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Title: Developing Scientists as Champions of Diversity to Transform the Geosciences

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Abstract:

To address complex geoscience questions, communities with a variety of experiences and perspectives are needed in local workplaces and institutions across academia and government. To achieve this goal, geoscience needs leaders who are champions of diversity who have positive attitudes towards others and act upon these attitudes to become change agents in advancing diversity and creating inclusive environments. We established a professional-development workshop, GOLD Institutes (GOLD: Geo Opportunities for Leadership in Diversity), to provide geoscience leaders with the tools and skills necessary to be self-reflective of their own ideas and to promote diversity, equity, and inclusion in their respective institutions. Our objective was to equip senior geoscientists, who are at the core of local communities of practice (CoPs), with knowledge of diversity, equity, and inclusion theories and practices to lead change across the discipline. In this preliminary report, we investigate institute participants' perceptions of allophilia (love of the other) and identify actions taken by senior geoscientists to promote diversity, equity, and inclusion within local CoPs. Results indicate that senior geoscientists who participated in the institute had high scores on the Allophilia Scale and took steps to integrate diversity, equity, and inclusion into their day-to-day activities, and in a few cases created new workplace support structures for diversity and inclusion. Future work will build upon these results by refining professional-development opportunities that target the needs of geoscience champions of diversity.

INTRODUCTION:

Transformation in the geosciences is needed to improve diversity, equity, and inclusion. Reports in recent years have highlighted the lack of diverse, inclusive environments within the

geosciences. Some of these reports emphasize representation and diversity. For example, the National Science Foundation's National Center for Science and Engineering Statistics reported that only 43% of the doctoral degree recipients in Earth, atmospheric and ocean sciences in 2012 were women (National Science Foundation, 2013). Furthermore, less than 5% of doctoral graduates were Black, Hispanic, American Indian, or Alaska-natives, combined (National Science Foundation, 2013). Also, Cech (2015) reported that lesbian, gay, bisexual and transgender (LGBT) individuals are underrepresented across the entire federal workforce. In addition to diversity and representation, numerous studies have shown prejudice and harassment are common in geoscience workplaces (e.g., Cech & Waidzunas, 2011; Fouad & Singh, 2011), leading to "chilly" workplace climates that act as barriers to the full inclusion and participation of individuals from underrepresented backgrounds. Bernard and Cooperdock (2018) conclude: "We will limit the science we do if we do not become more inclusive. We need to do better" (p. 295).

Many efforts to improve diversity and inclusion have focused on the pathways of students into the geosciences at the elementary, secondary, and postsecondary levels and into the geoscience workforce (e.g., Williams, Morris, & Furman, 2007; Windham, Stevermer, & Anthes, 2004). These efforts are necessary but will not be sufficient for large-scale change if those graduates encounter hostile environments in universities, research labs, and field sites, or are encumbered by antiquated and unfair hiring and promotion practices. Therefore, current geoscientists need to adopt the complementary goal of transforming geoscience workplaces into inclusive, supportive environments. Beyond the United States, efforts have largely focused on the inclusion of women in the field, particularly in Europe. The UK and Ireland's Athena SWAN program, for example (also now rolling out in Australia), has led to an increase in commitment to

the careers of women in STEM university settings, but has only recently looked to engage departments beyond issues of gender to consider intersections with race and, to a lesser extent, other marginalized identities (Advance HE, n.d.). Project Juno, which is championed by the UK's Institute of Physics, and has a similar structure and goals to Athena SWAN, is also targeted at improving gender equality (Institute of Physics, 2017). These efforts are reflected by professional organizations, such as the European Geoscience Union, who are prioritizing diversity of gender, age, and discipline in their diversity, equity, and inclusion work (European Geoscience Union, n.d.). In this respect, the U.S. has had a leadership role in considering marginalization of individuals along the axes of e.g. race, disability, LGBTQ status, veteran status, and along multiple intersecting identities.

Transforming the geosciences to improve diversity and inclusion is the primary goal of Hearts of GOLD (Geo Opportunities for Leadership in Diversity), which is a grant-funded project designed to pilot a new model of professional-development workshops. This project included workshops, called the GOLD Institutes, to develop champions of diversity by engaging participants in discussions of diversity, equity, and inclusion with a focus on enacting change in their local workplaces. Workshop participants were scientific leaders across geoscience institutions and organizations in the United States, who have demonstrated some interest and/or success in working toward greater diversity and inclusion (e.g., mentoring minority students, serving on diversity committees for professional societies) but could also benefit from additional experience, skills, and tools to be more active and effective in their endeavors. This preliminary, exploratory report shares initial insights from participants' experiences and their efforts to improve diversity and inclusion in the year following the initial workshop. In the following sections, we provide definitions for the terms and theories that were

used to guide the development of the training and this investigation. We then continue with the methods and results of our study of the participants in the GOLD Institutes.

Champions of Diversity

Champions of diversity is a term coined by the National Science Foundation (NSF) in their solicitation for proposals to create change in the geosciences (National Science Foundation, 2016). Change in systems rarely occurs without leaders who are dedicated to explicitly promoting improvements (Nadler & Tushman, 1990). NSF defined champions of diversity as individuals who lead to wide-scale use of evidence-based practices related to diversity, equity, and inclusion. To develop Hearts of GOLD, we argue that champions of diversity should have a desire to include all groups in the pursuit of geosciences and compel others to join their campaign. That is, champions of diversity have positive attitudes towards others and act upon these attitudes to be change agents in their home organizations and across the geoscience disciplines. These champions use a variety of strategies to promote diversity and inclusion. They are reflective of their own practices and beliefs, notice threats to inclusivity and navigate personal interactions to challenge biases, and build or rebuild systemic structures that promote diversity and inclusion, including positive cross-group behaviors (Siem, Stürmer, & Pittinsky, 2016).

Central to this effort is the obvious display of "allophilia," from the Greek for "love of the other." Pittinsky (2005) initially used this term as a more appropriate antithesis of "prejudice," because "tolerance" is too neutral. This term is applied specifically in the context of intergroup leadership where one is balancing the need for strong intragroup identification and cohesion while also discouraging or reducing intragroup conflict. Even beyond feelings and attitudes, scholars have connected allophilia with ally behavior (Gonzalez, Riggle, & Rostosky,

2015). Pittinsky (2013) argues that strong leaders define their sphere of concern and their constituencies more broadly than just their own ingroup, and that allophilia helps them balance the ingroup/outgroup tradeoff. Conversely, poor leaders are likely to use ingroup identities to motivate followers at the expense of intergroup relationships and greater good for all.

To support research by those seeking to quantify positive attitudes rather than only the presence or absence of negative attitudes, Pittinsky and colleagues (2011) developed the Allophilia Scale, which uses a six-point measure of agreement with items describing attitudes about members of a specific outgroup. The Allophilia Scale has been validated for a variety of settings, including both university students and adult participants (Alfieri & Marta, 2011), social justice advocates identified as allies by people of color (Ostrove & Brown, 2018), attitudes toward religious minorities (Rosenthal, Levy, Katser, & Bazile, 2015), attitudes toward ethnic outgroups (Korol, Fietzer, Ponterotto, 2018; Pittinsky et al., 2011), perceptions of different age groups (Wagner & Luger, 2017), social distance toward people with obesity (Magallares, 2017), attitudes toward persons with dementia (Kinney et al., 2016; Lokon, Li, & Kunkel, 2018), and translation for Spanish populations (Morales & Magallares, 2017). Notably, in a study of a predominantly White cadre of teachers in schools with predominantly ethnic minority students, teacher allophilia was significantly related to student achievement, which suggests practical outcomes from increased allophilia (Pittinsky & Montoya, 2016).

Communities of Practice

Champions of diversity act as change agents in their institutions and across the geosciences including higher education, national laboratories and government agencies, and professional societies. To understand how the actions of champions of diversity can lead to

change in these institutions, we must consider how an organization acts as a community of practice, how change occurs, and in what ways leaders can promote these changes.

Communities of Practice (CoPs) are a collection of people who are historically and socially defined and have shared knowledge and value (Wenger, 1999; Wenger, 2000, Wenger, McDermott, & Snyder, 2002). An organization acts as a CoP when it has these shared knowledge and value, hereafter called competencies. For example, within the geosciences, a national laboratory, such as the National Severe Storms Laboratory, has shared knowledge around and places value on preparing research results for communication with other scientists.

Organizations change through the development of new competencies through socially-constructed processes of the people of the organization as well as between people and the organization's external environment (Brown & Duiguid, 1991; Mizruchi & Fein, 1999). Because we consider organizations to be communities of practice, the socially-constructed process of identifying and adopting new competencies can be described using the CoP terms of brokers, bridges, and events (Wenger, 2000). In CoPs, *brokers* introduce new knowledge by applying ideas from outside of the organization to challenges faced by the CoP. *Bridges* are artifacts or discourses that facilitate the adoption of new ideas. For example, when developing a strategic plan for increasing diversity and inclusion, a community of practice may seek out research articles that highlight the value of diversity in promoting innovative science to frame the discussion of inclusion. Finally, *events* are situations and structures that allow for these new ideas to be discussed and to be socially defined. In this way, new competencies can be adopted by the community; *brokers* bring new ideas from other communities that can take the form of *bridges* that are shared and discussed at *events*.

Organizational change is efficient when leaders cultivate CoPs to manage and develop competencies (Radcliffe, Crosthwaite, & Jolly, 2002; Wenger, Dermott, & Snyder, 2002). Leaders at the core of the community have influence over CoP processes because members look to them for examples and instructions of what they should be doing (Boud & Middleton, 2003; Wenger, 2000). A champion of diversity can cultivate organizational change by acting as brokers, developing bridges, and creating events to adopt new competencies related to diversity, equity, and inclusion.

Communities of practice as a framework for promoting change has been applied in a variety of STEM contexts, such as a college of engineering in a university (e.g., Radcliffe, Crosswaite, and Jolly, 2002), a science-activity club for young girls (Watermeyer, 2012), and a teacher credential program for current STEM professionals (Grier & Johnston, 2012). Notably, Radcliffe, Crosthwaite, and Jolly (2002) report on a "Catalyst Center" to promote a diverse working, learning, and research culture in a college of engineering. When referring to communities of practice to lead change, the authors highlight the integrated approach the center takes to make large-scale change through the in-situ efforts of their advocates. Our study builds upon this work by investigating the role of senior geoscientists as in-situ advocates in their institutions for diversity improvement.

Theory of Change

A theory of change is the logic behind the design of initiatives aimed at creating large-scale change (Blame & Mackenzie, 2007; Connell & Kubish, 1998; Robson, 2017; Vogel, 2012). Evaluators of change initiatives developed the concept of 'theories of change' when they realized the importance of context in evaluating these programs (Blamey & Mackenzie, 2007). In evaluation, a theory of change is not necessarily meant to be the same as a scientific theory and

is sometimes referred to as a logic model that connects the activities, context, and outcomes of change initiatives (Connell & Kubisch, 1998; Robson, 2017). Hearts of GOLD's theory of change is based on the application of allophilia and Communities of Practice.

The GOLD Institutes were designed for senior geoscientists who want to move the greater discipline toward inclusivity and who are formal scientific leaders poised to promote change. When participants return to their organizations, they act upon their love of others (allophilia) to redefine community of practice competencies concerning diversity, equity, and inclusion (Figure 1).

[Insert Figure 1 here.]

SETTING

GOLD Institutes

The GOLD Institute is a two-day, professional-development workshop designed to train geoscientists in diversity, equity, and inclusion principles and practices and to empower them to become champions for diversity. The inaugural institute was held in July 2017 in Colorado Springs, Colorado. Planning for the institutes began approximately 10 months in advance with a review of the curricula provided by the Knapsack Institute (KI), who also served as facilitators. KI is a well-established effort at the Colorado Springs campus of the University of Colorado that uses social-justice pedagogy to effectively navigate discussions about diversity and inequality. The curricula went beyond typical "diversity training" to include interactive education with an emphasis on inclusive-leadership development specifically within the geosciences. In the planning phase, a pilot workshop with the investigators and facilitators was held to refine the content to be particularly relevant to the geosciences.

The call for nominations was issued at least eight months in advance each year. Announcements were disseminated via websites, social media, and e-newsletters for a number of professional societies and groups, including the American Geophysical Union, CLIMLIST, Earth Science Women's Network, Geological Society of America, National Association of Black Geoscientists, and Society for the Advancement of Chicanos/Hispanics and Native Americans in Science.

Nominations required a statement of recommendation from the nominator, nominee's discipline/area of expertise, and contact information for both the nominee and nominator. For the 2017 cycle, 74 nominations were reviewed and evaluated according to the following criteria:

1. Demonstrated willingness or eagerness to support diversity and inclusion efforts in the geosciences along with a lack of experience, expertise, or confidence in how to proceed in this realm;
2. Demonstrated participation in geoscience education and research;
3. Current employment at a public or private two-year or four-year academic institution, government research facility, scientific society, or other geoscience organization; and
4. Established or emerging scientific eminence as demonstrated through research experiences, publications, award/honors, and service to the geoscience community.

The purpose was to identify those who want to see positive change but have never been active in trying to create it. The name "Hearts of GOLD" was chosen as a reference to this group of people. Therefore, it was inherent in the call for nominations that participants should not be experts in teaching and/or promoting diversity and inclusion.

Research subjects

Twenty-eight nominees were invited to participate in the inaugural GOLD Institute, and 23 (82.1%) attended. Two participants could not attend in 2017 but accepted in 2018, so the overall acceptance rate could be reported as 89.2%, which was much higher than anticipated. Initial guidance from NSF representatives was to expect an acceptance comparable to that for grant-reviewer invitation (i.e., ~25%). Approximately 70% of the participants represented groups traditionally underrepresented in geosciences leadership, including women and people from underrepresented groups. A total of 23 individuals representing 22 different institutions and organizations participated in 2017. Five participants from the 2017 institute returned as mentors in 2018 to foster connections between the cohorts.

All participants in the inaugural institute (n=23) were invited to be part of this research study, which was approved by the appropriate Institutional Review Board (IRB). Attendees were invited to take part in the research one week prior to the institute as part of the invitation to take the allophilia survey. Research participation included invitations for follow-up surveys one week after the institute and one year after the institute. On the post survey that was sent one week after the institute, research participants were given the opportunity to provide their email to take part in a follow-up interview.

RESEARCH QUESTIONS

This research on the GOLD Institute was guided by two research questions.

1. To what degree do participants express positive attitudes toward outgroups?
2. In what ways do participants use bridges, create events, and/or act as brokers to facilitate change in their home community of practice?

The purpose of these questions is to guide exploratory research into the outcomes of the project. To address the first research question, we first expect champions of diversity to have allophilia. We have asked this question to evaluate if our recruitment process has identified those geoscientists with positive attitudes towards others. For the second research question, we analyze how participants acted as change agents by describing the actions they have taken to change the community of practice competencies at geosciences organizations in the year following their participation. Both of these questions will help us to understand to what extent our theory of change has been realized.

RESEARCH DESIGN AND METHODS

This investigation is part of a larger case study analysis (Yin, 2009). In this preliminary report, we answer two research questions using quantitative methods (Likert-scale survey) and qualitative methods (semi-structured interviews). We use our theoretical framing of allophilia and communities of practice to answer these research questions.

Data were collected from research participants via surveys and interviews. Research participants completed a survey before (within one week), soon after (within one week), and 12 months after the GOLD Institute. The interviews were conducted approximately 10 months after the institute, which placed them between the second and third surveys. Of the 23 attendees, 18 (78.2%) completed the survey prior to participation, 15 (65.2%) completed the survey sent one week after attending, and 8 (34.8%) completed the survey one year after participation. On the second survey, 13 attendees agreed to be contacted for a phone interview. Eleven attendees participated in the interview. In an effort to protect identities, we have not reported the demographics for participants.

Survey Methods

Each survey was administered using Qualtrics. As a measure of attitudes toward outgroups, the survey included the Allophilia Scale (Pittinsky et al. 2011). Item response options were based on a six-point Likert scale ranging from "strongly agree" to "strongly disagree," with no neutral option. The Allophilia Scale asks respondents to consider the degree to which they agree with statements about outgroups. For example, "I feel like I can be myself around [members of outgroup]." In our use of the Allophilia Scale, we defined outgroup using National Science Foundation's (2008) examples of underrepresented groups in need of broadening participation: Alaska Natives, Native Americans, Blacks or African Americans, Hispanics, Native Hawaiians and other Pacific Islanders, and Persons with Disabilities. For each statement on the Allophilia Scale, participants were presented with a randomly selected outgroup (e.g., Alaska Natives), so their answers were always with respect to a particular group, yet all outgroups were represented in a given participant's completion of all 17 items of the Allophilia Scale. Knowing that participants may be uncomfortable or frustrated with the restrictions of Likert scale options, we concluded the survey with an open-ended comment box, allowing respondents to explain their ratings.

While our sample size was too small for factor analysis, we relied upon previous research that supports five factors: affection (positive affective evaluations of outgroup members), comfort (a feeling of ease with outgroup members), kinship (a feeling of closeness with outgroup members), engagement (a tendency to seek to affiliate and interact with outgroup members), and enthusiasm (having emotionally heightened positive attitudes about outgroup members). In their exploratory and confirmatory factor analysis, Pittinsky and colleagues (2011) found the "five-factor interpretation of allophilia is robust and replicable" (p. 46), with alpha coefficients ranging

from .88 to .92. Responses to the Allophilia Scale are interpreted as an overall score and scores across five factors (i.e., subscales).

In analyzing data from the Allophilia Scale, our primary focus was simple descriptive statistics, revealing potential benchmarks for future application of the Allophilia Scale with geoscientists. Because the research question focused only on participants' attitudes toward outgroups, without any particular attention to time (e.g., before or after the institute), we calculated the mean and standard deviation for all observations and compared them to the Allophilia Scale validation study (Pittinsky et al.,, 2011), analyzing differences with a simple T-test and a p-value of .05. Although the limited number of participants prevents rigorous interpretation of differences between groups and points in time, the exploratory nature of this study warranted more detailed reporting so future researchers can consider options for expanded studies. Accordingly, we used descriptive statistics (means and standard deviations) to analyze the data in logical groups, including before and after participation, as well as allophilia ratings for each outgroup (i.e., Alaska Natives, Native Americans, Blacks or African Americans, Hispanics, Native Hawaiians and other Pacific Islanders, and Persons with Disabilities). In total, we analyzed 41 observed completions of the Allophilia Scale from 18 program participants, with all of them having the opportunity to provide self-ratings at three points in time: one week before the institute, one week after the participation, and one year after participation. We used paired sample T-tests to consider differences between individual ratings at each point in time. Due to lingering questions about the assumption of normal distributions, we also analyzed the data using a nonparametric test, specifically the Wilcoxon signed rank test.

Interview Methods

The interviews were semi-structured and designed to last less than 30 minutes to accommodate the busy schedules of the participants. The interviews had three sections. The first section asked about the participant's history with diversity, equity, and inclusion and their current professional experience. The second section covered the participant's decision to attend the GOLD Institute and their thoughts on the training. The third section included questions about the participant's activities related to diversity, equity, and inclusion that occurred within the last year. The interview protocol is available as supplemental material.

Interviews were scheduled with individuals via email and conducted over the phone. These conversations were recorded and then transcribed. The concepts of bridges, brokers, and events as detailed by Wenger (2000) framed the constant comparative analysis of the interviews (Glaser, 1965). Definitions for these codes were discussed and agreed upon by two researchers prior to the beginning of coding. Next, these researchers independently coded for brokers, bridges, and events in the same interview. Then, the researchers compared their work and found they had identified mostly the same occurrences of bridges, brokers and events. Furthermore, after discussion, they agreed on all of them. The researchers slightly modified the definitions according to the slight differences in interpretation that occurred in the first attempt at coding. For example, the "events" definition was adjusted to specify that events must physically bring people together rather than generally bringing people together. Next, the researchers coded a second interview independently and compared their codes. Their codes had a 10/11 or 91% agreement. According to Campbell (2013), researchers often identify acceptable agreement percentages between 70% and 94%, but intercoder agreement ranges have no firm cutoff. Instead, researchers should be particularly careful to consider if high agreement is due to chance

(Campbell, 2013). Through discussion, the two researchers were able to determine that the 91% agreement was true agreement and not due to chance. Because of the high levels of agreement, the researchers split the efforts in coding the remaining interviews with the definitions in Table 1. Although one coder completed the initial analysis of the remaining interviews, both coders read and were familiar with the entire set of interviews. The interviews and corresponding codes were each discussed throughout the process by both coders according to constant comparative analysis methods. In the results, we use *categories* to reference the deductive codes of bridges, brokers, or events.

In the second round of analysis, three lists were compiled which contained all the examples of each category- bridges, brokers, and events. That is, all the bridges were combined in one list, the brokers in a second list, and the events in a third list. Within each of these lists, the occurrences of the categories were gathered into themes. For example, a theme within the broker category was "Noticing importance of diversity, equity, and inclusion in day-to-day situations." Eight participants reported activities that were labeled as this theme. The two researchers discussed the themes within each category and agreed upon them. During this discussion, the researchers also referenced the original transcripts in accordance with constant comparative analysis. In the results, we use *themes* to reference the inductive sub-codes of similar activities within each category.

To discuss the themes as they relate to participant effort, we ranked them along a continuum from low to high on a scale of time and effort needed to complete the activity. We chose this ranking continuum based on previous work in organizational learning that discusses change as a "continuum of innovating practices" that spans from "daily activity" to "radical innovation" (Brown & Duguid, 1991, pg. 53). With our results, we hope to help future

champions of diversity change competencies in their organizations. Substantive significance is given to results that are useful for an intended purpose (Patton, 2001). By ranking the themes, we enhance the usefulness of our results by reporting findings that champions can use to identify activities that they have both the time and resources to enact.

To rank the themes, two researchers independently ordered each theme according to how much time and effort it would take to complete. Except for three instances, the researchers agreed on the ranking without discussion. However, to recognize that some interpretation of time and effort is dependent on context of the champion of diversity, we stress the importance of being "near the highest ranking" or "near the lowest ranking" instead of the specific ranks. For example, the theme of broker activities of noticing the importance of diversity, equity, and inclusion in day-to-day activities was ranked as low time and effort. This low rank indicated that the day-to-day activities existed prior to the addition of the new ideas of diversity, equity, and inclusion and "noticing" of these activities requires little time and energy.

Roles of the researchers

The grant-funded investigators, all of whom are authors, attended the GOLD Institute and they were involved in designing the training. However, they did not lead the diversity, equity, and inclusion sessions and were not participants in the research. One of the authors is a research assistant who did not attend the institute. The two researchers who analyzed the interviews had different roles during the training sessions. One of the researchers attended the institute and was familiar with both the attendees and the workshop material. To offset the potential bias of the first researcher, coding was completed with another researcher who did not attend the institute and did not know the attendees prior to the interviews. The differences in familiarity with the workshop and its attendees provides credibility and confirmability of this investigation. Despite

their different backgrounds, both researchers agreed on the examples of categories and themes identified from the interviews.

RESULTS

Research Question 1: Allophilia

As anticipated, our recruitment of individuals who were interested in diversity, equity, and inclusion resulted in participants who displayed higher allophilia scores (Table 2) compared to participants in an early validation study (Pittinsky et al., 2011), and their scores are quite similar for various groups of people which are underrepresented within the geosciences (Table 3). While the small number of research subjects prevents rigorous and robust analysis, we have reported means and standard deviations on logical groupings, knowing that readers and program participants may consider such averages in their overall assessment of the Allophilia Scale.

[Insert Tables 2 & 3 here.]

Mirroring findings of the Allophilia Scale validation study, participants' ratings were highest for the affection subscale and lowest for the kinship subscale. Regarding the restrained attraction to kinship, one participant's comment offers insight on a potential explanation:

> "I can't claim a kinship or a sense of belonging with groups I don't belong to...being a Black American, I also can't claim that I have a desire to be more like another group. However, I very much seek to understand, affirm, and form bonds with Native peoples and with Persons with Disabilities...that would naturally lead to a cultural exchange."

Considering ratings among different underrepresented groups, all were highly rated, with the highest overall ratings for "Blacks or African Americans" and the lowest overall ratings for

"Persons with Disabilities." The following participant comment offers some insight on discernment among rating options:

> "I struggled with several of the answers. Mostly, because statements are worded in terms of categories rather than individual people. For example, I feel very strong kinship with a disabled friend of mine; but even with him, I can barely gauge the impacts the disability has on his life. Hence, I can't say that kinship with people with disabilities in general would be a fair statement, simply because I have not had to deal with disability in my own life."

Other participant comments conveyed the comfort with reporting the highest possible ratings was inhibited in part by lack of exposure. For example, participants shared the following:

> "These questions were difficult to answer because I've never met and had a relationship with an Alaska Native or a Pacific Islander. I respect all people regardless of ethnicity, but its difficult to assess whether I'm impressed by people I've never had significant engagement with."

> "I would like to think that I have as positive attitudes about people from underrepresented minority groups as about people from my own racial group. However, I realize I live in a segregated society where I have little chance through my work or my residential community to meet people from under-represented groups. I would not like to put people from other groups on some sort of magical pedestal, nor would I pretend to know what their lives are like, since I think that would be offensive, but I am impressed with the achievements of people who have overcome disadvantages and bias."

Research Question 2: Bridges, Events, and Brokers in Communities of Practice

In this section, we report on the participant activities within the categories of bridges, brokers, and events in three ways: (1) through themes of participants' activities within each category, (2) with rankings that approximate the level of effort required to complete each theme in relation to the other themes identified within the category, and (3) as relationships across the categories. At times the activities of brokering, bridges, and events co-occurred. In the final section of these results we discuss this relationship among the three categories.

Bridges

Bridges are either artifacts (such as policy documents) or discourse that allows for sharing of ideas across community boundaries. Nine participants reported using at least one bridge (Table 4). Some participants made small adjustments by taking advantage of pre-existing artifacts to facilitate the sharing of ideas while other participants created new artifacts or accessed new discourse opportunities to share ideas. The most common themes of activities were providing GOLD Institute materials as a resource, discussing or facilitating the discussion of diversity, equity, and inclusion with the network of investigators or participants, and writing a public blog, article, or newsletter. An example of making small adjustments by accessing pre-existing materials was described by a participant who shared materials with other members of his academic department. They said, "there was good information [from Hearts of GOLD] that I did share, I went to a couple of meetings, and I made a handout, photo copies, from the literature and shared that with people." Another participant facilitated and contributed to the writing a of a new bridge in the form of a white paper on diversity, equity and inclusion. To contribute to this effort, the participant dedicated time to working group meetings and the writing process. This was a substantial time and effort above and beyond the regular activities of the participant.

Events

Events are activities that physically bring the community together to discuss diversity, equity, and inclusion. Nine participants reported creating or taking part in an event (Table 5). Small adjustments to prior activities included attending diversity, equity, and inclusion professional development and engaging in informal discussions. On the other end of the rank continuum, two people created a process within their institution for planning to be diverse, equitable, and inclusive. The most frequent themes of events were participating in informal discussion and planning for inviting an external expert to lead a discussion. One participant described their plans to host a workshop, "I noticed the issue of implicit bias- how important that is... we're going to bring a group to the university to [host a] workshop on implicit bias." In this case, the participant is creating an event where diversity, equity, and inclusion will be discussed. The participant also expressed that this will likely be a mandatory event where all community members will be asked to engage in discussion.

Brokers

Brokers bring new ideas to the community. An activity within the broker category signifies that the participant reported applying new ideas from the GOLD Institute to the local community. Ten participants reported acting as brokers (Table 6). The most frequently reported brokerage was noticing the importance of diversity, equity, and inclusion in day-to-day situations. One participant described this process as "there's daily opportunities to see things and to try to understand them in the context of inclusion and diversity…the daily routines and the things that we're faced with, whether it's students' complaints, whether it's hiring faculty." This participant spoke about bringing ideas to the workshop to understand day-to-day events and to help use this information to create inclusive environments. The second most commonly reported

brokering activity was considering how diversity and inclusion concepts can and should impact hiring routines for new scientists or acceptance into the program for students. An example of this broker theme was described by a participant who said "I never really appreciated before that if you want to be a more diverse, inclusive institution you have to start at the recruitment level. In meetings with our faculty members, with others who are members of hiring committees [and other people I interact with professionally] that was something that I emphasized." This participant brought ideas from the GOLD Institute to the process of hiring new faculty members.

In addition, three participants described the planning of new events where brokerage can take place. Two of these participants provided more information about these events and what bridges supported their work. These cross-cutting activities are described in more detail in the following section.

Because the participants had some shared characteristics (attended the same training and were all geoscientists), they may have applied the same diversity, equity, and inclusion concepts to their local workplace. However, participants' reports did not indicate any patterns in application of new ideas. Many participants referenced only generally discussing diversity and inclusion. Only four participants identified specific topics that they brought back to their community. These topics were unique to each participant, including implicit bias, privilege, microaggressions, and the differences between equality, inclusion, and social justice.

Relationships among bridges, brokers, and events

Sometimes a suite of activities included a bridge, a broker, and an event. Thus far, we have discussed each of these separately but in this section, we highlight the two participants who described forming committees in the workplace that used all three processes. In both instances,

the participant spearheaded the creation of a new committee. These committee meetings created events where diversity, equity, and inclusion could be discussed. In one committee, these discussions were supported by bridges in the form of GOLD resource material provided by the participant. In addition, the first committee created a bridge in the form of a written strategic plan for incorporating diversity, equity, and inclusion within the workplace. In the second example, the committee did not develop a strategic plan but instead addressed immediate needs of the workplace. This included two bridges: a diversity and inclusion statement for the workplace and guidelines for inclusive field work. We have not provided direct quotations in this section because the details provide too much specific information that could be connected to the participants. In both examples, participants created a committee that held meetings where discussion of diversity, equity, and inclusion resulted in the creation of bridges to share with all members of the workplace.

LIMITATIONS

Like all forms of research, this study has limitations. As an exploratory study, we have relied upon participants' self-reported allophilia and change-agent activities. In both instances, the participants were aware of the type of answers that would be the most desirable (high levels of allophilia and implementation of diversity, equity, and inclusion ideals). This may have led them to provide these types of responses. For the allophilia analysis, not every survey participant had the opportunity to respond to items for each underrepresented group, which could have skewed results. In addition, the involvement of the team of grant investigators as participants in the workshop was beneficial for training even more geoscientists in diversity, equity, and inclusion but may have introduced bias to this study, since the researchers and subjects gained increased familiarity with one another. For this reason, the research questions were limited to

non-evaluative exploration. Future work will need to consider how evaluation of geoscience diversity, equity, and inclusion workshops can define success and contribute to improvement of the professional development.

The study also involved trade-offs and decisions associated with a small number of research subjects, exacerbated by the inevitable problem of non-response. In the analysis of quantitative data, we treated each completion of the Allophilia Scale as a separate data point. Although we could have averaged the Allophilia Scale ratings for each individual and restricted ourselves to that unit of analysis, the result would have been no practical difference in the means yet reporting of smaller standard deviations, which would result in an increased false sense of confidence in our findings. It is important to remember this is an exploratory study, and we are not generalizing any of our findings. Instead, our hope is that our findings spark ideas for future research. More research is necessary to fully uncover the potential of allophilia and community of practice characteristics for improvement of diversity, equity, and inclusion in geosciences.

DISCUSSION

We defined "champions of diversity" as leaders who are reflective of their own practices and beliefs, notice threats to inclusivity and navigate personal interactions to challenge biases, and build or rebuild systemic structures that promote diversity and inclusion. Our theory of change posited that developing champions of diversity from scientific leaders will lead to positive changes in the geosciences discipline. We used the Allophilia Scale to determine to what extent participants have positive attitudes towards others. We analyzed interviews to determine how participants facilitated the adoption of new competencies in their home community of practice.

Results suggest that we were successful in attracting geoscientists to the workshop who held the positive attitudes towards others that are needed to act as champions of diversity. One of the first considerations for professional development is the motivation of scientists to participate. Many discussions may focus on incentives for participation or punishments for abstaining (e.g., Oliver, 1980). Conversely, participation may be considered an internal motivator. Hearts of GOLD was designed from the perspective that there are some senior geoscientists who want to create inclusive environments but lack the training, tools, and skills that are necessary to lead change. Even the name, "Hearts of GOLD," was chosen because it references those who want to do good for others, especially in the latter parts of their careers when they are considering their legacies. We created a nomination system that was meant to honor individuals who have shown their dedication in the past and could benefit from focused training. Our results on the allophilia support our conjecture. We found that our participants have positive attitudes towards others. In fact, many of them were connected to other geoscientists whom they recommended for the training and desired for the training to be made available to even more champions of diversity. Future work should explore how this network of allies can be used to increase the impact of professional development. Further, the concerns of NSF representatives about the availability and willingness of senior geoscientists to participate in the GOLD Institute were not realized; we received numerous nominations and saw an acceptance rate of nearly 90%.

We know that change requires more than positive attitudes towards others. Systemic issues have greatly contributed to the challenges that we face in the geosciences (Bernard & Cooperdock, 2018). For this reason, we considered how participants were able to facilitate the adoption of new competencies in their own activities. While we have ranked themes according to time and effort, we recognize that time and effort does not always result in institutional change.

For example, policies that take a long time to develop can be misinterpreted or enacted in a way that is unexpected (Coburn, 2001). Instead, the benefit of this suite of examples is that change agents can identify a variety of activities that they can enact given their professional roles. Indeed, our findings are complementary to the findings of Goldstein Hode, Behm-Morawitz, and Hays (2018). These authors reported that cultural competency was increased by professional development but could not speak to institutional change. With our study we have begun the investigation into specific change agent actions after professional development participation.

At the GOLD Institute, the participants were given time to consider how they would apply the new ideas at their home institutions. Potential future iterations can provide more pointed activities aimed at leading change by building on the successes of previous years. These activities will not be prescriptive but will build on the first participants to think about how diversity, equity, and inclusion can be created in the geosciences.

CONCLUSION

While preliminary, the results presented here are encouraging. Indeed, we have shown that many leading geoscientists are aware of the problematic lack of diversity in their discipline, and they are eager to make positive change. These leaders are already recognized by their peers, proteges, and/or students as doing good in this area. However, it also seems apparent that, despite their eagerness to lead change, these scientists have been waiting for help. If workshops like the GOLD Institute can act as the catalyst for activating these concerned geoscientists, then change may be within reach.

Participants in the GOLD Institute have shown that they can lead real changes within their workplaces, and it seems that few of them were doing this prior to their participation in this

project. One ongoing challenge of this effort will be to maintain enthusiasm and support for colleagues as they try to lead change. The Hearts of GOLD investigators have spent much time discussing strategies for supporting the network of participants into the future. It may require consistent, active nurturing, or it could be self-sustaining once a critical mass is achieved. Either way, it is important that this effort not be allowed to fade, so future research is necessary to identify successful strategies for maintenance as well as creation of these champions for diversity.

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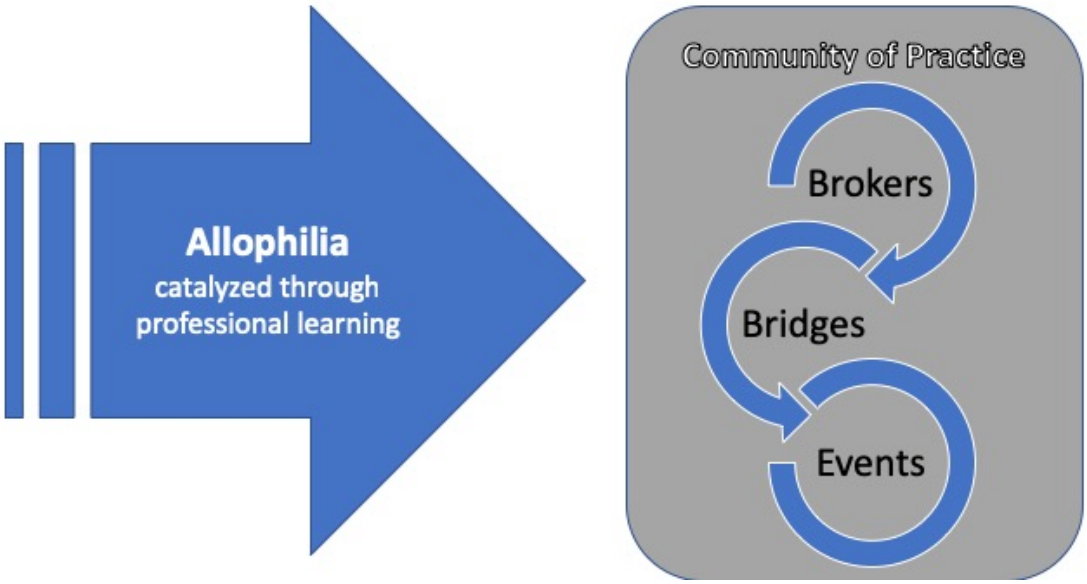
700 FIGURES Captions



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702 Figure 1: *Hearts of GOLD Theory of Change*

TABLES

Table 1:

Category definitions based on Communities of Practice terms (Wenger, 2000)

Communities of Practice Term	Category Definitions
Bridge	An artifact, tool or document that can be understood by people in different communities. Discourse which allows people to negotiate meaning across boundaries.
Broker	A person bringing new ideas from the workshop back to their job.
Event	A physical gathering of the community to help it develop a new identity.

Table 2:

Allophilia scale means and standard deviations for data collected from Hearts of GOLD 2017 Institute participant self-ratings (before, one week after, and one year after participation), alongside data from the scale's validation study (for comparison purposes).

	Hearts of GOLD Participant Self-Ratings				Validation Study Subjects (n=200)
Subscale	Before (n=18)	1-Week Post (n=15)	1-Year Post (n=8)	All (n=41)	
Affection	5.31 (1.18)	5.25 (0.63)	5.22 (0.65)	5.27 (0.90)	4.41 (1.12)
Comfort	4.88 (1.19)	5.20 (0.71)	5.13 (1.01)	5.04 (0.99)	4.03 (1.27)
Kinship	3.39 (0.94)	4.16 (0.90)	3.96 (1.23)	3.78 (1.03)	3.03 (1.20)
Engagement	5.13 (1.19)	5.28 (0.67)	5.25 (0.46)	5.21 (0.89)	3.76 (1.20)
Enthusiasm	4.51 (1.19)	5.00 (0.76)	4.75 (1.50)	4.74 (1.11)	3.56 (1.20)
Allophilia - All	4.72 (0.96)	5.01 (0.52)	4.90 (0.84)	4.86 (0.79)	3.80 (1.01)

Note 1. Paired samples t-tests indicate the only significant difference between ratings at each point in time are for the subscale of Kinship, between the pre-survey and the one-week post survey. Wilcoxon signed rank tests indicated the same.
Note 2. T-tests indicate all of the Hearts of GOLD ratings are all significantly different from the ratings in the Allophilia scale validation study.

Table 3:

Hearts of GOLD participants' allophilia statistics for underrepresented groups in need of broadening participation (as defined by the National Science Foundation).

Group	Mean	Standard Deviation
Blacks or African Americans	5.01	0.96
Native Americans	4.96	0.95
Hispanics	4.88	0.83
Alaska Natives	4.83	1.01
Native Hawaiians and other Pacific Islanders	4.78	0.93
Persons with Disabilities	4.76	0.77
All underrepresented groups	4.86	0.79

Note. While the data reflect 41 completions of the Allophilia Scale, the outgroups were randomized across items with each administration of the survey, so each response to the Allophilia Scale included some items for each outgroup, rather than all scale items for all six outgroups. When individuals (n=18) completed the Allophilia Scale at a different point in time (e.g., before and after the Institute), they received a new random match between items and outgroups.

Table 4:

Themes within the bridge category and the number of participants who reported activities within each theme. Activities are ranked approximately such that those requiring less time and effort are at the top. Nine participants reported at least one bridge.

Ranking	Theme	Number of Participants
Less time and effort	Provided GOLD Institute material as a resource (article or definition)	4
	Discussed or facilitated the discussion of diversity, equity, and inclusion with colleagues outside of the local workplace	2
	Discussed or facilitated the discussion of diversity, equity, and inclusion with the GOLD Institute network of investigators or attendees	5
	Wrote a public blog, article, and/or newsletter	4
More time and effort	Wrote a community-guiding document on diversity, equity, and inclusion (e.g., white paper)	2

Table 5:

Themes within the events category and the number of participants who reported activities within each theme. Activities are ranked approximately such that those requiring less time and effort are at the top. Nine participants reported at least one event activity.

Ranking	Theme	Number of Participants
Less time and effort	Has had informal conversations with colleagues about diversity, equity, and inclusion	4
	Includes discussion of diversity, equity, and inclusion as part of hiring meetings	3
	Discuss diversity, equity, and inclusion at faculty meetings	2
	Makes a choice to attend diversity, equity, and inclusion lunches or professional development	2
	Developed/developing/plans to create a diversity, equity, and inclusion talk/workshop	4
More time and effort	Create a process for strategic planning, statement, policy development	2

Table 6:

Themes within the broker category and the number of participants who reported activities within each theme. Activities are ranked approximately such that those requiring less time and effort are at the top. Ten people reported at least one brokering activity.

Ranking	Theme	Number of Participants
Less time and effort	Noticing importance of diversity, equity, and inclusion in day-to-day situations	8
	Acting as a resource when sought out by others	1
	Hiring procedures or student acceptance influenced by diversity, equity, and inclusion	5
More time and effort	Created events where brokerage could take place	3