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Advancing inclusion in the geosciences: An overview of the NSF-GOLD program

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ABSTRACT

Here we report on five pilot projects working to develop effective professional development aimed at improving diversity, equity, and inclusion within the geosciences. All five projects were funded by the NSF GEO Opportunities for Leadership in Diversity (GOLD) program, which was designed to bring together geoscientists and social scientists to create innovative pilot programs for preparing and empowering geoscientists as change agents for increasing diversity. Each project has different objectives and applies different combinations of methods, but focuses on professional development, bystander intervention training, and the formation of new networks in the pursuit of systemic, institutional change. This article describes the origins, aims, and activities of these projects, and reflects on lessons learned to date. These projects are still ongoing, but in their first two years they have received more interest than anticipated and more demand than can be fulfilled, suggesting an unserved need in the field. We have also found that teams with varied backgrounds, experiences, and expertise are vital to overcoming common struggles in facing inequalities. Coaching from experts in diversity, equity, and inclusion keeps the teams motivated, particularly when many team members are accustomed to typical scientific research. Finally, institutional change requires time to catalyze, develop, and institutionalize, highlighting the importance of sustained effort over years.

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Introduction

The share of women¹ earning geoscience degrees has reached 40% (Wilson, 2018), representing a significant increase over the past four decades (Bernard & Cooperdock, 2018), but the discipline still lags behind STEM fields as a whole (NSF, 2017). Over the past 40 years, about 85% of U.S. citizen Ph.D. recipients in the geosciences have come from white, non-Hispanic backgrounds, whereas 7% have come from racially/ethnically underrepresented groups (i.e., African American, Hispanic/Latinx, and Native American; Bernard & Cooperdock, 2018). The remainder are mostly Asian Americans, and a smaller number who do not identify with a single race/ethnicity. The share of underrepresented students earning bachelor's degrees in the geosciences in 2017 was 8% (Wilson, 2018). Over the past

40 years, the proportion of underrepresented groups earning degrees in the discipline has not changed (Bernard & Cooperdock, 2018).

Recognizing the need for systemic change to disrupt these trends and encourage diversity, equity, and inclusion, NSF-GOLD was established. The name GEO Opportunities for Leadership in Diversity (GOLD) is derived from the Directorate for Geosciences (GEO) and the desire to identify and enhance discipline-specific leaders who can make positive changes in the area of diversity. More specifically, the purpose of GOLD is to prepare and empower scientists to become agents of change for increasing diversity. GOLD Program leaders at NSF employed a novel method, called an “Ideas Lab,” for achieving these goals.

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¹We use women/men for NSF gender identity statistics, reserving the language of female/male for instances in which biological distinctions are relevant to the discussion at hand.

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Origins in the Ideas Lab format

The NSF Ideas Lab is a method to encourage novel questions and ideas from a diverse group of participants. Participants meet for five full days of intense activities designed to challenge, frustrate, stir emotions, and force collaboration. There is little or no agenda shared with participants in advance, and the result is a series of research or other project proposals. The concept was originally created in the United Kingdom in 2003, where they are called “Sandpits,” and NSF has been using Ideas Labs since 2009.²

For the GOLD Ideas Lab, NSF invited a diverse group of 30 participants—geoscientists, social scientists, and other practitioners working in STEM. Led by Knowinnovation, a company that commonly facilitates Ideas Labs and Sandpits (<https://knowinnovation.com>), the end goal for all this creative energy was for these 30 individuals to design and develop collaborative professional development programs that could be field tested with small groups of geoscientists, with the goal of using these pilot projects as a proof of concept to scale up. NSF, in consultation with Knowinnovation, selected geoscientists as well as those with expertise in behavioral change, social psychology, leadership development, and other related areas. NSF also brought in a director and five mentors who had histories of working in the areas of diversity, equity, and inclusion in science. Although the mentors participated fully in the Ideas Lab, they were not eligible for funding because they were also acting as impartial reviewers of the participants working toward proposals.

Every day of the Ideas Lab was densely scheduled, with breaks for little more than three meals from 8 a.m. until 8 p.m., and most participants continuing to work together until around midnight each day. This process resulted in several great ideas. Many participants had at least some role in multiple ideas, and not all great ideas were fully developed. Nevertheless, by the end of the week, participants pitched the most feasible and most popular six proposals to a panel of NSF program officers. Based on these presentations, NSF invited the most promising projects to submit full proposals to NSF. Five proposals were eventually funded.

GOLD projects

The author team of this commentary includes at least one principal investigator (PI) from each of the

projects that are funded by NSF GOLD. The projects seek to build leadership capacity of individual scientists and the organizations in which they work. Collectively, the projects capture the multiple contexts in which geoscience education occurs, and aim to:

- cultivate an ethical model of community-based geoscience research,
- create more equitable cultures of geoscience fieldwork,
- leverage the influence and wisdom of senior scholars toward inclusion,
- empower faculty to recognize and respond to prejudice in workplaces, and
- change departmental culture by supporting small groups of change agents.

In what was an initially discomfiting aspect of the initiative, NSF representatives pushed the PIs to orient projects toward engaging with parties other than students—namely, toward people with power to make decisions that affect student participation. This conceptual orientation is consistent with evidence that organizational change can happen by changing the mindsets and practices of gatekeepers and other leaders (Bensimon, 2005; Kezar, 2012; Posselt, 2016).

In this respect, the inclusion of both geoscientists (about 75%) and social scientists (about 25%) on project teams has been a defining feature of GOLD. It enables a crucial strategy across these diverse projects: equipping geoscientists, who are not trained in social science, with current theories for (a) discussing diversity, equity, and inclusion; (b) implementing effective educational practices; and (c) effecting changes toward these goals. Well-intentioned geoscientists may know, for example, the importance of saying something when they see harassment or assault, but rarely do they know how to handle such situations when they arise. Training in bystander intervention in three of the five GOLD projects has begun to empower scientists with knowledge and skills to make their work more inclusive.

Summaries of projects, research, and theories

In addition to their shared origins in the Ideas Lab process and multidisciplinary leadership teams, the initial GOLD projects have conceptual and programmatic similarities, which are summarized in Table 1. All five include professional development opportunities for participants and are oriented toward the broad aim of changing institutional culture. Three of the five

²For details and history of the Ideas Lab format within NSF, see https://nsf.gov/discoveries/disc_summ.jsp?cntn_id=136669. For details of the original solicitation by NSF-GEO, see <https://www.nsf.gov/pubs/2016/nsf16516/nsf16516.htm>.

Table 1. Features of NSF-GOLD pilot projects.

Project	Professional development included	Bystander intervention training	Explicitly addresses systemic issues	Forms new social or professional networks	Changes institutional culture
ASPIRE Community-engaged science broadens vision of what and whom science is for; social science research design contributes to reflection and growth by mobile working group leaders.	Y	Y	Y	N	Y
FIELD Focus on field work; participants were leaders of field experiences at a variety of institutions, representing a full range of career stages.	Y	Y	Y	Y	Y
GeoDES Mixed-reality simulations to help geoscience faculty identify prejudices and prejudicial structures, and then take action to redress those issues.	Y	Y	Y	N	Y
Hearts of Gold Multiple cohorts of senior scientists learning how to use their influence to spread allophilia (i.e., love of those who are different) in support of healthier cultures for diverse students and colleagues.	Y	N	Y	Y	Y
Sparks for Change Mentoring triads of early-career faculty from an underrepresented group, senior faculty, and external expert on broadening participation.	Y	N	Y	Y	Y

create new social or professional networks; all five explicitly address equity, diversity, and inclusion as systemic issues; and three offer bystander intervention training as part of professional development.

Active Societal Participation in Research and Education

A common paradigm for science is discovery emanating from curiosity about the natural world, carried out by testing discipline-specific theory. Disenfranchised communities, however, may see problems emanating from environmental injustices as more relevant than theory-generating research; therefore, a growing number of scientists are moving out of the ivory tower and directly into communities to conduct geoscience research that addresses community-identified problems that are both social and scientific. Active Societal Participation in Research and Education (ASPIRE) pilots a model of place- and community-based geoscience research distinguished by scientists and community members, facilitated by an individual who has a foot in both worlds. Together, they collaborate in an ethical exchange of knowledge, values, and cultural perspectives about one specific ecological, environmental, or geoscience challenge. ASPIRE supports six mobile working groups of scientists and community members addressing local challenges using the tools of geoscience. Presently, three groups are supported for research in South Dakota, Hawaii, and Los Angeles, with three more to start up in 2019. One project, led by Dr. Andres Aguilar of California State University– Los Angeles, engages community members who live, work, and play along the Los Angeles River to measure the chemical composition of river water and its safety for various purposes. Their measurements are informing Aguilar’s scholarship and clarifying appropriate uses of the river water. Another study brings together a

family-owned watercress farm just outside of Honolulu with researchers from the University of Hawaii–Manoa to understand how urbanization and changing water policy are affecting the water quality on their farm and, by extension, the crops’ and the indigenous farm’s sustainability.

How projects and others, in practice, resemble the idealized model of ethical place-based research is one topic of research under way. Another research aim is advancing knowledge of what leadership of place-based, community-based science entails. ASPIRE uses cultural sociological theories about social and symbolic boundaries to understand how working group leaders operate as boundary spanners, linking the cultures and approaches to knowledge production among communities and geoscientists. Mobile working groups of PIs are participating in a narrative inquiry over the course of their project—including extended pre/post interviews as well as writing monthly logs on issues of common concern. The ASPIRE pilot strives to integrate both scientists’ sensibilities and those of communities who have been excluded or have opted out of the geosciences.

Fieldwork Inspiring Expanded Leadership for Diversity

Fieldwork is a central activity for geoscience learning and has been characterized as “a key benchmark in the transition from student to scientist and from novice to expert” (Feig, 2010, p. 249). However, cultural dynamics like financial cost, anxiety about outdoor experiences, attitudes of ableism, and threat of sexual assault prevent some people from entering or continuing in the discipline. The association of geosciences with outdoor activity can hinder the engagement of some populations, including those from black, Latinx, and indigenous backgrounds (e.g., O’Connell & Holmes, 2011; Stokes, Levine, & Flessa, 2015). For

these populations, the wilderness can be associated with human histories of natural resource extraction, military expansion, labor exploitation, colonization by settlers, and dispossession of land, each of which has been facilitated in some part by disciplinary practices of geosciences (e.g., Whyte, 2017; Yusoff, 2018). For example, in the United States, slavery and Jim Crow laws made the rural outdoors dangerous for African Americans, especially in the South (e.g., Edmondson, 2006; Finney, 2014; Hackman, 2015); concern about safety in rural areas remains a legacy of this history for some African American college students today. Globally, the mining of natural resources—such as gold, coal, and tin—has been associated with exploitative labor with Asian, black, and indigenous peoples (Whyte, 2017; Yusoff, 2018). Fieldwork Inspiring Expanded Leadership for Diversity (FIELD) aims to raise awareness of historical, engrained barriers in geoscience field experiences and to make field activities more inclusive by equipping leaders with perspective, skills, and solidarity.

The initial phase of the project involved ethnographic research by social scientists (i.e., authors Nuñez and Possett) in an undergraduate field camp and graduate-level field course. Findings highlighted how typical classroom or lab boundaries break down in the field, with positive and negative consequences for inclusivity. Fieldwork demands of generating hypotheses about the formation of landscapes inspires cognitive, social, and physical disequilibria that can inspire unique learning (see Feig, 2010; Mogk & Goodwin, 2012), but it also requires instructors to attend to all students' well-being and engagement. Working long hours in high temperatures, for example, put students in one of the courses at risk for heat stroke.

Next, the FIELD project convened a three-day leadership institute for faculty and field-camp geoscientists. Drawing on the research of the project's first phase, the FIELD Institute at Colorado State University's Mountain Campus offered training in practical skills like bystander intervention and managing cross-cultural relationships. It also facilitated opportunities for collaborative development of new approaches to fieldwork. The final phase will consist of evaluation, assessment, and construction of a professional leadership model based on results of the FIELD Institute. FIELD Institute participants will work together to interrupt and advance new alternatives to these dynamics in their own sites, and the leadership team intends to generate models for

inclusive fieldwork that can be adapted across all educational levels.

Geoscience Diversity Experiential Simulations

Geoscience Diversity Experiential Simulations (GeoDES) aims to provide professional development for a cohort of 30 geoscientists to develop their (a) knowledge of social justice issues in geosciences, (b) bystander intervention skills, and (c) leadership skills for targeting exclusionary gatekeeping decisions. Critical elements of the approach include an intensive three-day workshop and three mixed-reality simulations, which combine human conversational intuition with artificial intelligence. The "human-in-the-loop" architecture used in GeoDES provides highly authentic and realistic scenarios that allow participants to learn and practice specific skills and strategies they learn throughout the project. For example, one simulation provided participants with the opportunity to learn and practice how to recognize biases that arise in faculty search committees and then to advocate for promising candidates who do not possess such traditionally valued experiences as graduating from a prestigious elite university, publishing in a journal the committee members recognize, and having a well-known mentor. Ongoing professional development also included monthly virtual meetings in which participants discussed applying their knowledge and skills to their home institutions.

To date, the GeoDES team has collected longitudinal survey data at four time points spanning one year of participation. We (i.e., authors Chen, Jackson, and Teppen and the GeoDES leadership team) have also collected audio and video data of our participants engaging in the mixed-reality simulations. Although we are in the beginning stages of data analysis, we have some preliminary findings from the quantitative data. Using a Bayesian analytical approach, we found that participants' ($n=29$) beliefs about their individual capabilities (i.e., self-efficacy) and beliefs about their department's collective capabilities (i.e., collective efficacy) to confront prejudices and prejudicial structures grew sharply from the start of the project [Mean (self-efficacy) = 3.45; Mean (collective efficacy) = 3.14] to three months after starting [Mean (self-efficacy) = 4.38; Mean (collective efficacy) = 3.96]. Although self-efficacy had declined to a mean of 3.78 and collective efficacy to 3.28 one year later, there was still overall growth from start to end. To put more fine-grained details to this overall landscape of self-reported changes in beliefs, we plan to use the video

data of participants in the three simulations to explore the variety of ways participants approached the situations presented to them in the simulations and the degree to which they challenged prevailing norms tactfully.

Ideally, GeoDES participants develop multiple habits for leading organizational-level change by (a) intervening whenever exclusionary behavior is witnessed; (b) strategically advocating for marginalized voices when participating in key gatekeeping decisions, such as hiring; and (c) changing institutional policies such as annual merit review processes to reward people who engage in diversity, equity, and inclusion efforts. Participants learn a social closure model (Murphy, 1988) that helps articulate the processes by which exclusion occurs. Further, GeoDES participants engaged in mixed-reality simulations in which they *practiced* all three of these forms of leading change. Research can inform the scaling up of this type of innovation to larger groups, thereby generating broader impacts on other fields.

Hearts of GOLD

Hearts of GOLD aims to develop and test professional development training for established scientific leaders in the geosciences—the GOLD Institute—to give them the content knowledge, tools, and skills needed to become champions of change for diversity. It is hosted in Colorado Springs and facilitated by Drs. Dena Samuels and Stephany Rose of the Knapsack Institute at the University of Colorado–Colorado Springs.

Its task is to move attitudes among opinion leaders in the geosciences away from negative intergroup attitudes to positive ones. Pittinsky (2005) described those positive intergroup attitudes as *allophilia*, borrowed from the Greek for “love of the other.” We need to foster those positive attitudes among opinion leaders, because they can promote behavior change among those around them (Valente & Pumpuang, 2007). The method is inspired by Wenger’s communities of practice (Wenger, 2000), in which leaders set the values for the community but often have little access to other communities to bring in new ideas. The GOLD Institute provides this access by hosting two cohorts that receive a two-day, transformative, intensive workshop targeted at existing scientific leaders to develop them as leaders in diversity. These leaders will promote scalable change by taking action to promote allophilia within their home institutions and within their roles as members of professional societies. Furthermore, participants will form a national

network of geoscientists who support each other in extending allophilia throughout the geosciences.

Hearts of GOLD employs the most conservative strategy of the GOLD projects, but it has a multicohort model that will help promote grassroots growth over time. Accordingly, five participants from the first cohort joined those in the second to help bridge the two groups.

Sparks for Change

The Sparks for Change team uses a model of small-group dynamics so early-career, underrepresented minority faculty members can become effective leaders in changing department culture concerning diversity, equity, and inclusion in the geosciences. These groups consist of an early-career, underrepresented minority faculty member and a senior faculty member from the same unit, as well as an expert on broadening participation who is external to that unit. Each member of the small group emphasizes a specific leadership style relevant to his or her position in the department. The project held a three-day workshop in 2017 to highlight these leadership styles, build social bonds within and among small groups for postworkshop support, and develop action plans that use leadership insights to change department culture toward diversity, equity, and inclusion.

Research begins with identifying an institutional inertia in geoscience departments. Although many departments are, in principle, open to diversity, equity, and inclusion, there may nevertheless be benefits to maintaining the status quo. Overcoming the diffuse benefits of the status quo requires groups of active, empowered change agents. The project hypothesizes that small groups of committed change agents will change the department culture with a concrete action plan in order to overcome that inertia (Bergstrom, 2010). This is an emergent approach to changing department culture specific to the institution where change agents are located and does not focus on top-down directives; rather, leadership development unlocks the skills and capacities small group members already possess and asks them to leverage those skills to effect change.

A promising possibility from the Sparks for Change model is its potential for proliferation. It is lightweight and scalable, and shows how accomplishing small goals might be scaled up to broader contexts (McGinnis & Ostrom, 2007). Another aspect of this research is the role of the outside expert, who may

keep the group focused on breaking inertia and enabling broader change.

Reflections and recommendations

Although data collection and the required external project evaluation are still under way in a majority of the projects, we have learned that project similarities are more than a function of the common funding stream and our shared focus on building capacity for diversity leadership. Several noteworthy patterns have emerged. First, although our small pilot projects were funded to accept only 30 participants, our projects received far more requests to participate than we were able to accept. In fact, some participants even volunteered to pay their own way to attend institutes and trainings associated with the projects—clear indications of a hunger within the geosciences to learn how to facilitate change and enact values of diversity, equity, and inclusion. Upon attendance, participants have eagerly engaged with the opportunities for professional development these projects offer, which include network formation, self-reflection, dialogue, and bystander intervention training. Simply learning to notice and label bias can lead to more inclusive attitudes and (perhaps) actions (Forscher, Mitamura, Dix, Cox, & Devine, 2017). Equipping scientists with social knowledge and skills appears to be an important, underrecognized lever for change.

As the projects mature, we will also be attending to barriers to sustainable change within scientific and educational institutions, such as those related to the existing academic incentive structures. For example, in FIELD, leaders may be committed to more inclusive practices, but these may increase financial costs in a time when funding for fieldwork is already threatened or declining. We will have more to report on barriers by the end of the pilot phase, but we anticipate now that clarity about these barriers will only reinforce GOLD's focus on systemic change.

For other geoscience educators engaged in diversity, equity, and inclusion efforts, we can make a few early recommendations: First, geoscience education is inherently interdisciplinary, and the problems of exclusion and lack of diversity are inherently social. We thus endorse GOLD's vision of leadership teams representing diverse social identities and both social and hard sciences, who bring distinctive knowledges and ways of knowing to the work. Social scientists have brought in new research tools and practices, enhanced the awareness and intentionality of research design, and allowed for more rigorous evaluation.

Geoscientists on each project ensure alignment of efforts with geoscience cultures and translate social science concepts to participants. PIs, participants, and coaches alike are becoming geo-social-science boundary spanners. For example, all of the authors of this article continue working closely across disciplines, supporting and learning from each other.

Second, diversity does not come without its challenges: Differing disciplinary cultural norms and social identities may yield misunderstandings within even high-functioning teams. We therefore recommend leadership teams include external advisors or coaches. For example, during the Ideas Lab, even though participants were a diverse group with diverse expertise, NSF was intentional about hiring an external group to facilitate the creative idea generation while keeping participants within the boundaries of what the program would realistically fund. Furthermore, as the projects started and matured, NSF funded two coaches—Diana Kardia and Kelly Mack—to help manage potential conflicts among and within GOLD groups so that our diversity could be transformed into products such as a podcast series that explores the skills and experiences required to lead efforts to broaden participation (for more information, see Kardia Group, LLC, 2018).

Finally, work like this takes time. Therefore, we recommend project development on the time scale of at least three to five years, particularly if leaders have not previously worked together. In our own experience, with more participants, a longer timeline, more substantial funding, and more cross-fertilization among the projects, our potential for impact would no doubt be greater.

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