The Cascadia Coastal Hazards and Resilience Training, Education, and Research (CHARTER) Fellows Mentoring Model for Underrepresented Students

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ABSTRACT

Engaging underrepresented scholars in climate change-related research is not just a matter of diversity and inclusion but a necessity for addressing the complex challenges we face as a global society. While government officials, scientists, environmentalists, practitioners, and other stakeholders have increased calls for collaborative approaches, historically underrepresented communities, specifically students, still need to be included in such initiatives and collaborations. The National Science Foundation (NSF)-funded Coastal Hazards and Resilience Training, Education, and Research (CHARTER) program responds to this gap by explicitly incorporating and supporting historically underrepresented students from K-12, community college, undergraduate, and graduate schools with diverse lived and educational backgrounds into disaster and hazard research and spaces. Through the CHARTER Fellows program, we maintain that our model:

1. Assists in combating the barriers that historically marginalized and underrepresented students face by creating a pipeline training cohort system.

2. Increases representation in the disaster and hazards field by centering students that reflect the overall population.

3. Advances disaster science by including diverse perspectives and creating convergent work among other researchers, practitioners, and educators.

4. Creates practical opportunities to produce equitable experiences and educational outcomes for underrepresented groups.

This project highlights our experience developing and facilitating this new innovative minority mentoring model. Through this work, we provide program details, lessons learned, and recommendations for faculty to incorporate our model when engaging with underrepresented undergraduate students.

1. Introduction

Diversifying the STEAM (Science, Technology, Engineering, Arts, and Mathematics) field is paramount, and its implications extend far beyond traditional academic or professional boundaries. Many of the individuals who are underrepresented within the STEAM field are also the ones most disproportionately affected by a rapidly changing climate, inequitably exposing them to many dis-

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asters and hazards. These individuals include but are not limited to, Black, Indigenous, and people of color, including those who identify as queer and non-heteronormative (BIPOC+), folks with disabilities, women, those from low-income households, and the members of the lesbian, gay, bisexual, transgender, queer or questioning, and two-spirit (LGBTQ2S+) community [1,2]. Including historically marginalized and underrepresented groups in the STEAM fields, thus, is not just a matter of equity but serves as a strategic imperative that holds significant potential for advancing disaster and hazard scholarship and working toward equitable adaptation methods and practices for all of society. While underrepresented folks in the STEAM fields have increased and research on diversity issues is ongoing, there is still an ever-present disparity with the lack of diversity in thought, practice, and presence [3–5]. This initiative responds to this need through an ongoing five-year pilot project, which included creating a fellowship program within a larger National Science Foundation (NSF)-funded project, the Cascadia Coastal Hazards and Resilience Training, Education and Research (Cascadia CHARTER) Program. The objectives of the fellowship program, the CHARTER Fellows program, were to 1) identify avenues to diversifying and incorporating underrepresented students and disciplines in the disaster and hazards field; 2) examine the impacts of implementing a culturally sensitive minority mentoring model to assist and support students as they matriculate through school and the fellowship program; and 3) explore opportunities to develop and implement hands-on disaster and hazard-related learning experiences and training opportunities to provide exposure to the field.

Castro et al. found that often, there needs to be more recognition regarding the strength that diversity initiatives can serve in forwarding the primary goals of an institution [6]. Structural impediments often challenge these processes, including deep histories of racism, lack of representation in governance systems, and competing priorities among historically marginalized groups, decreasing opportunities for integrating different knowledge systems and perspectives. Additionally, the underrepresentation of certain groups in leadership positions, academia, and research roles contributes to a lack of role models, which creates challenges for those individuals to envision themselves succeeding in STEAM areas. Other factors likewise create hostile environments and challenges that discourage individuals from pursuing careers in STEAM and from contributing to disaster and hazard scholarship [5,7,8].

Through our objectives and understanding of the need for more co-production of knowledge and inclusion in disaster and hazards scholarship, we developed the CHARTER Fellows Program to 1) assist in combating the barriers that historically marginalized and underrepresented students face by creating a pipeline training cohort system; 2) increase representation in the disaster and hazards field by centering students that reflect the overall population; 3) advance disaster science by including diverse perspectives and creating convergent work among other researchers, practitioners, and educators; and 4) create practical opportunities to produce equitable experiences and educational outcomes for underrepresented groups. We present our experience developing and facilitating this new innovative minority mentoring model and provide recommendations on how other faculty can use our model to engage more significant numbers of undergraduate minoritized students in the future.

2. Background of Cascadia Coastal Hazards and Resilience Training, Education, and Research (CHARTER) program

The NSF-funded Cascadia Coastline and Peoples Hazards Research Hub, or Cascadia CoPes Hub, began in the fall of 2021 between four partnering academic institutions: Oregon State University (OSU), University of Washington (UW), University of Oregon (UO), and California State Polytechnic University, Humboldt (HSU). The Hub comprises various teams of researchers aimed at increasing knowledge and resilience to natural hazards and climate change among coastal communities in the Pacific Northwest (PNW) [9,10] One core component of the Cascadia CoPes Hub is the Cascadia CHARTER Program. Within this Program, we developed a minority mentoring model – the CHARTER Fellows program – for undergraduate students who identify as BIPOC+, LGBTQIA2S+, first-generation, and/or low-income. Ultimately, the CHARTER Fellows program was constructed to provide prospective sophomores or juniors (n = 10 per cohort) with innovative experiences in STEAM disciplinary practices designed to help them successfully matriculate through university life. Additionally, this program incorporates a pipeline technique to support historically underrepresented students from K-12, community college, undergraduate, and graduate schools with diverse educational and lived experiences in disaster and hazard research and spaces.

Through this experience, CHARTER Fellows are exposed to multiple training opportunities focused on supporting and conducting research, coastline threats, vulnerability challenges, and community resilience. Beyond this training and practical application, the Fellows are also tasked with the opportunity to engage in backward mentoring with communities and future Fellows, which includes presenting findings and learnings to educate high school students about events like earthquakes and tsunami inundation threats to communities.

3. Literature review

3.1. Current state of STEAM education and disaster scholarship

Since the 21st century, STEM education has gained traction from elementary to post-secondary schools. Studies argue that this shift toward these disciplines propels students to examine complex societal problems using various scientific and technological methods [4,11]. Educators, policymakers, and other stakeholders concerned about a rapidly changing society have long advocated for integrating STEAM education [4,11,12]. Including the 'A' in the now-evolved STEAM education tract integrates the principles and foundations of art-focused subjects like multimedia, language, and social studies to complement the other sciences, thus broadening perspectives and methodologies in the overall research field. This evolution and transformation of the STEAM movement was in the hope of enacting social change, improving human dynamics and adaptability, and moving society forward, all to enrich students' lived and learned experiences [4]. Most research on STEAM education often interrogates the dynamics of curriculum development, pedagogical techniques, and building skills applicable to forward society [13,14]. Others have even investigated the intersection be-

tween gender and racial biases, identity formation, empowerment, and agency [15,16]. Despite such calls and understandings, however, historically underrepresented individuals remain overshadowed within the STEAM discipline and excluded from disaster risk reduction practices, techniques, and discussions even though there is an understanding that they are the communities most disproportionately susceptible and impacted by such climate hazards [17,18].

The environmental, disaster, and hazard fields have historically been white and male-dominated, with many studies highlighting the implications of patriarchy, white supremacy, systemic barriers, and financial strains that occur for underrepresented scholars [19–22]. For instance, research and projects in STEAM, disaster, and climate change often require substantial funding and have traditionally flowed to well-resourced or predominately white institutions [23–25]. While there have been significant efforts to diversify, especially after the resurgence of the Black Lives Matter movement following the murders of Breonna Taylor and George Floyd, underrepresented groups have continued to face challenges when applying for and securing funding, limiting their ability to pursue innovative research and contribute to scientific advancements [17,26]. These efforts to acknowledge and integrate students and faculty who vary in disciplines and social identities (e.g., race, gender expression, age, sexual preferences) at research-intensive institutions and universities have fallen far short of their lofty promises for structural and institutional change.

Without the perspectives of these marginalized groups with respect to disaster preparedness research and community preparation, current research leaders are destined to continue making assumptions about the needs of these groups. The diversity of perspectives from this unique group of researchers will likely ensure that vulnerable communities facing life-altering impacts like future earthquakes, extreme heat, and tsunamis are better prepared for the event and the recovery period afterward. As such, there needs to be a focus on incorporating folks who identify with these communities in these research fields and disciplines to ensure their adaptability and recovery process to climate change impacts is as equitable and comparable to their more privileged counterparts.

3.2. Processes of marginalization for historically underrepresented groups

In the STEAM fields, processes of marginalization and exclusion manifest in several ways, impacting disaster scholarship and society at large. For instance, compounding structural barriers, including unequal access to quality education, lack of social support and resources, and limited financial assistance, all contribute to how marginalized individuals navigate academia and the STEAM disciplines, historically limiting their ability to contribute to disaster research and solutions [17,18]. Dominant Western-based knowledge systems within academia also contribute to the marginalization or devaluation of other knowledge systems, especially within the STEAM fields. Such overshadowed viewpoints include Indigenous or community-based knowledge relevant to disaster experience, adaptation, and resilience [27,28]. This perpetuated devaluation exists because of various power dynamics like sexism and colonization, structural inequities within academia and research settings, and techniques perpetuating exclusionary practices [29–31]. For instance, BIPOC + scholars often have limited access to opportunities, resources, and decision-making roles due to gatekeeping of collaborative opportunities or being over-capacitated without social, institutional, or financial support [32–34]. This bias, as seen in the disparity of federal grant recipients, for example [35,36], limits the integration of diverse perspectives in disaster scholarship. Additionally, biases and stereotypes based on ethnicity, race, gender or gender expression, sexuality, or socioeconomic status can create adverse environments discouraging marginalized individuals from entering or thriving in STEAM fields, hampering their contributions to disaster research and society [37–39]. Addressing these processes of marginalization and exclusion in STEAM fields is crucial for advancing disaster scholarship and fostering a more equitable and resilient society.

For historically marginalized, underrepresented students to be interested in or persist in STEAM-related disciplines, research has shown that they need to develop an STEAM-specific identity that builds on their interest by engaging in disciplinary practices [40–43]. For instance, studies show that when community college students, especially those from low-income or communities of color, have early and positive interactions with university faculty and have opportunities to interact academically and socially with peers at 4-year institutions, it can play a defining role in preparing and supporting students to transfer to 4-year universities [44,45]. The need for such representation is particularly indispensable considering the existing state of the disaster and hazard field is predominately white and/or male. A recent survey of applicants to the highly competitive, career-launching NOAA Hollings Undergraduate Scholarship found that students who identified as White made up 71% of successful applicants. In comparison, Black and Hispanic students comprised less than 5% of successful applicants [46]. Beyond race and gender, specific disciplines (e.g., Meteorology, Engineering, and Earth Sciences) have also comfortably existed in this space, inadvertently excluding social scientists and underrepresented scholars who often confront barriers to participating in and contributing to disaster and hazard research [2,47]. Many competitive scholarship and fellowship programs nationwide have low numbers of traditionally underrepresented students in their programs [48]. Historically embedded and ever-present inequities, such as systemic racism, ableism, socioeconomic disenfranchisement, homophobia, patriarchy, exclusionary academic and learning environments, and sexism, are some of the causes of these barriers [49–54].

3.3. Incorporating historically underrepresented STEAM perspectives in STEAM and disaster/Hazard research

Prior research has supported the importance of conceptualizing opportunities for forwarding disaster research by incorporating diverse ideologies, frameworks, individuals, and techniques to promote social change and increase society's capacity to address current and upcoming threats [17,21,55]. Diverse scholarship in climate and disaster studies is immensely valuable as it brings forth unique perspectives, innovative solutions, and inclusive approaches that might otherwise be overlooked. For instance, Indigenous communities possess deep knowledge about their environments, including early warning signs, adaptive practices, and sustainable resource management techniques, like Indigenous fire management practices influencing modern wildfire mitigation approaches ([56–58]). Incorporating individuals like Indigenous folks and traditional ecological knowledge systems into disaster studies can enrich our understanding and lead to more contextually relevant, culturally sensitive resilience strategies.

To address the multifaceted climate and environmental challenges, some have advocated for a systemic approach to broaden public knowledge and engagement between both scientific experts and civil society actors [59]. Many studies highlighted various approaches and methods to address extreme events and have primarily centered on ethics and procedures for training and educating future generations of researchers and practitioners [17,60–62]. This point is especially pertinent as the threat of climate-related disasters is increasing and highly concerning. In such endeavors, scientists and community members must align perceptions of what constitutes as useful scientific knowledge, including how, where, and for whom it is applied since communities vary according to location, cultural, social, and political history, hazard coping strategies, and knowledge bases [63–65]. Tribal communities throughout U.S. coastal regions, for example, have played critical roles in shaping awareness of coastal hazards. Especially with incorporating Traditional Ecological Knowledge (TEK), such awareness has led to a better understanding of climate-related risks and influenced preparedness-promoting policies [66]. Previous research suggests that integrating TEK and local ecological knowledge (LEK) can help yield more holistic, contextualized, and historically informed approaches to disaster risk assessments [67–70].

With findings and understandings like these, scholars have highlighted the various ecological, social, and land-based vulnerabilities that will negatively impact under-resourced and historically marginalized individuals and the various strengths they have used thus far to mitigate current threats [71–73]. As Errett has found, disaster research can significantly evolve by incorporating these individuals as they are familiar with the issues and nuances that exist for communities most vulnerable to disasters [18]. These individuals likewise hold relationships with community members and leaders, which can increase the number of participants who contribute to disaster scholarship and community resilience. As such, calls for groups like women and BIPOC + have increased, pushing research and the disaster field to begin reflecting the overall population. This integration can be critical in advancing disaster science and current actions used to serve the greater public. Such recognition has prompted calls to involve individuals and scholars who identify with these individuals, who will fall victim to these vulnerabilities. This push forward is argued to ensure a sound, equitable, and reflective research process reflective of the communities they serve, study, and advocate for [17,74,75]

Additionally, researchers from social science backgrounds like Sociology, Public Health, Communications, and Anthropology frequently focus on social vulnerability, understanding how social factors like race and ethnicity, class, sexuality, and gender intersect with disaster impacts [55,76,77]. Works rooted in such disciplines frequently highlight disparities in disaster impacts, informing policy and interventions to address systemic inequalities, thereby creating more equitable and effective resilience strategies. Community-based participatory methods, a technique social scientists often employ, involve collaboration between researchers and communities affected by disasters, empowering community members as co-researchers [78–80]. Such techniques ensure marginalized communities' lived experiences and priorities are at the forefront of research, leading to more relevant and impactful interventions tailored to their needs. Feminist and queer scholars explore the gendered impacts of disasters and hazards, considering how gender roles and power dynamics influence vulnerability and adaptation strategies [81–83]. This perspective sheds light on overlooked aspects of climate impacts, informing gender-responsive policies and resilience-building efforts, ultimately highlighting underscored nuances, thus benefiting the entire community. Incorporating these perspectives into research and policy-making leads to more holistic, culturally competent, and practical approaches to mitigate, respond to, and recover from disasters, benefiting society by fostering resilience and equity.

3.4. Gaps in current inclusion methods and practices

While these and other studies have called for integrating underrepresented groups in the STEM field (ibid), few programs integrate STEAM-related disaster and hazard scholarship, with a diversity program focused on training and mentoring folks from underrepresented disciplines and backgrounds. There is also limited research on programs that address the barriers, hindrances, and learning opportunities formulated for historically marginalized and underrepresented students from primary, secondary (i.e., K-12), and postsecondary schools (i.e., community college, undergraduate, graduate, and postdoctoral programs) [84,85]. In the STEAM fields, technologies, and tools are often designed without inclusivity in mind. Ensuring that technologies are accessible to individuals with different abilities is crucial for fostering a more inclusive environment. However, education, training, and disaster preparedness resources are not always distributed equitably. Inclusion methods should address disparities in resource allocation to ensure that all communities have access to the necessary tools and knowledge, providing them the opportunities to engage in disaster and hazard scholarship. Additionally, inclusion methods should account for the intersectional experiences of individuals, acknowledging that they may face multiple layers of discrimination [55]. Moreover, there needs to be more information on how existing programs work toward creating a supportive pipeline for underrepresented groups to evolve and integrate their interests into disaster and hazard-related research and scholarship.

Mentoring initiatives tailored to the needs of marginalized individuals in STEAM fields can create a ripple effect. If conducted intentionally, these programs empower individuals and contribute to a more diverse, inclusive, and innovative climate and disaster studies landscape. Exclusive networks and gatekeeping practices within STEAM disciplines may prevent marginalized individuals from accessing mentorship, collaborations, and publication opportunities, hindering their participation and impact in disaster research [86,87]. The exclusion of their diverse voices in disaster scholarship also leads to limited perspectives within the field, hindering the development of comprehensive, culturally sensitive, and inclusive solutions to address hazards and climate change impacts [18]. By addressing structural barriers, nurturing diverse perspectives, creating inclusive and equitable environments, and encouraging holistic development, mentorship can be a powerful tool for cultivating a generation of scholars and practitioners who can contribute meaningfully to addressing complex challenges like climate change and disasters in ways that benefit society.

These gaps call for research and methods to conceptualize how to acknowledge and directly combat spaces of discrimination (e.g., lack of social support or networking opportunities) to promote a pathway to diversifying the field with underrepresented individuals and social science-related disciplines. This pilot project aims to address those gaps.

4. Methodology and framework

4.1. Cascadia CHARTER Fellows Program Design

Many Cascadia CoPes Hub partners have tried various innovative approaches to create productive STEAM pipelines for underrepresented students. To engage underrepresented students in disciplinary practices, we recognized that we needed to adapt and plan for living in a post-COVID-19 environment that may restrict travel and in-person interactions. To date, most innovative mentoring STEAM programs have been small-scale (n ≤ 10 participants) and difficult to replicate or scale up. In response, we collaborated across four universities and one community college to leverage the normalized use of Zoom and existing social media technology to create a multi-campus mentoring program for up to 30 nontraditional undergraduates. We aimed for a balanced group that is geographically, racially, economically, sexually, and ethnically diverse, has an equitable gender ratio, and comes from coastal, urban, semi-rural, and rural communities. As a result, the CHARTER Fellows Program takes a hybrid delivery format for many activities across the hub's geographically separated campuses. This technique is serendipitous since the hub involves multiple universities. Each has created target programs and plans for recruiting, retention, and graduation rates for low-income households, gender-diverse, and students of color in STEAM fields. We utilized email, traditional posters, campus networks, and Twitter as outreach tools to share Cascadia CHARTER activities, Hub products, and findings about the future of coastal Cascadia—leveraging and expanding our contacts within the region.

During this three-year fellowship, Fellows met in person for key opportunities and more regularly across partner institutions via Zoom and received a stipend to support their participation. Ultimately, CHARTER Fellows 1) gain exposure to integrating hazard assessment, mitigation, and adaptation— including comprehensive planning, policy-making, and exposure to some engineering; 2) are exposed to the dynamics of science communication; and 3) participate in hub-related disciplinary practices. They also engage with project researchers and partners, graduate student trainees, and postdocs. As each fellowship ends, we recruit new Fellows into the Program. This results in a cohort of up to twenty in the fellows pipeline.

4.2. Recruitment and sample

Historically marginalized racial groups are currently underrepresented in STEAM disciplines relative to the general population at each of the Hub's partner institutions. Across Cascadia (congressional districts, ACS 2019), Hispanics are 14.8% of the population, Blacks/African Americans 2.3% of the population, and American Indian/Alaska Natives (AIAN) 1.6% of the population. Hispanics/Latinos and AIAN are underrepresented in both undergraduate and graduate enrollments across OSU, UW, UO, and HSU (11.5% of undergrad students are Hispanic/Latino, 0.6% AIAN; 7% of grad students are Hispanic/Latino, 0.7% AIAN), and in degrees conferred. Underrepresentation is even more significant in STEM degrees conferred, e.g., women (35%), Hispanic/Latinos (3%), Blacks/African American (1.4%), and AIAN (0.7%) [88].

As such, in years one and two, we identified and recruited up to ten underrepresented students and mentored them to be CHARTER Fellows based on criteria that often create barriers to their inclusion in disaster and hazard scholarships. We sought candidates who were sophomore, junior, or transfer students at Hub institutions to ensure at least two years of participation in the Program. We avoided freshman students because they have proven in the past to be too new, i.e., "green" to the institution. While the applicant's GPA was considered, the individual's goals, interests, time commitment, and social and educational background all contributed to their selection or acceptance into the Program. Other contributing factors included whether they were the first in their family to attend college or were Pell Grant recipients, which we used as a proxy measure to operationalize the lower socio-economic status of individuals.

Research has shown that underrepresented students are more likely to apply and successfully compete for positions when they feel personally welcomed and supported by the host organization, with best practices including in-person meetings, interviews, and mentoring throughout the application process [89–91]. For outreach, team leads tapped into existing organizations on all Hub campuses focused on the success of underrepresented students. Some of these organizations included the Louis Stokes Alliance for Minority Participation (LSAMP), the College Assistant Migrant Worker Program (CAMP), Minorities in Agriculture, Natural Resources, and Related Sciences (MANRRS), Science & Math Investigative Learning Experiences (SMILE) program; and Indian Natural Resources, Science and Engineering Program (INRSEP) + Diversity in STEM. We also tapped into the network of university-wide professional college advisors.

5. Cascadia CHARTER program activity overview

Through three programmatic areas, the Cascadia CHARTER Program aims to help build, strengthen, and reinforce the science identities and stretch the STEAM pipeline of underrepresented populations by expanding opportunities to participate in informal and formal training, education, and co-produced hazards science research at the elementary, middle school, high school, community college/undergraduate, graduate, and postdoctoral levels. Two of the three Cascadia CHARTER Program areas focus on students at the undergraduate level or K-12, described below.

5.1. CHARTER Fellows Program: Undergraduate students from 4-yr & 2-yr institutions

The cohort's first year is dedicated to building skills and knowledge: leadership, communication, and presentation skills; the human and natural history of the Cascadia region; scientific inquiry, the principles of conducting transdisciplinary science in teams, and disciplinary research methods; and interpreting and communicating science as it relates to hub-specific research. CHARTER Fellows participate in a one-week mini-boot camp on the West Coast each year. During this time, Fellows meet Hub researchers to learn about their respective areas of research, interact with the graduate students and postdocs who are part of the Cascadia Graduate Research

Traineeship physically come together, and begin to identify how they can participate in the Hub's research for the remainder of their fellowship. Additionally, during this time, Fellows are immersed in the hub's natural hazards research efforts through lectures, demonstrations, and model simulations; learn about the local community where the boot camp is being held and the issues and solutions related to natural hazards; and begin to explore or apply their previous learning as it relates to engaging in research. Fellows also work on team building, confidence-boosting activities, identity development, and leadership activities throughout the project duration [92]. Table 1 below is an overview of the CHARTER Fellows Program, including the objectives/goals of the Program, the accompanying student-centered activities, and the proposed and preliminary outcomes.

5.2. Cascadia TEACH: higher education-K-12 citizen science research experiences

The objective of these funded class field trips is for the Fellows to train high school students (whom they will have met and mentored already) to collect data in their communities (surveys, interviews). While not yet launched, this research experience aims to connect with STEAM teachers from high schools in various collaboratories to gauge their interest in a hub-related citizen science project. Data collected by the high school and CHARTER Fellows will then be integrated directly back into the Hub. The overarching goal of Cascadia TEACH is to link hub researchers with community college and secondary school educators and exchange research and experiential-based knowledge to explore and test ways in which citizen participation in landscape change simulation modeling and engagement with local places and people can influence perceptions of society's choices and enhance coastal hazard preparedness. Some activities we propose include: 1) enacting a Cascadia teacher training focused on exploring coastal hazards; 2) alternative future modeling tools for participating teachers to utilize in their classrooms; 3) collaborating with middle school students and artists to create visual representations of their understanding of environmental change, natural hazards, the modeled outputs of the hub, and what that means to their communities; and 4) the contribution to existing educational programs dedicated to historically marginalized folks to determine if and how Cascadia TEACH and CHARTER Fellows' learning and products can be used in their educational or informational resources and activities. Fellows' training of high school students is meant to position them as disciplinary experts and mentors for students who may relate to them across various identities.

In sum, through the Cascadia CHARTER Program, our vision is to build, strengthen, and reinforce the STEAM identities of Cascadia CHARTER participants and stretch the STEAM pipeline through the middle school to postdoctoral levels so that we might increase our mentoring footprint to 300 or more middle and high school students who become more exposed to and engaged in STEAM disciplinary practices; and, that they might see, or have reinforced, the possibilities of a future college-level career.

6. Outputs of program 2 Years post-launch

Table 2 below provides an overview of the demographics of CHARTER Fellows from Cohorts 1 and 2, highlighting key factors such as race, gender identity, Pell Grant status, disability, sexual orientation, and whether they are the first in their family to attend college. In Cohort 1, the racial distribution includes Black/African American, Hispanic/Latino, White/Native American, Asian, Biracial, and White individuals. Gender identity encompasses women, men, and individuals identifying as transgender or genderqueer. The data also delves into Pell Grant status, disability, and sexual orientation categories. Cohort 2 exhibits a similar breakdown, al-

Table 1

Overview of the Cascadia coastal hazards and resilience training, education, and research (CHARTER) fellows program.

Objectives and Goals	Fellow-Centered Activity	Outcomes of Program
This program works to do the following: 1. Increase students' basic knowledge and awareness of tectonic and climate-driven coastal hazards. 2. Provide underrepresented students access to extracurricular activities and mentoring that enhance their knowledge, awareness, and experience with tectonic and climate-driven coastal hazards. 3. Increase the exposure to research-based practices to discover and further the knowledge and awareness of tectonic and climate-driven coastal hazards. 4. Track students' post-graduation trajectory for five years after completing the CHARTER Fellowship to document their continued participation in STEAM-related careers and education.	Orientation: → Fellows engage in a 3-h orientation to review the goals and objectives of the Program, meet other fellows, listen, and share what motivated them to apply for the Fellow's Program. → Fellows learn to identify critical elements for making presentations accessible to the general public. Institutional All-Hub Team Meeting: → Fellows attend a yearly All-Hub meeting with the collaborating institutions to engage with researchers, mentors, students, and practitioners. Qualitative Training: → Fellows participate in five training sessions lasting up to 75 min. Summer Boot Camp: → Fellows participate in a 3-day in-person training boot camp. Activities include lectures, cohort bonding, science communication practice, community engagement, and model simulations. Back to School Orientation: → Fellows matriculate to the next year of the CHARTER Fellows Program, where they choose to work under a researcher or 'backward mentor' an incoming Fellow.	Once completed, Fellows will be able to do the following: 1. Define and describe at least three different qualitative research methods for data collection and practice collecting data using at least two different qualitative research methods. 2. Define basic concepts that are key in hazard mitigation knowledge. 3. Describe Traditional Ecological Knowledge (TEK) and Local Ecological Knowledge (LEK) and their relation and role in hazard mitigation knowledge. 4. Identify and define adaptive capacity variables that communities can take to mitigate hazards. 5. Compare and contrast different communities' capacities to mitigate hazards. 6. Practice supporting community engagement activities that include communicating science.

Table 2
Overview of the demographics of CHARTER fellows from cohorts 1 and 2.

	Race	Gender Identity	Pell Grant Status	Disability	Sexual Orientation	1st in family in college
Cohort 1	Black/African American (n = 2) Hispanic/Latino (n = 4) White/Native American (n = 2) Asian (n = 0) Biracial (n = 1) White (n = 1)	Woman (n = 4) Man (n = 5) Trans (n = 1) Genderqueer (n = 0)	Yes (n = 5) No (n = 5)	Yes (n = 2) No (n = 8)	Heterosexual (n = 6) Bisexual/Pansexual (n = 3) Gay/Lesbian (n = 0) Queer (n = 1)	Yes (n = 5) No (n = 5)
Cohort 2	Black/African American (n = 1) Hispanic/Latino (n = 1) White/Native American (n = 1) Asian (n = 1) Biracial (n = 1) White (n = 5)	Woman (n = 7) Man (n = 2) Trans (n = 0) Genderqueer (n = 1)	Yes (n = 3) No (n = 7)	Yes (n = 2) No (n = 8)	Heterosexual (n = 4) Bisexual/Pansexual (n = 2) Gay/Lesbian (n = 3) Queer (n = 1)	Yes (n = 5) No (n = 5)

lowing for a comprehensive comparison between the two cohorts. This information offers insights into the diversity and characteristics of CHARTER Fellows across the specified demographics.

6.1. Demographics of current fellows

After two years of cohort building within the CHARTER Fellows Program, there are 19 active undergraduate Fellows. Some majors represented by the Fellows include Environmental Science, Physical Therapy, Public Policy, Medical Anthropology, Geography, Library Studies, Environmental Justice, Sociology, Emergency Management, and Urban Planning. Within Cohort 1, 10 undergraduate students were recruited, with two Fellows only completing one year in the Program and deciding not to matriculate through the fellowship due to other personal and academic responsibilities. A significant issue was the need to hold down paid employment to pay for school. In Cohort 2, 10 undergraduate Fellows were initially accepted into the Program. Due to conflicting scheduling and other responsibilities, such as outside jobs and internship opportunities, three Fellows reluctantly declined to finish the Program. However, the team leads continued actively recruiting students who would greatly benefit from participating with the CHARTER Fellows to backfill the spaces when someone drops out.

6.2. Current opportunities for research and training

This Program aimed to expose underrepresented students from various disciplines to research-based practices to discover and further their knowledge of community-based techniques and methods. To put their training into practice, in Spring 2023, Cohort 1 Fellows co-created a survey for folks ages 18 and older to understand their risk perception and preparedness efforts towards future earthquakes and tsunamis in the PNW. This survey design consisted of 10- 1 h-long meetings where the Fellows would brainstorm and develop the survey. Five Fellows from Cohort 1 have taken the data results from this project (n = 520) and created their own research projects and goals, presenting them at various conferences and professional meetings. Topics included barriers and experiences faced by transfolk and risk perceptions of the Latine/a/o community. Such a practice exposed the students to the nuances of quantitative, qualitative, and community-engaged research, including removing biases, being inclusive and intuitive, and asking questions often overlooked in past surveys.

Cohort 2 Fellows will simulate this training exercise, learning qualitative research techniques. The Fellows will co-create interview protocols to explore further the findings and conclusions that Cohort 1 found. Both projects will work towards advancing disaster science by considering perspectives from younger members of society, thus reflecting the current state of vulnerable populations and creating space for questions concerning gaps in current preparation techniques.

Both cohorts have experienced intensive summer boot camps to expose the Fellows further to developing a STEM identity. This 3-day training consisted of community engagement activities with coastal communities in Oregon and Washington, including local government officials, tribal communities and leaders, local businesses, schools, and universities. This Bootcamp, which was consistently regarded as a highlight of the Program, worked to bring awareness to the different cultural values, techniques, and methods used by coastal communities to build up their resilience in the face of climatic and environmental hazards like sea-level rise, flash flooding, earthquakes, and tsunamis. Fellows were also exposed to technological resources like drones, iPADs, cameras, and apps to gain awareness of the benefits and existence of modern and upcoming tools used by well-resourced institutions and communities. Through this training, Fellows engaged in activities including community asset mapping, critiquing and examining recently passed policies in California, meeting with tribal councils and communities, and visiting the vertical evacuation center. Four out of 10 Cohort 2 students did not participate in the Bootcamp training because of time conflicts or because they received a summer internship closely related to their interests.

6.3. Graduation and beyond

To track our progress with students, we conducted exit interviews with Fellows who chose to leave the fellowship early or have graduated through the Program. Ideally, we would follow the Fellows' journey up to 5 years after graduation to continue providing mentoring or social support. What we have seen, however, is that our students are only around for up to two years. One problem we had is that our Fellows are movers and shakers on their respective campuses; hence, over time, they get involved in other activities at university and then drop out of our Fellows' Program in pursuit of something else, like participating in study abroad internships, stu-

dent government, other training programs or leadership opportunities that can assist with their academic and personal careers. While most students who have decided to leave the fellowship have cited other responsibilities as the catalyst to their departure, they all believed the Program was beneficial and an opportunity they would suggest to their peers. In understanding these dynamics and the nuances that exist for students who require more support, we aim to adjust our Program to work to build sustained membership and launch programs like the Cascadia TEACH Program. This Cascadia TEACH Program, for example, needs modifying so that we are trying to match them up with researchers in the Hub who are not returning to school.

7. Discussion

Engaging underrepresented students in disaster, hazard, and climate-related research is not just a matter of diversity and inclusion but a necessity for addressing the complex challenges we face as a global society. Training and engaging underrepresented students in these fields holds immense importance for building a resilient, effective, and holistic approach to mitigating the impacts of natural hazards, disasters, and climate change. True progress in tackling hazards and disasters requires a multiplicity of perspectives, as the impacts of disasters and hazards are felt differently across various communities. This progress, however, requires recognizing that these issues disproportionately affect marginalized communities, who often have less access to resources and decision-making processes. By involving underrepresented students, this fellowship Program brings fresh viewpoints considering social, economic, and cultural factors, leading to more nuanced and effective strategies. This diversity of such viewpoints is crucial for generating innovative solutions considering the complex interplay between social, economic, and environmental factors.

Mentorship fosters a sense of belonging, builds confidence, and encourages leadership, ultimately contributing to a more inclusive and skilled workforce, especially concerning disasters, hazards, and climate change overall. Methods rooted in intention play a pivotal role in nurturing talent and empowering underrepresented students. By providing mentorship opportunities, established professionals guided and supported these students in understanding the nuances between their identities, their chosen disciplines, and the disaster and hazards fields. This mentoring Program was created to ensure that students who are historically overshadowed and uninvolved in this field feel supported academically and socially as they matriculate through their academic journey, helping them navigate the challenges and barriers they might face. The CHARTER Fellows Program worked to have several points of contact and resources for the Fellows to lean on for academic and social support. Some actions include having consistent training meetings, emphasizing the benefits and opportunities that exist in the program, and providing hands-on experience. Through these actions, our efforts helped to support student development and provide direct academic and social support in navigating their interests.

The participation of students with diverse educational backgrounds and disciplines also enriches the research landscape within the Hub and the disaster and hazards field overall. For instance, incorporating social sciences, humanities, and arts alongside traditional STEM disciplines could offer a more holistic approach to understanding and mitigating the effects of coastal hazards. Integrating folks in medical anthropology could provide insights into community responses to health-related dynamics of disasters. At the same time, artistic expressions help communicate scientific findings to the general public more effectively. Additionally, the ongoing recruitment of new Fellows ensures the continuity of diverse perspectives, knowledge, and experiences within the Program. This succession planning sustains a culture of inclusivity and innovation, fostering long-term impacts on research and community resilience efforts.

Engaging underrepresented students enriches the field with fresh perspectives on adaptation, mitigation, and community resilience. By involving individuals from diverse backgrounds, we worked towards increasing the likelihood of implementing culturally sensitive, contextually appropriate, and sustainable strategies in the long term. Moreover, collaborating with underrepresented communities in disaster and hazard work empowers them to shape policies that directly impact their lives. For instance, the inclusion of historically marginalized groups in the Cascadia CoPes Hub, such as BIPOC+, LGBTQIA2S+, first-generation, and low-income students, fostered a more comprehensive understanding of hazards and disaster impacts. Including Indigenous perspectives and culturally sensitive techniques in their disaster resilience training acknowledges traditional knowledge and offers effective community-centered solutions rooted in cultural practices and values, thus widening their exposure to non-western methods and encouraging creativity when considering how to integrate their current skills within their disaster work. With these practices, we encouraged students to become ambassadors of change by fostering an inclusive environment, spreading awareness, and advocating for policies prioritizing climate and environmental justice, regardless of their participation in the fellowship program.

8. Recommendations

8.1. Create engagement strategies cognizant of barriers faced by underrepresented individuals

Research has shown that underrepresented students are more likely to apply and successfully compete for positions when they feel personally welcomed and supported by the host organization, with best practices including in-person meetings, interviews, and mentoring throughout the application process [89–91]. As underrepresented students and scholars often face challenges beyond academia (e.g., financial constraints and lack of social support), we recommend implementing direct outreach cognizant of the barriers and needs of such underrepresented students. Addressing structural impediments by recognizing and confronting deep-seated issues like racism, lack of representation, and competing priorities among historically marginalized groups within academic institutions works to ensure that the students feel validated and supported in a field where representation of folks who identify with them is often low.

Additionally, establishing and cultivating mentoring models that combat barriers faced by underrepresented scholars exposes them and provides them with the necessary guidance, resources, and opportunities to engage in the disaster and hazards field and participate meaningfully. Mentoring models designed to be culturally sensitive and inclusive can counter deep-seated issues like

racism, gender bias, and economic disparities, thereby fostering an environment that is more welcoming and supportive for all. Such programs also empower individuals from underrepresented groups by providing encouragement, guidance, and validation for their contributions to climate and disaster studies, boosting their confidence and engagement. We recommend establishing mentorship models similar to the CHARTER Fellows program, explicitly targeting underrepresented students across educational levels (e.g., K-12, undergraduate, graduate, and postdoctoral) and financial backgrounds (e.g., considering Pell Grant status) to provide guidance and support for their integration into disaster research spaces. Allocating stipends to all students participating in disaster-related programs works to acknowledge and address the financial barriers that may hinder their involvement. Continuously assessing the effectiveness of these programs and initiatives through feedback loops and evaluation metrics also allows for adaptive improvements and long-term success.

We maintain that developing programs akin to the CHARTER Fellows program, focusing on creating pipelines that support historically marginalized and underrepresented students, not only benefits their academic growth but also amplifies community engagement and outreach efforts. For instance, involving these students in public-facing activities and backward mentoring helps bridge the gap between scientific research and the general population, enhancing science communication strategies tailored to various audiences. This approach also allows for intergenerational learning, empowering high school students with valuable information about hazards and resilience strategies. Moreover, it works towards creating a cycle of knowledge sharing that could be sustained beyond the duration of the fellowship, continuously enriching the community's understanding of hazards.

8.2. Implement direct learning and training programs and opportunities

Access to resources is fundamental to enabling meaningful participation. Many underrepresented students need more resources to pursue education and training in these specialized areas or may not be exposed to or encouraged to engage in climate and disaster work. The Cascadia CHARTER Program works to expose students to communities, academics, and practitioners from various fields and provides access to different types of work they participate in outside of the traditional ones that exist in their respective fields. Such implemented and intentional exposures encouraged students to envision their pre-existing skills and how they can accompany the knowledge and opportunities they receive through the CHARTER Program with their careers.

We recommend designing and implementing practical opportunities that promote equitable experiences and educational outcomes for underrepresented groups to open access to resources and support. Developing courses integrating disaster studies with diverse disciplines and acknowledging the value of interdisciplinary perspectives work to address the complex challenges that underrepresented individuals and communities face, especially in academic settings. Providing training in hazard assessment, science communication, policy-making, and engineering aspects of disaster mitigation acknowledges the need for diverse skill sets in addressing disasters and hazards. Integrating such perspectives expands opportunities for underrepresented students to engage in disaster research and creates inclusive environments within institutions by promoting diverse voices and perspectives in research discussions, project collaborations, and decision-making processes. This process also increases the exposure to a broad range of experiences, from hazard assessment to community resilience strategies.

We also recommend fostering partnerships with other institutions and organizations working towards similar goals, promoting collective efforts and shared resources to amplify impact. Promoting the co-production of knowledge by involving diverse stakeholders in research processes increases inclusive and equitable representation in decision-making and research design. By ensuring equitable access to educational materials, research training, internships, and workshops, we can open doors for individuals who might otherwise be excluded, fostering a more comprehensive and representative workforce. Encouraging convergent work among researchers, practitioners, and educators, emphasizing integrating diverse perspectives to advance disaster science and practice, can also ensure the continuity of programs by planning for the long-term recruitment and retention of underrepresented individuals in disaster research and planning initiatives.

9. Conclusion

The Cascadia CHARTER Program and its CHARTER Fellows Program are viable avenues for the future of mentoring students, especially considering the rapidly changing climate with impending disaster events and hazards. Creating a proactive, faculty-led, and well-resourced program that inserts students into the research team establishes a sense of belonging, mattering, and respect for their contributions to the overall ideas and suggestions. The Fellows, representing multiple underrepresented and marginalized communities, also helped connect the project with communities experiencing high risks and vulnerability as they are used as the 'face' of those who assist with data collection and community outreach.

As such, we maintain that incorporating underrepresented students in STEAM and climate-related scholarship is a win-win scenario, not just an ethical pursuit but a strategic imperative. Embracing true equity, diversity, mentorship, and access to resources ensures that our efforts to address critical and continuously overshadowed issues are comprehensive, innovative, and effective. Providing students with opportunities and social capital like resources and meaningful relationships can unlock a wealth of untapped potential to drive innovation and lead to more comprehensive solutions. With this process, we imagine that this intentional, active fellowship program is one that can be replicated for different broader impacts of NSF-like initiatives and other facets dedicated to diversifying an academic space. Society gains from their fresh perspectives, innovative ideas, and dedication to creating a sustainable future. By investing in their education, mentorship, and participation, we pave the way for holistic solutions that genuinely address the needs of all communities and drive us toward a more resilient world. By harnessing a diverse force's collective intelligence and experiences, we are better equipped to create a sustainable and resilient future for all.

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Dr. Lisa Gaines and Dwaine Plaza contributed to the project's conception and design. Dr. José W. Meléndez created the Program's design details and outline, which are presented in Table 1. All of the authors performed material preparation, data collection, and analysis. Dr. Cassandra Jean wrote the first draft of the manuscript, and Lisa Gaines and Dwaine Plaza commented on previous versions. All authors read and approved the final manuscript. The authors declare that they have no conflict of interest.

CRediT authorship contribution statement

Cassandra Jean: Project administration, Supervision, Visualization, Writing – original draft, Writing – review & editing. **Lisa Gaines:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Methodology, Project administration, Resources, Supervision, Writing – review & editing. **Dwaine Plaza:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Project administration, Resources, Supervision, Writing – review & editing. **José W. Meléndez:** Conceptualization, Data curation, Methodology, Project administration, Resources, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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