, who understand the need to talk about these issues from a different perspective."
	"It's encouraging, too, to see people you can more closely identify within leadership roles."
Recruit BIPOC students (for example, invite BIPOC students currently in the major to speak at high schools or campus orientation).	"I feel like there's just a need to get more students in there that are minorities."
Create resources to support BIPOC students (for example, financial scholarships, research opportunities and student groups).	"I would love to see a student group that are students of color interested in environmentalism… focused on supporting each other and career development and leadership development… and maybe… have workshops or teach-ins about environmental justice issues and have guest speakers come in… so it would be a way that they're supporting each other but then they're also teaching the [university] community about these issues as well."

Table 2 | Racial/ethnic identities of students interviewed (all resided in the United States)

	Site 1	Site 2	Total
African-American	3	0	3
Asian-American (including Burmese, Chinese, Filipino and Vietnamese)	5	2	7
Latinx (including Ecuadorian and Mexican)	2	4	6
Mixed races/ethnicities (including Arabic-White, Asian-White, Black-White, Chinese-Vietnamese, Japanese-Puerto Rican, Mexican-Filipina and Puerto Rican-Mexican-White)	5	3	8
Total	15	9	24

such changes can draw on research literature on promoting racial equity in STEM education[41–44] and should be prepared to persist through resistance[45].

This study catalysed practical steps to increase racial diversity, equity and inclusion at both study sites, including forming dedicated committees to facilitate change, faculty/staff training, pedagogical revisions, review of hiring practices and financial and other supports (for example, peer mentoring) for BIPOC students. Participants' recommendations might apply differently in other contexts; however, the action research approach transfers across settings. IES programmes can engage in action research involving BIPOC students and faculty as coresearchers to learn about the experiences of BIPOC in their own institutions and then tailor programmatic changes to improve the learning environment accordingly. Standpoint theory emphasizes that marginalized groups, in this case BIPOC students, hold knowledge based on their social positions that is unapparent to non-marginalized groups; thus, research on racial/ethnic diversity within IES degree programmes should start with the perspectives of BIPOC students[36].

It is important to keep in mind a limitation of our study: grouping students of distinct racial/ethnic identities (Table 2) under the umbrella of BIPOC overlooks the unique standpoints of different racial/ethnic groups. The oppression of BIPOC to uphold white supremacy has taken different forms, including slavery, genocide and settler colonialism, and Orientalism (portraying Asian, Arab and some other non-white cultures as exotic, inferior and often threatening)[46]. This has led to both shared and distinct experiences of discrimination and internalized oppression. While we heard shared experiences of feeling excluded across BIPOC students, we also heard distinct barriers faced, for example, by a Black male student and a female, first-generation immigrant, Vietnamese-American student; these arose from specific social stereotypes and expectations placed on them by members of other racial groups and their own. Future research can differentiate the experiences of students from distinct racial/ethnic groups by using larger sample sizes with greater representation of each group or by separately studying the experiences of specific groups.

Students' race/ethnicity also intersects with other social identities, such as class, gender, sexual orientation, citizenship status, language, religion or disability status, which can influence their experiences within IES programmes. Because pathways to belonging and engagement within higher education differ among students' unique, multifaceted identities[32,47], this is an important area for further research. For example, Ireland et al.[48] observe that educational research addresses the experiences of Black students in science and of female students in science but overlooks the 'simultaneous racialized and gendered experiences' of Black female students in science. Future research can ask specifically about other social identities and how these relate to students' experiences of exclusion or inclusion. Despite these limitations, the present study offers a transferable process for investigating BIPOC students' experiences in IES programmes and building solidarity coalitions among racially/ethnically minoritized students. It also documents their insights and recommendations for shifting the environmental field from a narrow 'white environmentalism' to one that embraces the diverse perspectives and approaches required for solving complex social-ecological crises.

Methods

We followed an action research approach using grounded theory methodology. Action research involves a democratic process by which stakeholders experiencing a problematic situation and professional researchers collaborate to collect and analyse data that supports action leading to a more just situation. Together, the professional researchers and stakeholders define the research questions and cogenerate knowledge about them for the express purpose of taking action to promote social change[31]. With roots in multiple fields including industrial

democracy, feminist research and popular education, action research has been applied across a wide range of contexts from community development to organizational learning, environmental management and higher education. Central to the approach are: (1) valuing practical knowledge gained through lived experience and (2) the equitable sharing of power in knowledge construction[49]. Unlike much undergraduate research in which students take part in a faculty-driven research project, this research was driven intellectually by BIPOC students with the support of faculty who ensured they had the resources needed to conduct the research rigorously and ethically.

The study began when Espedido and Rivera, both BIPOC and IES students, raised concerns with faculty (Schusler and Chaudhary) about the lack of racial/ethnic diversity within their degree programmes. The two initially sought to recruit more BIPOC students to the programmes but quickly realized through conversations with admissions personnel that recruitment alone would not guarantee prospective students' ability to attend the university nor their retention once enroled. At this point, Chaudhary, Espedido, Rivera and Schusler decided that investigating the experiences of currently enroled BIPOC students could usefully inform actions towards increasing racial/ethnic diversity, equity and inclusion within IES programmes. These four people designed the research and five other BIPOC students (Engel, Hernández, Howerton, Marcos and Sepp) subsequently joined the research team and contributed to data collection, analysis and/or reporting. Thus, the nine-member research team included two professional researchers and seven BIPOC students, with the latter holding dual roles as participants and researchers. The research was designed to address the questions: how do students of colour experience undergraduate IES degree programmes in terms of (1) their motivations to choose an environmental major, (2) supports or impediments to their success and/or satisfaction in the programme and (3) desired changes that they perceive would make programmes more racially and ethnically inclusive?

We selected grounded theory methodology to prioritize BIPOC experiences rather than preconceived conceptions about their experiences. Grounded theory involves '*developing* theories from research grounded in data rather than deducing *testable* hypotheses from existing theories' (italics in original)[30]. We followed a constructivist approach to grounded theory through which we aimed to elucidate the research problem of increasing racial/ethnic diversity, equity and inclusion in undergraduate IES degree programmes through our interactions with participants and their perspectives. Our resulting explanations offer interpretive depictions of the phenomenon studied—the experiences of BIPOC students as undergraduate environmental majors—not exact representations[30], although we sought to develop as robust an interpretation of the data as possible. Semistructured interviews[50] comprised the data collection method. The research was approved by Institutional Review Boards for the ethical conduct of research with human participants at Loyola University Chicago and DePaul University.

The use of action research with BIPOC students holding dual roles as researchers and participants strengthened the study. Sharing racial/ethnic identities, or even sharing experiences across different racial/ethnic identities, can foster coherence among participants and researchers that enhances the rigour of research findings[51]. Each student on the research team who conducted interviews was an experienced facilitator in conversations about race and ethnicity. That they also identified as BIPOC in environmental majors positioned them with a high degree of relatability to both the interviewees and the social contexts of the study sites. Sharing these aspects of identity with participants improved rapport and reduced the likelihood of researcher reactivity (that is, the researcher's presence influencing how the participant responds)[52]. One can logically expect that BIPOC students would respond more openly and frankly to questions posed by a BIPOC peer than by faculty (even BIPOC faculty), given the more equitable power relationship between peers. Indeed, interviewers observed that participants appeared comfortable as they spoke about their experiences, which suggests they felt able to share openly.

It was important, however, that BIPOC students on the research team did not allow their own experiences to bias their interpretations of the data[52]. Responding themselves to the interview questions in an interview conducted by another member of the research team allowed each student researcher to gain awareness of their own perceptual lenses and thereby minimize the undue influence of these as they conducted the research. That BIPOC students led data collection and analysis, along with the research team's prolonged engagement in the study settings and use of peer debriefing during analysis, assured the results' credibility. An audit trail documenting the research team's intentions, instrument development, raw data, reduced data, data synthesis and process notes about methodological and analytic decisions provided dependability and confirmability of results[53].

Study sites. The study took place at two private universities in a major metropolitan region of the midwestern United States, each enroling >10,000 undergraduates at the time of data collection (2017–2018). Both were majority white institutions with 38.7% BIPOC among the entire student body at site 1 and 39.0% at site 2. Site 1 enroled 291 undergraduates in six majors related to environmental sustainability; 29.4% of these majors identified as BIPOC. Site 2 enroled 166 undergraduates as environmental science or studies majors, of whom 20.5% were BIPOC. Both programmes feature multidisciplinary curricula that stress environmental and social sciences and humanities, Earth and ecological systems sciences and undergraduate research experiences. The results may be more transferable to other universities with similar characteristics (that is, predominantly white institution in a racially diverse geographic setting, mid-size university and multidisciplinary curricula) than those with contrasting attributes (for example, large public university, small college and racially homogenous geographic setting). Yet, across institutions, IES programme administrators and faculty can apply the same action research approach to discover results that are unique to BIPOC students' experiences within their own context.

Participants. Using purposeful sampling[50], we invited students with declared environmental majors at each school who self-identified as BIPOC to participate in an interview. On two to three occasions, the academic dean or department chair at each site emailed the study's recruitment message to all undergraduate environmental majors. The email invited those identifying as a racial/ethnic minority in the United States to contact the researchers if they would like to take part in an interview. Twenty-four students of varied racial/ethnic backgrounds participated (Table 2), including the seven BIPOC students on the research team (five at site 1 and two at site 2). The racial/ethnic composition of interviewees' home communities as well as the primary or secondary education schools they attended also varied. Some grew up in predominantly communities of colour, others in largely white communities and only a few in areas with a mix of racial/ethnic diversity. All interviewees provided documented informed consent before participating in data collection.

We concluded data collection after identifying several theoretically and practically important emergent themes; however, we do not claim to have reached theoretical saturation in sampling. The results offer transferable insights but cannot be generalized beyond the study participants; the perspectives of other students of colour at each study site may differ from those reported here. As explained in the above discussion, another study limitation relates to analysing the experiences of BIPOC students as one group when participants possessed widely diverse racial/ethnic identities. To ensure confidentiality, we could not differentiate results by participants' specific racial/ethnic identities, as some may be the only student with that precise racial/ethnic identity in their major. Our results do not take into account differences in experiences across distinct racial/ethnic groups nor students' intersectional experiences[54]. In future studies, it would be fruitful to illuminate such intersectional nuances of BIPOC students' experiences[48].

Data collection. We conducted indepth, semistructured interviews with participants individually or, more often, in small groups of two to three students from May 2017 to June 2018. Taking place on participants' respective campuses, the interviews lasted from 30 to 90 min. The interview guide (Supplementary Information) began with questions about the student's decision to attend that specific university and select an environmental major, prior educational experiences and extracurricular involvement. We then inquired about students' perceptions of how their racial/ethnic identities influenced their experiences within the environmental major. We asked them to discuss their experiences in the major both in and out of the classroom, including their comfort speaking with peers and professors about race, instances of overt or covert racism, opportunities available to them as BIPOC students, and whether they felt supported by faculty, staff and peers. Finally, we invited interviewees to recommend actions that could make their IES degree programme more racially/ethnically equitable and inclusive. Because the interviews had the potential to raise negative experiences, such as recalling racial discrimination, we provided participants with a list of mental health providers, racial/ethnic identity affinity groups and other resources available to students on campus and in the local community at the interview's conclusion. Each interview was audio-recorded with participants' permission. The recordings began after participants' introductions so that identifying information was not recorded and confidentiality was ensured. The recordings were transcribed and the transcripts imported into NVivo 12 by QSR International to manage the data for analysis.

Data analysis. Using grounded theory, we examined inductively participants' words describing their experiences as BIPOC students in environmental majors. Grounded theory uses an iterative process of initial coding, constant comparison, focused coding and memo-writing to identify converging and diverging patterns in the data and arrive at emergent themes[30]. To the best of our ability, we set aside preconceptions and constructed our interpretations through extensive interaction with the data to develop the most acute elucidation of its meaning.

Initial coding involved carefully reviewing each meaningful segment of data and creating a descriptive label capturing its essence. Each code was also ascribed properties describing the nature of data it encapsulated. While coding a transcript, the analyst systematically compared how each new segment of data related to or deviated from prior codes. This allowed for revising, adding or creating subcodes to more robustly depict the data. The analysts and lead author met weekly to review codes, arrive at agreement about each code's meaning and compare the analysts' coding in light of the data to determine which codes best represented the data. Through this iterative process and in communication with one another, each analyst created new codes and applied codes developed by others to produce collectively a preliminary set of analytic categories. When we began analysis, we managed data from the two sites separately; however, because no conflicting codes

arose between the data from the two sites during initial coding, we merged the datasets to proceed with focused coding.

Two rounds of focused coding involved continuing comparative analysis of the preliminary category system with the data within and across transcripts to discern which categories held the most explanatory power pertinent to the research question. During focused coding, the analysts substantiated some categories and reconfigured others by separating, combining or otherwise synthesizing codes to most saliently reflect the data and illuminate overarching ideas about the data that became the key themes reported in the results above. Writing analytic memos throughout this iterative process helped the analysts refine their interpretations by elaborating on the meaning of codes, documenting recurring patterns or unique perspectives, identifying budding connections between codes and exploring potential relationships within and across categories[30]. Ongoing weekly conversations between the analysts and, periodically, with the full research team helped to reach agreement on data interpretation. Our goal was consensus coding; we deliberated about analytic decisions until we agreed on a collectively developed coding system that all concurred robustly represented the data[55]. On a few occasions, interpretations differed between the BIPOC coresearchers and white coresearcher, who at times felt defensive about participants' critiques of an IES programme that she helped develop. In these instances, we centred the interpretations of the BIPOC coresearchers whose standpoints better situated them to interpret the data. This analytic decision illustrates the power-sharing required for meaningful action research. Rich description provided through the inclusion of multiple, illustrative quotes for each thematic category in the Supplementary Tables enables readers to discern the transferability of results to their own contexts[53]. For ease of reading, we removed from excerpted quotes utterances common in conversation, such as repeated words, 'you know' and 'like'.

To those interested in conducting action research to understand the experiences of BIPOC students in their own IES programmes, we recommend the following: (1) Build relationships among coresearchers. Faculty and students on our research team had developed prior relationships through classes. If such relationships do not exist, then it will be important to invest time to learn about one another, develop trust and establish shared norms for working together. (2) Be clear about the overall project goals, each researcher's personal goals and how these interact. Researcher reflexivity is essential to reduce potential biases and draw on researchers' positionalities in ways that strengthen the research[52]. We accomplished this through individual written reflections and collective conversations. (3) Let BIPOC students drive the research. The BIPOC coresearchers on our team played key roles identifying the research questions, designing the interview guide, addressing ethical considerations and analysing, interpreting and reporting data. (4) Include a social scientist with expertize in the research methodology. We used grounded theory and conducted semistructured interviews (Supplementary Information); however, action research can use any multitude of methods. At least one team member should possess relevant methodological expertize and the ability to train coresearchers. (5) Identify one member who serves as the team's facilitator, ensuring ongoing coordination and communication among all coresearchers. In our project, a faculty member filled this role. (6) Allow flexibility as students' situations change. The students who led our project's design and data collection graduated and passed the baton to others who led the data analysis and interpretation. Throughout, we maintained electronic communication and periodically met in person with the entire team to foster continuity and the continued engagement of all coresearchers. (7) Stay open-minded and embrace learning together. (8) Report results to participants, others who can help enact institutional change and IES scholars. Understanding BIPOC students' experiences in IES programmes across a wide range of higher education contexts will increase knowledge that can inform action to advance racial equity in environmental sustainability.

Ethics approval. This research was approved by the Loyola University Chicago Institutional Review Board (project no. 2190) under an IRB Authorization Agreement between Loyola University Chicago and DePaul University.

Reporting Summary. Further information on research design is available in the Nature Research Reporting Summary linked to this article.

Data availability

The authors declare that the data supporting the findings of this study are available within the paper and Supplementary Tables.

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Author contributions

C.E., B.R., T.S. and V.B.C. conceived the study. C.E., B.R., M.E. and J.M. conducted focus group interviews and provided editorial comments. J.M., M.H., A.H. and K.S. conducted analyses. T.S. wrote the paper with contributions from M.H. and K.S. All authors provided editorial comments on the manuscript.

Competing interests

The authors declare no competing interests.

Additional information

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Correspondence and requests for materials should be addressed to T.M.S.

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Study description	Action research following grounded theory methodology used qualitative methods to explore the experiences of students of color in undergraduate environmental sustainability degree programs toward the aim of increasing knowledge about how to improve racial diversity, equity and inclusion within such programs.
Research sample	Non-representative sample of 24 university students in two different undergraduate environmental sustainability degree programs who identify as students of color (3 African-American, 7 Asian-American, 6 Latinx, 8 mixed races/ethnicities). Rationale for sample selection was that students of color in undergraduate environmental sustainability degree programs could best speak about their own experiences.
Sampling strategy	Purposeful sampling based on these selection criteria: undergraduate major in environmental sustainability degree program who self-identifies as a racialized minority in the United States. Data collection concluded upon identifying several theoretically and practically important emergent themes; however, we do not claim to have reached theoretical saturation.
Data collection	Student members of the research team interviewed participants using a semi-structured interview guide. Interviews were audio-recorded and the data transcribed for analysis. Audio recordings were deleted after confirming accuracy of the transcriptions.
Timing	May 4, 2017 to Mar 7, 2018
Data exclusions	Not applicable. All data were included in data analysis.
Non-participation	Not every student eligible to participate in the study chose to do so (precise number unknown). No participants dropped out.
Randomization	Not applicable.

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Methods

n/a	Involved in the study
☒	☐ ChIP-seq
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☒	☐ MRI-based neuroimaging

Human research participants

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Population characteristics	See above
Recruitment	On 2 to 3 occasions, the environmental sustainability program's academic dean or department chair at each university e-mailed the recruitment message to all undergraduate environmental majors. The e-mail invited those identifying as a racialized minority in the U.S. to contact the researchers if they would like to take part in an interview.
Ethics oversight	IRB approval from Loyola University Chicago and DePaul University

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