# Geo-Needs

## Stakeholder Needs Assessment for Broadening Participation in the Geoscience Workforce

GEO-NEEDS FOCUS GROUP MEETINGS REPORT

AUGUST 5–7 AND 9–11, 2015

NIU CONFERENCE CENTER, NAPERVILLE, ILLINOIS, USA

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# Executive Summary

Despite a significant investment of resources, underrepresented minorities constitute ~8% of the geoscience-related workforce, making the geosciences one of the least diverse of all science, technology, engineering, and math (STEM) disciplines. While this pattern of underrepresentation has been attributed to numerous factors, the Geo-Needs project is focused on lack of access to undergraduate courses and programs of study at two-year technical and community colleges (2YCs) and minority-serving institutions (MSIs). Based on our analysis, only about 2.5% of institutions with geoscience degree programs are federally designated as minority-serving. Furthermore, geoscience programs are rarely available at 2YCs, which typically have higher minority student populations. As a result, 2YC and MSI students are often excluded from the geoscience workforce simply because few pathways from these institutions to geoscience careers currently exist.

To address this issue, four focus group meetings were held in August 2015 at the Northern Illinois Conference Center, Naperville, Illinois, USA. Meetings were structured to learn about participants' perceptions of the needs, barriers, and opportunities facing 2YCs and MSIs in expanding or developing geoscience programs and experiences for their students. Specifically, the Geo-Needs project sought to achieve two overarching goals:

- Identify and clarify barriers and opportunities for better use of existing instructional resources that engage underrepresented students in the geosciences at 2YCs and MSIs.
- Explore with stakeholders what an "ideal model" of resources, partnerships, professional development, and ongoing support for faculty and institutions might look like.

At the focus group meetings, 40 participants from 34 institutions or organizations across the United States explored what is known about the status of geoscience instruction at 2YCs and MSIs, and made recommendations for expanding access to the geosciences for underrepresented students at these institutions. Participants were drawn from four key stakeholder groups: 2YC and MSI geoscience instructors, 2YC and MSI administrators, organizations that create and/or disseminate geoscientific resources and educational materials, and researchers with expertise in equity, access, and diversity in either the geosciences or broadly in higher education. These four groups provided a breadth of knowledge and expertise, generating new perspectives on the persistent challenge of broadening participation in the geosciences.

Each focus group meeting was framed as a gap analysis in order to identify the current state of geoscience instruction at 2YCs and MSIs, articulate the desired state, and brainstorm about resources, programs, infrastructure, and other support needed to attain the desired state. Participants considered the broader context of the geoscience community as it relates to broadening participation. To facilitate out-of-the-box thinking, a series of activities guided brainstorming and discussion of how key stakeholders might interact to bring about the desired state. An ideal model methodological approach was used to compare current and desired levels of interaction among stakeholders. Finally, participants responded to guided prompts in order to implement what they learned in their own contexts to help the community reach the desired state of geoscience instruction at 2YCs and MSIs.

Barriers and opportunities to instructing minority students in the geosciences at 2YCs and MSIs fell into five major themes across the four meetings: (1) a misalignment between minority student needs and institutional cultures and structures, (2) use of place-based instructional resources, (3) uneven dissemination of "what works" for minority recruitment and retention in the geosciences, (4) the importance of trust and personal relationships, and (5) improved marketing of the geosciences. Based on these themes, participants made specific recommendations for key stakeholder groups, synthesized below.

## For Instructional Faculty

- Build and participate in regional networks of 2YCs, MSIs, and four-year institutions. These networks have the potential to dramatically increase access to the geosciences for minority students.
- Use directed research, active learning, and place-based instruction, all of which have great potential for engaging minority students in and beyond the geoscience classroom.
- Establish relationships with alumni and local employers in order to optimize opportunities for internships, site visits, and invited speakers so that underrepresented students become aware of potential geoscience careers.
- Work with academic advising, student groups, the campus diversity office, and other existing resources to promote geosciences on 2YC/MSI campuses.

### For Institutions and Administrators

- Determine and disseminate specific institutional contexts, needs, and opportunities for geoscience instruction and research. The strategies for a lone instructor at a suburban 2YC trying to attract more minority students may be quite different from actions needed to bring a degree program to an established MSI.
- In campuses with regional or distributed models, target geoscience courses to campuses with high populations of underrepresented students, and market these courses as serving community needs.
- Work with faculty to increase the presence and identity of geosciences on campus. If no dedicated geoscientists are on campus, work with faculty in the physical or environmental sciences or related disciplines.

### For Funding Agencies

- Provide additional support for ongoing collaborations between stakeholders communities. These connections may sometimes go outside the typical duties.
- Provide funding for additional meetings like Geo-Needs, but focus on specific contexts and actionable plans.

### For Geoscience Professional Organizations and Resource Providers

- Help facilitate networking between stakeholders. This could be most effectively done in a virtual format, or at regional conferences.
- Involve end users (2YC and MSI instructors) from the very first stage of product development to ensure that resources are adopted by these users.
- Create modular instructional resources that are easily adapted to local geologic contexts, and use local examples with minimal burden on the instructor.

### For Geoscience Employers

- Build relationships with geoscience departments at local higher education institutions; local geoscientists can be a great resource for mentoring, providing guest lectures, internships, and field trip opportunities.

### For Geoscience Researchers

- Build and participate in regional networks of 2YCs, MSIs, and four-year institutions in order to develop trust between students, institutions, and researchers and to strengthen data collection methods.
- Build research partnerships with 2YCs that do not have access to the resources needed to do geoscientific research. Students who obtain research experience in their first two years of college are much more likely to persist and succeed in science disciplines.

### For Geoscience Education and Higher Education Researchers

- Explore longitudinal studies, data clearinghouses, and other mechanisms for improved capture of data on student choices and career pathways.
- Collaborate on review papers that identify what strategies are and are not successful in recruitment and retention of minority students in the geosciences. Ensure that these strategies are disseminated to both the geoscience education community and the community of researchers in diversity in higher education.
- Partner successful student recruitment and retention programs with social scientists to explore theory behind the success and mechanisms that could work elsewhere.
- Work with professional societies and institutional administrators to elevate the status of geoscience education as scholarly work meriting tenure and promotion.

Across all of the meetings, participants recognized the need to move from a model that focuses on the lack of academic skills to a model that recognizes the skills and strengths that underrepresented students bring to the educational setting. They recognized the need to reframe and market the geosciences as a profession that serves the public good. Furthermore, multiple groups advocated for broadly defining the utility of a geoscience course of study for fields such as planning, education, and business, rather than presenting a singular pathway from a geoscience degree to employment in the traditional sectors such as oil and gas, mining, environmental consulting, and academia.

One step that would move these issues forward is improved dissemination of what works, both in terms of empirically tested models and theory. Broader dissemination may also bring more attention to the issue of underrepresentation in the geosciences. We suggest creating "action briefs" or "spotlights" of successful programs and/or specific strategies across different contexts and accumulating the existing strategies through published literature review papers. Furthermore, we recognize that not all 2YCs and MSIs have similar contexts. Future meetings should explore specific institutional contexts (e.g., a meeting for tribal colleges trying to establish geoscience programs, a meeting for increasing minority student participation at urban 2YCs). Bringing together individuals facing a common problem has greater potential to generate lasting solutions. The voices shared here are only a start; sustained effort from the entire geosciences community is needed to achieve our goal of a having a broad, diverse, and well-prepared geoscience workforce.

# 1. Introduction

## 1.1 PROJECT OVERVIEW

As communities seek reliable sources of clean water, prepare for a changing climate, use a wider variety of energy resources, and mitigate the risks of natural hazards, employment opportunities in the geosciences have expanded. Traditionally, students prepared for careers that address these types of issues through earning geoscience degrees at four-year colleges and universities. Students attending two-year technical or community colleges (2YCs) and federally designated minority-serving institutions (MSIs) typically do not have access to the same career opportunities because geoscience programs are rare at these institutions. As a result, 2YC and MSI students, who are overwhelmingly from ethnic and racial minorities underrepresented in the geosciences, are often excluded from the geoscience workforce.

Geo-Needs is a National Science Foundation (NSF)-funded project that explores barriers and opportunities for enhancing geoscience instruction at 2YCs and MSIs so that students who attend these institutions have greater opportunities for employment in the geosciences. Specifically, the project aims to:

- Identify and clarify barriers and opportunities for better use of existing instructional resources that engage underrepresented students in the geosciences at 2YCs and MSIs.
- Explore with stakeholders what an "ideal model" of resources, partnerships, professional development, and ongoing support for faculty and institutions might look like.

To achieve these goals, Geo-Needs held a series of four, three-day focus group meetings that included key stakeholders. Teams of instructors and administrators met concurrently from August 5–7, 2015. Providers of geoscience educational resources and education researchers met concurrently from August 9–11, 2015. All meetings were held at the Northern Illinois University Conference Center in Naperville, Illinois, USA. Each meeting considered specific questions that speak to the overall project goals (Table 1). All meetings engaged participants in small group and whole group discussions, brainstorming sessions, collaborative Web authoring, and individual reflection. Guest speakers enriched these dialogs by sharing new perspectives. At the completion of the stakeholder meetings, the project team reviewed participant input and summarized findings across the groups. An external evaluator independently reviewed all project activities, including recommendations for improving the meetings, authored Section 5 of this report (Evaluation), and reviewed final products. This report includes the results and recommendations of the Geo-Needs meeting focus groups, and is also available on the project website (http://serc.carleton.edu/geoneeds).

## 1.2 STATUS OF THE GEOSCIENCES AT 2YCS AND MSIs

A discussion of the status of geoscience education must begin with a clear definition of "geosciences." For this project, we adopted the American Geosciences Institute (AGI) (Wilson, 2014) definition inclusive of:

- Geoscientist – subdivided into environmental science, hydrology, oceanography, atmospheric science, geology, geophysics, climate science, geochemistry, and paleontology
- Geoscience Engineer – subdivided into environmental, exploration, geotechnical, and manager

A course or program of study in any of these areas was considered included within the definition of geosciences.

Federally designated underrepresented minorities (URMs) include African Americans, Hispanics, and Native Americans/Alaskans. Most reports that present statistical data on URM education and employment focus only on these groups. In our presentations and meeting discussions, however, we encouraged participants to consider all persons who may be currently underrepresented in geoscience professions, including women, persons of color (not specifically designated as URMs), multiracial persons, persons with disabilities, LGBT (lesbian, gay, bisexual, and transgender) persons, and low-income and/or first-generation college students. We wanted discussions to be as inclusive as possible and to reflect the diversity of students at 2YCs and MSIs.

At present, URMs make up ~8% of the geoscience-related workforce (Wilson, 2014). This pattern of underrepresentation has been attributed to numerous factors, such as (1) lack of access, especially pre-college, to the geosciences (Levine et al., 2007); (2) lack of awareness and family support of geoscience career opportunities (Huntoon

Table 1. Structure and substance of the four focus group meetings.

| | |
|---|---|
| **FOCUS GROUP 1**<br>Academic Administrators: Design, Implementation, and Institutionalizing Geoscience Programs for a Diverse Geoscience Workforce | This meeting focused on administrators helping to identify potential sustainable opportunities for enhancing existing geoscience instruction and establishing new instruction at 2YCs and MSIs.<br>• Why are opportunities for instruction in the geosciences important for students at 2YCs and MSIs?<br>• What can the geosciences offer to enhance the institutional mission?<br>• How can the geosciences best prepare students from underrepresented groups for career opportunities?<br>• How can the geosciences serve the communities in which they are situated?<br>• What resources do these institutions need to establish and sustain a program of study in the geosciences? |
| **FOCUS GROUP 2**<br>Instructors: Course and Curriculum Development for a Diverse Geoscience Workforce | This meeting focused on the needs of individual 2YC/MSI instructors for reaching and engaging currently underrepresented students in the geosciences.<br>• What instructional resources are currently used by 2YC and MSI instructors in geoscience courses and programs?<br>• What support mechanisms are needed to help instructors develop courses and curricula designed to introduce and recruit students to career possibilities in the geosciences?<br>• What can be done to support instructors who may not have specific training in the geosciences, and thus, have to teach "out of field"?<br>• What professional development programs will help support these instructors?<br>• What classroom resources are needed to initiate and deliver new courses of study in the geosciences? |
| **FOCUS GROUP 3**<br>Developing and Providing Responsive Curricula to Broaden Participation in the Geoscience Workforce | This meeting focused on how resource providers interact with 2YCs and MSIs to provide timely and responsive instructional resources, materials, and tools.<br>• How do resource providers disseminate their products and communicate to potential users?<br>• How do resource providers identify what curricula or materials are needed?<br>• What role can 2YCs and MSIs play in the development of culturally responsive curricula?<br>• How can curricula be designed to support not only knowledge gains but also development of soft skills and habits of mind desired by employers? |
| **FOCUS GROUP 4**<br>Geoscience Education Research for Broadening Participation in the Geoscience Workforce | This meeting focused on opportunities to engage geoscience education researchers in addressing enduring questions about recruitment, retention, education, and workforce preparation of underrepresented students.<br>• What is currently known about the preparation of underrepresented students, particularly those at 2YCs and MSIs, for the geoscience workforce?<br>• What future work is needed to better understand the pathways and preparation of these students for the workforce?<br>• What work is needed to identify and disseminate "successful" interventions?<br>• What are potential barriers to conducting research at 2YCs and MSIs, and how might these barriers be overcome? |

and Lane, 2007; Stokes et al., 2015); (3) lack of adequate high school preparation in STEM (science, technology, engineering, and mathematics) (Baber et al., 2010); and (4) poor teaching in introductory geoscience courses (Levine et al., 2007). Our project focuses specifically on the first barrier. By cross-referencing publicly available lists of federally designated MSIs with lists of institutions offering geoscience degrees obtained from AGI, we found that only about 2.5% of institutions with geoscience degree programs are designated as minority-serving. Substantially more institutions offer courses in the geosciences, but the paucity of degree programs means that few pathways currently exist from 2YC and MSI institutions to the geoscience workforce. For a more complete discussion of the status of geoscience education and the geoscience workforce in the United States, please see the current AGI report (Wilson, 2014).

## 1.3 GENESIS OF THIS PROJECT

The idea for this project came about when four of the investigators (Petcovic, Mogk, Cartwright, and Turner) met at the 2014 NSF-Improving Undergraduate STEM Education (IUSE) Phase I Ideas Lab focused on developing novel approaches to increasing access to the geoscience workforce (http://www.nsf.gov/pubs/2014/nsf14033/nsf14033.jsp). During the Ideas Lab, participants from the full range of geoscience disciplines and from geoscience and science education engaged in brainstorming, discussion, and feedback sessions. We were asked to consider current obstacles to undergraduate student access to the geosciences and to develop novel ways around these obstacles. The four investigators were drawn together by a common question: How might we make more intentional use of the incredible

wealth of educational resources and opportunities already available in the geosciences to broaden participation at 2YC and MSI institutions? From this initial meeting, we submitted a proposal to investigate this question. Funding from the NSF-IUSE program was received in January 2015 to conduct the Geo-Needs focus group meetings.

During the proposal planning phase, we identified five stakeholder groups integral to broadening participation of URM students in the geosciences: employers, instructors at 2YC and MSI institutions, administrators (department chairs, directors, and/or deans) at 2YC and MSI institutions, organizations that provide educational resources and opportunities in the geosciences, and researchers who study or otherwise participate in geoscience education, outreach, and diversity in higher education. We chose these five groups because input from all of these stakeholders is critical to achieving lasting impact. For example, course and programmatic efforts in the geosciences are unlikely to be sustained by 2YC/MSI instructors without administrative support. Instructors, administrators, and resource providers should understand the needs of employers to ensure that students develop key skills and competencies. Education research informs teaching, and practical problems in teaching URM students in the contexts of 2YCs and MSIs can inform research. Ultimately, we decided not to hold a focus group meeting with geoscience employers, as efforts in this area on a national scale were already underway (e.g., Geosciences Employers Workshop, May 2015, http://www.jsg.utexas.edu/events/future-of-geoscience-undergraduate-education).

Another strategic choice made during the planning process was to use the term "focus group meetings" rather than "workshops" to describe project activities. A workshop implies that the main purpose of the meeting is for the participants to learn something from the conveners. While we hoped that participants gained valuable experiences from the meeting, this was not our main goal. Instead, the goal was for the project team to draw out and share participants' knowledge. In a focus group, members co-construct meaning through their interactions (e.g., Patton, 2002; Millward, 2012). Thus, we used discussion, brainstorming, feedback, and reflection shared among participants and between participants and conveners to facilitate rich interactions that addressed the goals of our project.

A third strategic choice was to run the focus group meetings simultaneously in two sets. The Instructor and Administrator meetings were paired so as to encourage teams from the same institution to attend the meeting. Educational innovations are more likely to persist when administrators support the work of their faculty and instructors (e.g., Handelsman et al., 2004). We also thought it would be valuable to include both groups in the same conversation, so as to solicit input from both "sides." The focus group programs included sessions with the full group as well as breakout sessions with each group separately. The Resource Provider and Education Researcher focus group meetings were also paired, though the programming for these groups had less overlap. We thought facilitating conversations between groups that provided educational resources and individuals who study diversity and learning would be valuable to both groups, as well as to the project's goals.

## 1.4 PREPARATION OF THIS REPORT

The purpose of this document is to describe the meeting participants' input, structure and substance of the focus group meetings, main findings that emerged, and evaluation data. As much as possible, we captured participant thoughts, discussion, and writing during the focus group meetings using Web authoring capabilities provided by the Science Education Resource Center (SERC) at Carleton College. Immediately after each meeting, the project team synthesized and summarized results. The report was written in sections by team members, with findings common to all groups developed by the full group. We attempted to preserve the actual words and perspectives of the participants as much as possible; however, we recognize that much is filtered through the perspectives and experiences of the team members. Participants were invited to review a draft version of this report, and comments were incorporated into the final version. The project evaluator also provided a check of the report contents against the evaluation data collected during the meeting.

# 2. Participants

## 2.1 PARTICIPANT RECRUITMENT AND DEMOGRAPHICS

Potential participants were identified by review of 2YC/MSIs that included some Earth science coursework as represented on their institutional Web pages, and the responsible faculty members or administrators were contacted directly with invitations to participate. Resource providers and geoscience education researchers were identified through a review of the literature, and colleagues with records of interest and contributions to diversity issues were invited to participate. The investigators co-developed a set of recruitment emails that introduced the project goals and provided a description of each focus group meeting. These emails were sent to individuals as detailed in the next sections. Potential participants were directed to the project website, where they registered with their contact information, institutional information, and responses to questions asking about goals for participating in the meetings and perceptions of barriers and opportunities for diversifying the geosciences. Ultimately, 40 individuals from 34 institutions or organizations across the United States participated in the meetings (Table 2, Figure 1). A complete list of participants is available in Appendix B.

Table 2. Overall participant information. Six higher education institutions had two participants.

| GENERAL DEMOGRAPHICS | # |
|---|---|
| Total participants | 40 |
| Total higher education institutions and organizations | 34 |
| Total higher education institutions | 27 |
| MSIs represented | 8 |
| 2YCs represented | 11 |
| 4YCs represented | 15 |

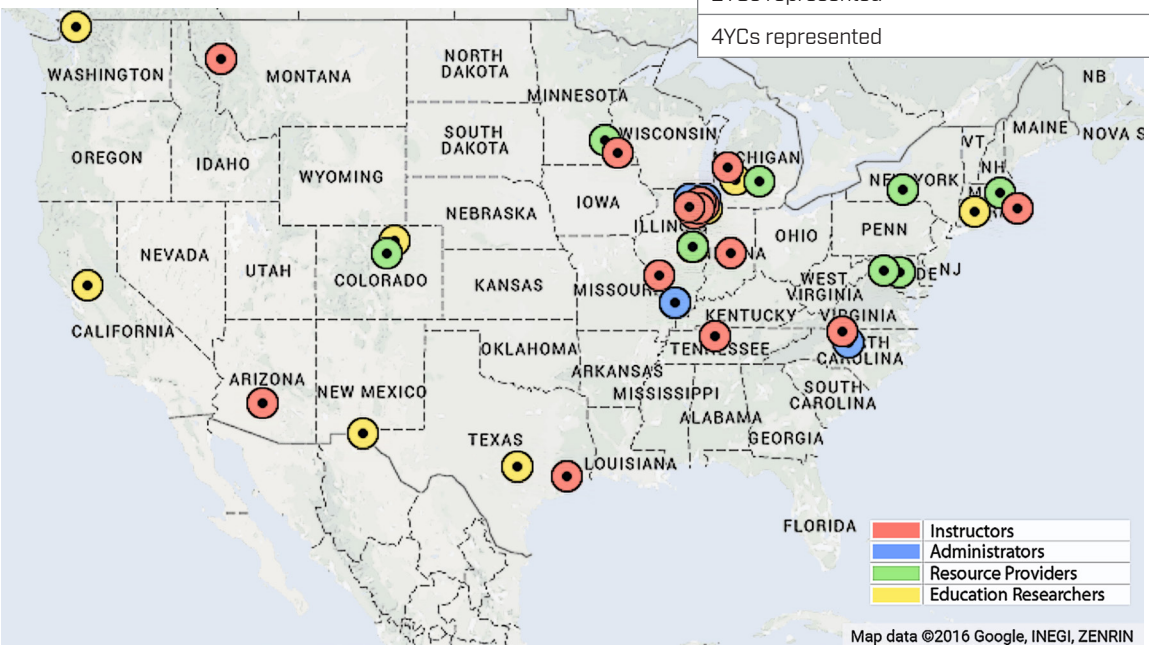


Figure 1. Location of participants' institutions.

### 2.1.1 Recruitment and Demographics of Instructors and Administrators

Since the goal of this project was to conduct a needs assessment with instructors and administrators from MSIs and 2YCs, we first developed a database of potential invitees. Publicly available lists of Historically Black Colleges and Universities (HBCU), tribal colleges and universities (TCU), and Hispanic-Serving Institutions (HSI) were cross-referenced with the AGI list of geoscience departments to identify institutions that already have geoscience programs. This procedure did not capture 2YCs with strong geoscience programs, or MSIs that may have a few geoscience course offerings but not a complete program. The project team sought to engage participants from institutions without geoscience programs as well as those from institutions that have had success promoting geosciences with URM students to ensure that a rich conversation would take place at the focus groups.

We were not able to consistently obtain faculty and instructor information from department websites because many institutions, particularly 2YCs, employ adjunct faculty. Instead, we contacted deans and program/department chairs from institutions that were listed in our database of MSIs and 2YCs and that teach courses in the geosciences, inviting those individuals to share the meeting information with their teaching faculty. Finally, we utilized SERC resources to help us identify faculty and administrators who had already participated in relevant professional development such as the SAGE 2YC program. As far as possible, instructors and administrators from the same institution were contacted simultaneously.

In addition to seeking a balance of participants from institutions representing a range of current geoscience offerings, we also recruited participants from diverse geographic regions and diverse types of institutions (e.g., rural vs. urban, small vs. large, teaching-intensive vs. research-intensive). We invited every 2YC and MSI in the greater Chicago region to increase the likelihood that local institutions would participate. A secondary goal of regional recruitment was the hope that informal collaborations and networking during the focus group meeting might be sustained afterward, creating a regional network of institutional support.

A total of five administrators and 16 instructors representing 17 institutions participated in the focus group meeting (Table 3; Appendix B). Three institutions had one administrator and one instructor participate. Twelve of the institutions offered geoscience degree programs, and all offered at least a single course in the geosciences.

### 2.1.2 Recruitment and Demographics of Resource Providers

Recruitment for this meeting began by generating a list of geoscience-serving government organizations (e.g., NOAA, NASA, USGS, state and regional surveys; note that a list of all acronyms and abbreviations in this report is provided in Appendix A), technical organizations with strong education and outreach programs (e.g., IRIS, EarthScope, IODP, UNAVCO), and professional organizations that support geoscience education and outreach (e.g., AMS, GSA). Organizations that warehouse as well as create educational materials (e.g., SERC, TERC) were also included. Targeted emails were sent to individuals from these organizations. In total, eight separate organizations were represented in the Resource Provider focus group (Table 4; Appendix B). Five of these organizations were federally funded, and three were state funded.

### 2.1.3 Recruitment and Demographics of Education Researchers

Recruitment for this meeting started with a search of the *Journal of Geoscience Education* to identify authors of research studies focused on geoscience diversity. We specifically targeted: (1) successful recruitment/retention

Table 3. Participant information for the Administrator and Instructor focus group meetings.

| ADMINISTRATORS/INSTRUCTORS | # |
|---|---|
| Total administrators | 5 |
| Total instructors | 16 |
| Higher education Institutions represented | 17 |
| MSI Institutions represented | 7 |
| 2YC Institutions represented | 10 |
| Higher education Institutions with geoscience programs | 12 |
| Higher education Institutions from Illinois | 7 |

Table 4. Participant information for the Resource Provider focus group meeting.

| RESOURCE PROVIDERS | # |
|---|---|
| Total resource provider participants | 8 |
| Organizations represented | 8 |
| Federally funded organizations | 5 |
| State funded organizations | 3 |

programs that have documented large impact at institutions in the literature, (2) non-geoscientist collaborators on geoscience education diversity research, and (3) geoscience education researchers who have focused on diversity research. As a result, participants in this focus group included geoscientists, geoscience education researchers, and education researchers specializing in success of URMs in STEM fields (Table 5). In total, 11 researchers participated in this focus group, eight from institutions with geoscience programs.

Table 5. Participant information for the Education Researcher focus group meeting.

| EDUCATION RESEARCHERS | # |
|---|---|
| Total education researchers | 11 |
| Institutions/organization represented | 10 |
| Institutions/organization with geo program | 8 |
| Geoscientist researcher | 3 |
| Geoscience education researcher | 4 |
| Higher education researcher | 4 |

## 2.2 CHALLENGES TO PARTICIPANT RECRUITMENT

Since the goal of this set of focus groups was to understand the barriers and opportunities for building diversity in the geosciences, our overarching goal was to recruit participants, particularly administrators and instructors, from minority-serving institutions. In total, 26 MSIs were individually contacted throughout the recruitment process. Of these, only seven separate MSI institutions (two HBCUs, one TCU, and four HSIs) were represented at the administrator and instructor focus groups. There was a unique challenge in recruiting administrators to participate. We were successful in recruiting five administrators, one of whom was a presenter.

# 3. Meeting Structure and Activities

## 3.1 OVERALL STRUCTURE OF THE FOCUS GROUP MEETINGS

Each of the four focus group meetings was structured to obtain information about the needs, barriers, and opportunities for expanding geoscience instruction for a diverse student population. We used a gap analysis as part of this process to identify critical resources, staffing, and programs needed to achieve these goals. This approach is commonly used to compare an organization's current level of performance with its desired level, then plan tasks needed to achieve the desired state. At Geo-Needs, meeting activities first invited participants to explore what is known about the status of geoscience instruction at 2YCs and MSIs. Next, participants were invited to consider the desired state of instruction. Third, a series of activities guided brainstorming and discussion of how key stakeholders might interact to bring about the desired state. Finally, participants were provided with guided prompts to consider actions they might take in their own contexts to reach the desired state.

Within this larger structure, we planned individual activities to align with goals specific to each meeting (Table 6; full meeting agendas are available in Appendix C). Because two stakeholder meetings were held concurrently (Instructors with Administrators, and Resource Providers with Education Researchers), we conducted some of the activities with the full group of participants and some with just the individual stakeholder group. As described below, some of the activities were common across the two meetings and all four groups, whereas others were designed to meet the goals established for each individual stakeholder group.

We recognize several sources that greatly influenced the planning, organization, and execution of the Geo-Needs meetings. First, our experiences at the 2014 NSF-IUSE Ideas Lab guided the overall tone of the meeting and was the source for several brainstorming activities as noted below. Second, the 2015 Earth Educators Rendezvous hosted by

Table 6. Alignment among project goals, individual meeting objectives, and meeting activities.

| PROJECT GOAL 1: Identify and clarify barriers and opportunities for better use of existing instructional resources that engage underrepresented students in the geosciences at 2YCs/MSIs | | |
|---|---|---|
| | **Meeting Objectives** | **Meeting Activities** |
| **Administrator** | • Determine why opportunities for instruction are important in the geosciences at 2YCs and MSIs<br>• Determine what the geosciences can offer to enhance the institutional mission<br>• Determine how the geosciences can serve the communities in which they are situated | • Pre-meeting preparation<br>• Think-Pair-Share Discussion: Institutional missions and workforce needs<br>• Group Discussion: Envisioning the ideal state |
| **Instructor** | • Identify instructional resources that are currently used by 2YC and MSI instructors in geoscience courses and programs<br>• Identify barriers to utilizing innovative resources for instructors at 2YCs/MSIs | • Pre-meeting preparation<br>• Think-Pair-Share Discussion: Existing instructional resources<br>• Think-Pair-Share Discussion: Institutional contexts |
| **Resource Provider** | • Determine how resource providers disseminate their products and communicate to potential users<br>• Determine how resource providers identify what curricula or materials are needed<br>• Identify the roles of 2YCs and MSIs in the development of culturally responsive curricula | • Pre-meeting preparation<br>• Gallery Walk: Getting know our organizations, sharing strengths and knowledge<br>• Gallery Walk: Utilizing our resources to improve diversity in the geosciences |
| **Education Researcher** | • Determine what is currently known about the preparation of underrepresented students, particularly those at 2YCs and MSIs, for the geoscience workforce<br>• Explore how research and evaluation activities in the context of geoscience programs that broaden participation can inform one another | • Pre-meeting preparation<br>• Guest Speaker: *Bridging research and evaluation in geoscience recruitment and retention programs*<br>• Gallery Walk: Identifying the knowledge base |

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Table 6. Continued...

| PROJECT GOAL 2: Explore with stakeholders what an "ideal model" of resources, professional development, and ongoing support for faculty and institutions might look like | | |
|---|---|---|
| | **Meeting Objectives** | **Meeting Activities** |
| **Administrator** | • Identify desirable certification/accreditation programs to enhance career opportunities in the geosciences<br>• Identify resources that institutions need to establish and sustain a program of study in the geosciences<br>• Identify successful ways to inform students from underrepresented groups about geoscience workforce possibilities.<br>• Determine how to prepare students from underrepresented groups for career opportunities in the geosciences. | • Guest speakers: *Geology at Waubonsee Community College*<br>• Developing Ideal Models<br>• Feedback and refinement of ideal models<br>• Guest speaker: *NSF Funding Opportunities for Broadening Participation*<br>• Individual reflection and action plans |
| **Instructor** | • Identify support mechanisms that are needed to help instructors develop courses and curricula designed to introduce and recruit students to career possibilities in the geosciences<br>• Identify what can be done to support instructors who may not have specific training in the geosciences and thus have to teach "out of field"<br>• Determine what supports are needed from administrators at 2YCs and MSIs to help utilize innovative resources<br>• Identify professional development programs that will help support these instructors<br>• Identify classroom resources that are needed to initiate and deliver new courses of study in the geosciences<br>• Determine possible delivery and support mechanisms for these innovative classroom resources.<br>• Identify what is needed to sustain new programs, curricula, and resources after development | • Guest speakers: *Geology at Waubonsee Community College*<br>• Developing ideal models<br>• Feedback and refinement of ideal model<br>• Guest speaker: *NSF Funding Opportunities for Broadening Participation*<br>• Individual reflection and action plans |
| **Resource Provider** | • Identify ways in which curricula and materials can be designed to support not only knowledge gains but also the development of skills desired by employers<br>• Identify ways in which curricula and materials can be designed to support not only knowledge gains but also habits of mind desired by employers<br>• Identify strategies for continual creation of new educational materials to meet the changing needs of the workforce and society<br>• Identify strategies for long-term maintenance of educational resources | • Guest Speaker: *Increase the Impact*<br>• Think-Pair-Share Discussion: Creating culturally relevant resources<br>• Group Discussion: Assessment and evaluation of materials and programs<br>• Guest speaker: *NSF Funding Opportunities for Broadening Participation*<br>• Review and refinement of ideal model<br>• Individual action plans |
| **Education Researcher** | • Determine the future work needed to better understand the pathways and preparation of URM students for the workforce<br>• Determine mechanisms for how research on workforce preparation of underrepresented students can inform teaching practices at 2YCs and MSIs<br>• Uncover potential barriers to conducting research at 2YCs and MSIs, and determined how might these barriers be overcome<br>• Identify mechanisms to promote greater quantity and quality of research on the issues presented in the meeting | • Group Discussion: Filling gaps in the knowledge base<br>• Guest Speaker: *Social Capital Theory as a Framework for Studying Diversity in the Geosciences*<br>• Guest speaker: *NSF Funding Opportunities for Broadening Participation*<br>• Review and refinement of ideal model<br>• Individual action plans |

the National Association of Geoscience Teachers (NAGT) and InTeGrate informed the icebreaker activity and gallery walks. Third, meeting planning, some activities, and the preparation of this report were informed by the 2015 ENGAGE meeting hosted by IRIS (Hubenthal et al., 2015). Finally, each project team member brought a wealth of prior experience in workshop design and leadership, professional development activities, and teaching that were incorporated into the meeting structure.

## 3.2 MEETING ACTIVITIES

This section describes the types of activities conducted at the four focus group meetings (see Appendix C for full meeting agendas). Development of the ideal model is described in the next section. Results of the activities are described in Section 4 of the report. SERC provided technical support for the meetings; discussion notes taken by a convener or participant, as well as individual and group written reflections, were recorded on a private Web space accessible only to the participants and project team.

### 3.2.1 Pre-Meeting Preparation

Prior to their arrival at each meeting, participants were asked to review a few resources relevant to the meeting goals and to prepare responses to questions. Resources and questions were available on each meeting website. Resources included reports, websites, journal papers, and videos related to diversity in the geosciences. Administrators were directed to review several resources related to building strong geoscience departments committed to diversity provided by On the Cutting Edge, NAGT, and AGI. Instructors were directed to resources about effective course design from On the Cutting Edge, and to resources related to recruitment and retention of diverse students from the InTeGrate project. Resource providers read a report summarizing effective strategies for sustained adoption of educational resources, and a paper about recruitment and retention of minority students in the geosciences. Education researchers read three journal articles related to recruitment of URM students in the geosciences, research on the public face of geoscience departments, and a study of self-efficacy among URM students in a geoscience program. Materials and questions specific to each meeting are listed in Appendix C.

### 3.2.2 Prompted Discussion

Two methods were used to guide participant discussion: think-pair-share and prompted whole group discussion. In a think-pair-share (Figure 2), conveners directed participants to specific questions. After a given time allocated for individuals to respond to questions, participants discussed their responses with a neighbor or in a small group. Pair/group responses were recorded on the private Web space. Pairs or small groups were then asked to report out to the whole group for further discussion. Many of these think-pair-share discussions were facilitated as "add ons," where each group adds to the previous group's comments. In the second method, participants simply responded to questions posted by the facilitators. One of the meeting conveners took notes on the private meeting Web space during every discussion.

Figure 2. Participants sharing ideas in a small group discussion.

### 3.2.3 Gallery Walk

The gallery walk method permits a combination of individual reflection and group discussion. The meeting facilitators wrote question prompts on large sheets of paper, which were hung at intervals around the meeting room. Participants went to each poster and individually wrote responses to the questions or comments on other participants' responses (Figure 3). In a variation on this activity, participants used Post-it notes or stickers to comment on the written responses. Participants then reported common ideas or themes within each poster, which in turn was used to generate discussion. Meeting facilitators photographed the posters and recorded discussion notes in the private Web space.

### 3.2.4 Icebreaker

The initial activity was chosen to set a welcoming tone immediately at the start of each meeting and to communicate the goals, meeting structure, and agenda to participants. The icebreaker was held in a private room located at a nearby restaurant. After a presentation of the project goals, we went straight into the icebreaker, which was adapted from a presentation by John Matsui (University of California, Berkeley) given at the 2015 Earth Educators

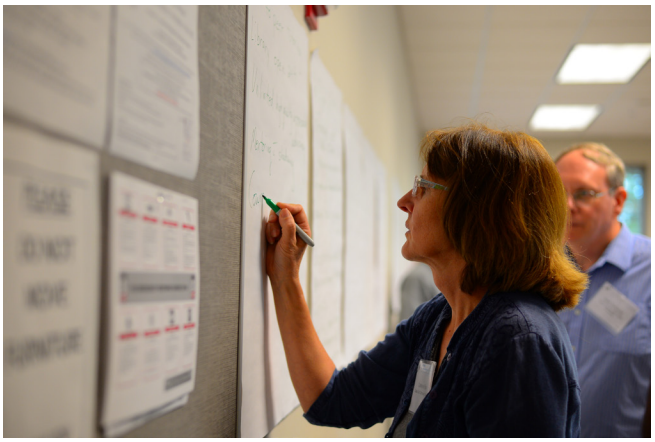


Figure 3. Participant adding comments to a poster during a gallery walk.

Rendezvous (http://serc.carleton.edu/earth_rendezvous/2015/morning_workshops/w11l). In this gallery walk, participants responded to prompts (Table 7) on Post-it notes after being shown an example created by the project team. Prompts were slightly different between the two meetings to accommodate the differing participant contexts and meeting goals. After individual writing, participants stuck their completed notes onto large pieces of paper placed around the room. We then invited participants to walk around and view the notes, then to ask one another questions about what was written on the notes. In both meetings, this activity generated lively discussion and an opportunity for individuals to compare their personal and institutional contexts. Results of this discussion are available on the Geo-Needs website.

After this activity and dinner, the presenters introduced project team members, reviewed the goals specific to each meeting, and summarized the current state of access to geoscience instruction among 2YCs and MSIs. We then reviewed upcoming activities and anticipated products of the meetings, and concluded with an overview of logistics and the pre-meeting assignment.

### 3.2.5 Team Norms, Parking Lot, and Soapbox

To set a tone of collaboration and respect, on the first morning of the meetings we introduced team norms using a think-pair-share activity. Participants were invited to pair with a neighbor and write on a Post-it note two possible norms that would guide interactions between group members during the Geo-Needs meeting. Participants then read the norm aloud to the group and added it to a poster. The facilitator grouped similar norms together as they were collected, and invited the group to create a collective name for similar norms. For example, the norm "Inclusion and Respect within the Group" generated during the Resource Provider-Education Researcher meeting included specific behaviors such as "make sure all participants have a voice and get a chance to talk" and "respect others' statements and opinions even if you disagree!" After the activity, norms were recorded and added to the project meeting website. We believed that allowing the participants to generate expectations for behavior would not only produce more authentic norms, but also encourage the participants and project leaders to live up to expectations.

The morning session concluded with an explanation of two other meeting procedures. We designated a poster in the main meeting room as a "Parking Lot"—a location for holding good ideas that were tangential to the topic at hand. Participants were invited to write these ideas on Post-it notes and "park" them for later discussion. The Administrator-Instructor meeting participants chose to use the Parking Lot, but the Resource Provider-Education Researcher participants did not. We also introduced the "Soapbox"—a 60-second time slot for a participant to share whatever he or she wanted with the group. Participants listed their name on the Soapbox poster; after each break, one to three participants were invited to talk. These activities, taken from the NSF-IUSE Ideas Lab, encouraged participants to stay focused on the meeting goals with the understanding that they would be free to share other ideas at a given time. Several participants in both meetings took the opportunity to talk about specific programs, opportunities, or educational resources.

### 3.2.6 Guest Speakers

Guest speakers were brought to the meetings to share new perspectives that could prompt creative new approaches to broadening access to the geosciences at 2YCs and MSIs. Each focus group meeting had between two and four guest speakers. Presentations are available on the project website.

All four meetings included a presentation by Jill Karsten, a program officer in the NSF Directorate for Geosciences. The goal of these presentations was to alert participants to potential funding sources that might support their individual action plans developed at the meeting. Karsten reviewed the policy and strategic plan guiding NSF's investments, as well as the education and diversity priorities for the Directorate for Geosciences. She then discussed several funding streams available at NSF related to broadening participation in the geosciences, including IUSE,

Table 7. Prompts and discussion questions for the icebreaker activity.

| ADMINISTRATOR & INSTRUCTOR MEETING PROMPTS | RESOURCE PROVIDER & EDUCATION RESEARCHER MEETING PROMPTS | DISCUSSION QUESTIONS (BOTH MEETINGS) |
|---|---|---|
| • Write three words or (short) phrases that describe your institution<br>• Write three words or phrases that describe the students with whom you interact the most<br>• Write a six-word sentence telling us why you are here | • Write three words or (short) phrases that describe your institution or organization<br>• Write three words or phrases that describe the ways in which you hope to broaden participation in the geosciences<br>• Write a six-word sentence telling us why you are here | • Take a minute to look around—what similarities and differences do you see?<br>• What intrigues you, or what do you want to know more about the notes? |

IUSE: Pathways into Geosciences (IUSE: GEOPATHS), IUSE: Education and Human Resources (IUSE: EHR), EHR Core Research program, Advanced Technological Education (ATE), EHR capacity-building programs, and an upcoming solicitation for 2016 called NSF INCLUDES.

Two guest speakers from a minority-serving community college that has been successful in recruitment and retention of URM students presented a talk entitled "Geology at Waubonsee Community College" to the Administrator and Instructor meetings. David Voorhees and Lorrie Stahl from Waubonsee Community College shared their experiences and perspectives on building their geosciences program. Voorhees is Associate Professor of Earth Science and Geology and Stahl is Assistant Dean for Mathematics and Science.

In the Resource Provider meeting, Jeffrey Froyd from Texas A&M University presented a talk entitled "Increasing the Impact." This NSF-funded study examined characteristics drawn from educational innovations that have been successfully adopted across STEM disciplines (Henderson et al., 2015). The goal of the talk was to give attendees researched-founded suggestions for how to develop, market, and implement educational programs most effectively. The overall message was that development and marketing should go hand in hand, which can be accomplished by incorporating end users of a product into an advisory role before development even begins. This path provides developers with a core group of users that is intimately familiar with the product for its release. The speaker also introduced a rubric that allowed participants to score the potential success of product adoption at their organizations.

Two guest speakers delivered talks at the Education Researchers focus group. Lorenzo Baber, formerly of University of Illinois at Urbana-Champaign and currently an associate professor at Iowa State University, spoke about "Broadening Participation in Geosciences: Observations from Research." He discussed his role as an education researcher partnering with geoscientists to study student participation in a program designed to recruit students into the geosciences (Baber et al., 2010). Baber also presented his recent work studying a set of STEM persistence programs using the framework of Interest-Convergence (Baber, 2015). This framework has not yet been applied to work in the geosciences. The second speaker was Caitlin Callahan, an assistant professor at Grand Valley State University and a geoscience education researcher. In her talk, "Social Capital Theory as a Framework for Studying Diversity in the Geosciences," Callahan explained how a theoretical framework appropriate to the research questions might be identified and how social capital theory, in particular, can be appropriated for studying diversity in the geosciences (Callahan et al., 2015). Both speakers were selected because their presentation topics would help guide the focus groups discussions toward generating new ideas beyond those in the existing geoscience literature and that may inform future work.

### 3.2.7 Individual Reflection and Action Plans

At the conclusion of each focus group meeting, participants were asked to individually respond to prompts in the private online work space. They were also asked to reflect on what they had learned and to list steps they would take when returning to their institution or organization to implement what they had learned. Participants were asked to share points from their action plans at the final discussion of the meeting.

## 3.3 DEVELOPING THE IDEAL MODEL

One overarching goal for the project was to create an ideal model that would promote and support recruitment and retention of underrepresented minorities in undergraduate education. Creating, annotating, and modifying this model was an integral part of all four meetings. In general, its creation was broken into a series of steps: (1) describe and agree upon the ideal future state, (2) determine the stakeholders required to reach this ideal state, and (3) connect the stakeholders and describe the relationships between each. In this way, the ideal model represents a network—each stakeholder a node and each relationship a link.

Model creation took place at the Administrator and Instructor meetings during their first full day of attendance. The final day was spent with each group discussing their own role in this model. The Resource Providers and Education Researchers were introduced to the constructed models at the end of their first full day and spent their final day discussing how they fit into the model.

### 3.3.1 Rationale for Ideal Model Approach

The ideal model activities stem from the need to move conversations about diversity and workforce preparedness away from the "pipeline" analogy (e.g., Fealing et al., 2015). The idea that students start as geoscience majors and then persist to the workforce as long as all the leaks are plugged is an overly simplistic representation of how students are recruited, retained, and prepared for the geoscience workforce. The pipeline is too linear to be an adequate analogy to the many ways students become scientists (Fealing et al., 2015). Especially in the geosciences, with its wide variety of subdisciplines, there are many ways in and out of the pipeline and not all of those breaches are negative. The pipeline model also dehumanizes and shirks

responsibility from the many stakeholders that students will interact with directly or indirectly along their educational pathway. An ideal model is a system that better represents recruitment/retention of URMs in the geosciences. It is a multidirectional system with multiple entry points and, more importantly, it focuses on the stakeholders and infrastructure that support students instead of the barriers of challenges that students face.

In its simplest form, the ideal model is an exercise in democratic concept mapping. The ideal model activities are adapted from William Trochim's "An Introduction to Concept Mapping for Planning and Evaluation" (Trochim, 1989), which has been used in social science research for many years. For Geo-Needs, concept mapping was used not to compare individual existing conceptions, but to build a synthesized model of what the geoscience community's student support structure could look like. Another benefit of this activity is that discussions around this process allowed the groups to build consensus. In contrast, a discussion format used in these types of meetings sometimes allows one or two strong voices to swamp the signal.

### 3.3.2 Ideal State – Third Third Ideas

The very first step was envisioning the ideal state of geoscience education at 2YCs and MSIs. An ideal state can be thought of as a vision for the way things could be given unlimited in resources and manpower, as well as equitable opportunity by all persons regardless of skin color, socio-economic status, gender, disability status, etc. While the very definition of an ideal state means that it is impossible to achieve, it is a useful place to start the conversation. For many people, identifying an ideal state is challenging because the mind immediately identifies problems and barriers to making that idea a reality. In most human contexts, this is a beneficial quality, but it can be a detrimental to the process of imagining an ideal state. From this ideal state perspective, we were better able identify barriers and devise solutions.

Figure 4. Participants creating and discussing the "ideal state" of geoscience instruction at 2YCs and MSIs.

To help participants get in the right mindset for describing the ideal state, we started with an activity taken from the NSF-IUSE Ideas Lab. The "third third" ideas postulates a hierarchy of three levels of ideas. The most basic level includes ideas that emerge quickly and naturally and are generally ubiquitous across people. The second level ideas are rarer and more exciting, but if given enough time, many people would think of them. Third level ideas are brand new and unique—the types of ideas needed to envision an ideal state. These third third ideas only come after people give themselves enough time to brainstorm all the more common ideas, usually requiring long and sometimes uncomfortable pauses in the group setting of a meeting.

Participants practiced this technique by brainstorming in a group as many "super powers" as they could imagine (recorded by a convener). This topic was chosen as universal to participants regardless of their background. After many of the common superpowers such as "flying" and "invisibility" were listed very quickly, there was a minute or two pause before another flurry of ideas and then a much longer pause before a few final ideas trickled out of the participants. These last ideas were the most unique.

We then introduced the third third philosophy to participants and showed them on the recorded list where the transition from second- to third-level ideas occurred. We then encouraged participants to replicate this process when trying to imagine an ideal state for participation of underrepresented students in the geoscience community and throughout the activities.

### 3.3.3 Ideal State – Gallery Walk

With the third third philosophy in mind, participants were then tasked with envisioning their ideal state for the geoscience community. They were broken into groups of three, and with markers and a poster responded to the prompt:

> *Imagine you had unlimited resources, time, etc. What would it take to achieve the goal of increasing the number of skilled geoscientists entering the workforce, or increasing appreciation and awareness of geoscience among non-geoscience students? As a group, you can choose one of these goals or both.*

We placed one caveat on the brainstorming for this activity—participants could not change the type of student or the socio-economic constraints on their institutions.

After posters were completed, we used a guided gallery walk to gather feedback on ideas (Figure 4). Each group used colored Post-it notes to comment on other posters.

One color indicated ideas on a poster that were also on the group's poster. This allowed the conveners to quickly identify commonalities across all groups. A second color was used to mark exciting and unique ideas. This helped everyone quickly find third third ideas. A third color indicated ideas that were unclear or need further discussion. These acted as drivers for in-depth discussion. After the feedback gallery walk, each group verbally reported out some of the ideas they came up with and the comments they received on those ideas.

### 3.3.4 Stakeholders

After discussion of the ideal state, the next step was to identify key stakeholders. Mimicking the third third activity, participants first created a list of stakeholders that would be needed to make the ideal state a reality. This activity produced over 60 different stakeholder groups. In order to make the ideal model manageable, we then tasked the group of participants to agree upon a smaller subset of stakeholders. After much discussion and debate, they came to consensus on eight groups:

- Faculty (including adjunct and term instructors)
- Students
- Administrators/institutions (including institutional resources and staff)
- Employers
- Community (interested public, taxpayer investment in; public that pays)

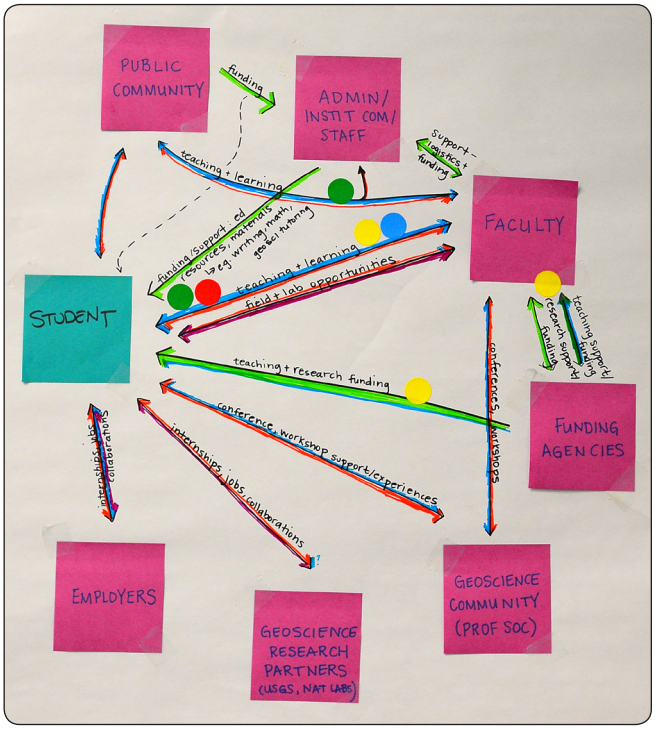



Figure 5. Example ideal model connecting stakeholder groups.

- Geoscience community (professional societies in the geosciences)
- Funding agencies (foundations and other sources)
- Geoscience research partners (USGS, national labs)

### 3.3.5 Ideal Models

With all eight stakeholder groups agreed upon, the next step was to create the ideal model in which all of these stakeholders would be connected and working together. This activity was done individually, where every participant created their own poster of the ideal model (Figure 5). Participants received eight cards with the names of the stakeholder groups. They then connected the stakeholders with arrows annotated to describe the type of collaborations or contacts. Because one of the goals of this project is to increase the use of educational materials, participants also noted with a sticker connections that might involve the creation or use of educational resources.

After the creation of individual ideal models by each participant in the Administrator and Instructor meetings, the conveners synthesized a rough ideal model that captured the essence of all the participant models. This model was used later in the meetings to prompt further discussion. For example, the Instructors and Administrators, being stakeholders themselves, were tasked with focusing on collaborations connecting their own stakeholder group. The Resource Providers, not being an identified key stakeholder group, were tasked with describing their role as a facilitator of these identified collaborations. The Education Researchers, also not identified as a key stakeholder group, were tasked with identifying which collaborations have been studied and which are needed areas of research (Figure 6).

Figure 6. Participant in the Resource Provider – Education Researcher meeting identifying connections on the synthesized ideal model.

# 4. Findings

## 4.1 FINDINGS FROM ADMINISTRATORS

### 4.1.1 Contexts, Barriers, and Opportunities

The first group discussion of the Administrators meeting explored existing contexts, barriers, and opportunities. A meeting facilitator took notes in the SERC workspace during this discussion. Administrators were first asked to provide some context about their institutions in response to the following prompts:

- *Report on the mission of your institution, its setting, and the profile of your student body.*
- *Who are your students? Where do your students come from? What are their needs?*
- *What are the workforce needs in your region?*

The range of institutions included rural and urban, commuter and in-residence, and institutions where there is no formal course of study in the geosciences (e.g., individual courses taught in other units on campus). Degree options also range from certificate programs to BA, BS, MA (non-thesis), MS, and PhD. Many administrators noted the high percentage of first-generation college students and a sense that incoming students were more likely to be academically underprepared as well as financially and time pressured. Administrators from MSIs shared that minority students tend to want to pursue work that gives back to their family and community. Workforce needs ranged from traditional geoscience employers such as oil and gas, consulting, and local and state government, to newer employment in policy, education, and planning. Administrators perceived that students needed training in professional behavior and skills such as critical thinking, communication, and teamwork to succeed in geoscience employment. It is clear that one-size-fits-all approaches will not adequately address the breadth of institutions and potential student populations needed to diversity the geosciences.

> "Institution-wide initiatives are needed to make the geosciences visible in recruitment of new students, admissions and advising services on campuses need to be able to provide degree and workforce information about the geosciences to incoming students, and departments and instructors need to work with institutional curriculum committees to be included in general education or core curriculum requirements."

### 4.1.2 Geosciences in the Institutional Mission

A second discussion period, recorded by a facilitator, focused more directly on the role of the geosciences in the institutional mission in response to the following prompts:

- *How is geoscience (or environmental science) taught at your institution?*
- *How can instruction in geoscience contribute to your institutional mission and the success of your students?*
- *What are your needs in staffing, resources, other to support geosciences at your institution?*
- *What resources currently exist that can help expand instruction in geosciences at your institution?*

The Administrators reported that the geosciences do not have a clear identity on their campuses, possibly because geoscience courses may be taught in physical science, environmental science, or related disciplines such as physics or engineering. Geosciences can play a foundational role at institutions by contributing to a variety of general education degree requirements, particularly when focused on societal issues such as natural hazards, resources, and planning, and in demonstrating concepts on the nature of science.

The Administrators did report numerous challenges in scheduling, sequencing, and articulation of courses to ensure student success. For example, successful completion of an associate's degree at a 2YC may mean that more rigorous science and math courses get concentrated in the next two years, placing a large strain on students. Articulation between 2YCs and four-year institutions may be difficult and place students in a bind about transfer credits or preparation for upper division courses. Institution-wide initiatives are needed to make the geosciences visible in recruitment of new students, admissions and advising services on campuses need to be able to provide degree and workforce information about the geosciences to incoming

students, and departments and instructors need to work with institutional curriculum committees to be included in general education or core curriculum requirements.

The Administrators also recommended identifying opportunities for geoscience instructors to engage in interdisciplinary courses to create exciting new learning opportunities for students in areas of personal enrichment for the faculty. Other strategies identified by the Administrators include increasing research opportunities for students particularly in the first two years (e.g., Gregerman, 2008; PCAST, 2012) and increasing internship and co-op opportunities to expose students directly to practical experience in the workforce. Most importantly, it is the personal relationships with instructors and peers that provide the motivation to pursue geoscience as a career and enable student success at all stages of the degree program.

### 4.1.3 Themes from the Administrator Meeting

The Administrators focus group explored strategies and activities that could be undertaken at the institutional and departmental levels to help increase diversity in the geosciences. There was general agreement among participants that if institutions are not inclusive of all students, we are missing the potential of a huge human resource. When we make our institutions and departments inclusive and welcoming of students from underrepresented groups, then all students benefit. The discussion revolved around four main themes.

First, Administrators recognized the importance of aligning the institutional and departmental missions with diversity efforts. Different types of institutions serve different student populations and occupy different niches in the educational ecosystem. Institutions of higher education occupy a special place in the communities they serve, and can optimize recruitment of diverse students through targeted recruitment efforts. Departments also need to work to build a diverse faculty and to represent departmental culture as being welcoming and inclusive. Continued professional development for faculty, staff, and instructors is needed to help them become more effective mentors and develop cultural literacy. Departments can also work with their administrations to make sure they are an essential and integral part of their institutions—contributing to the core curriculum, contributing to interdisciplinary courses, and providing service learning.

Second, the Administrators recognized the importance of knowing both national trends and the local needs of the geoscience workforce. Departments need to proactively seek relationships with local, regional, and national employers of geoscientists to demonstrate career opportunities. Many students may be reluctant to apply for jobs, so it is important to establish relationships with local employers and optimize opportunities for exchanges with companies, for site visits, and for invited speakers.

Third, the Administrators recommended developing a deep knowledge of the needs of their own students and developing structures that meet these needs. Our participants reported that their students are increasingly job- and task-oriented, and that students are motivated to improve their family and community situations. The Administrators also recognized that many students are academically underprepared to undertake a full load of geoscience, mathematics, and cognate courses, and that student success support structures are needed throughout their academic careers. Rather than characterizing these students as being in need of "remediation," a culture shift is needed that recognizes students as simply pursuing their collegiate academic journey from different starting points. Metrics of institutional success, such as time to graduation, may be better measured as persistence (steady, if slower, progress toward a degree) to accommodate the needs of URM students. Consequently, academic and financial support need to be provided for the duration of the student's collegiate experience. Students are financially and time-challenged; Administrators recommend paid opportunities for students to have co-op and internship experiences.

"Rather than characterizing these students as being in need of "remediation," a culture shift is needed that recognizes students as simply pursuing their collegiate academic journey from different starting points."

In addition to geological knowledge and skills, students need to develop communication, quantitative, and interpersonal skills (i.e., professional skills) to prepare for the future workforce. There is a growing call for undergraduates to have authentic research experiences starting in the first two years of their collegiate career (PCAST, 2012). It has been shown that these experiences, particularly for students from underrepresented groups, lead to higher retention and success rates as students gain ownership of and responsibility for their work (e.g., Gregerman, 2008). Support for research experiences, both embedded in coursework and as more advanced independent study

projects, is needed at the upper levels as well.

Along these lines, the types of degree programs offered can have a large impact on recruitment efforts. Although the MS "is the degree for employment and most likely to promote career growth within the profession" (Houlton, 2015, p. 2), this expectation can present a formidable barrier to choosing the geoscience career pathway for many students from underrepresented groups, particularly for first-generation college students. Departments and programs can demonstrate the range of career/job opportunities that require less formal education. Workforce preparation programs that require an associate's degree or certification in a particular work skill (e.g., GIS) may prove to be a valuable mechanism for recruiting diverse students to the geosciences.

Finally, the Administrators recommended more proactive marketing of the geosciences in two ways. First, students are not aware of potential career opportunities and the pathways that lead to these careers. Data about salaries and career opportunities (e.g., those available from AGI) can be actively shared with students in introductory courses. Beyond "traditional" geoscience careers (e.g., resource extraction, natural hazards, environmental remediation), departments can direct students to career opportunities where a degree in the Earth sciences can serve as a foundation for careers in public planning, law, teaching, and business. Rather than narrowly define the geosciences, consider students to be part of the geoscience community if they pursue careers in related field such as teaching, policy, planning, or business. A degree in geoscience can be marketed as preparation for these other career paths. Second, the Administrators recommended targeted outreach as a means of proactively marketing the geosciences. For example, departments need to reach out to institutional recruitment and admission offices to make sure that geoscience degree programs are well represented. Partnerships with feeder school districts and high schools, particularly those in high needs districts, can impact recruitment efforts. Four-year institutions can work with their feeder two-year colleges to develop articulation agreements, based on trust and respect, to ensure student success upon matriculation. Departments can also work to build relations with regional employers; local geoscientists can be a great resource for mentoring, providing guest lectures, attending or sponsoring field trips, and providing internship or co-op experiences for students.

### 4.1.4 Administrator Action Plans

At the end of the formal meeting program, administrators individually responded to the following prompts in the private workspace:

- *What strengths do you and your setting provide to broaden participation in the geosciences?*
- *For yourself and your setting, in what areas would you like to see improvements for broadening participation in the geosciences?*
- *What do you see to be an "ideal" plan of action to make steps toward improvement at your institution?*
- *What are the remaining challenging issues that you would like to see addressed in upcoming workshops?*

Responses to these prompts fell into four major themes. First, the Administrators recognized that improving connections with alumni and local industry would improve the recruitment and retention of diverse students. The Administrators planned to seek funding for minority scholarships from industries that employ alumni and from local employers. They suggested establishing an alumni advisory board to assist in identifying employers, curricular requirements, and targeted recruiting. Local employers could also be used in an advisory capacity to better align curricula with employer needs.

Second, the Administrators recognized that outreach to K–12 schools would offer additional opportunities for recruitment of minority students, particularly schools in high needs districts. Faculty could be directly involved in recruitment and outreach efforts. Faculty should be compensated (in terms of workload and recognition) for participation in outreach. Institutions can offer coursework and professional development for K–12 teachers to improve the state of geoscience education in schools. Outreach efforts should focus not only on students and teachers, but also on guidance counselors so that they are aware of employment opportunities.

Third, institutional changes are needed to improve the climate, image, and structure of departments and programs. For example, changes to department culture can create a more welcoming and supportive atmosphere that will improve student recruitment and retention. A focused effort should be made to recruit a more diverse faculty in order to demonstrate a meaningful commitment to broadening participation. Opportunities such as service learning and honors courses can attract a more diverse student population. In addition to creating a more welcoming department culture, administrators recognized that marketing the geosciences on campus is critical to recruitment efforts. The Administrators recommended reaching out to academic advisors and recruiters so that they are more aware of employment opportunities in the geosciences.

Finally, the Administrators recognized the need to use institutional data to bring geosciences to diverse student populations. Particularly in 2YCs with distributed

or regional models (e.g., a city, regional, or statewide network of affiliated campuses), geoscience course offerings can be targeted to the campuses with the highest minority populations.

## 4.2 FINDINGS FROM INSTRUCTORS

### 4.2.1 Instructional Resources: Challenges and Opportunities

Instructors initially engaged in small group discussions that explored the variety of resources that they utilize in the teaching. Each small group elected a recorder charged with taking notes on the private Web space. After the discussion period, each small group shared their primary points with the whole group. Discussion prompts were:

- *What are the resources most commonly utilized by your group members?*
- *How do your group members identify/find these resources?*
- *What are the challenges most commonly identified with these instructional resources?*
- *What, if any, instructional resources have your group members found that are effective for underrepresented groups?*

The most commonly identified resources were virtual/open educational resources that could be grouped into those that are: (1) quality assured (e.g., resources provided by professional geoscience-related organizations such as USGS, SERC, NOAA, NASA, UCAR, AMS, virtual field trips), and (2) quality unassured (e.g., resources found through searches on Google or YouTube). Many also commonly utilize physical material resources such as rocks, maps, physical models, or other equipment. Place-based resource that are either provided by publishers or created by instructors were noted as particularly important for creating relevancy. Experts invited as guest presenters and listservs were described as valuable resources. Some of the Instructors noted that students themselves were a valuable resources, especially their knowledge of the local environment.

Instructors find these resources through: (1) Google and YouTube searches, which require both courage and the ability to assess quality; (2) social media, including Facebook and Twitter links; (3) recommendations from colleagues at the same institution, colleagues from a four-year university, adjuncts, or local professionals; (4) professional society listservs, online activities, field trips, conference attendance, and meeting materials; (5) government agency and professional organization websites such as EPA, USGS, NOAA, NSF, STEM organizations; (6) students, for example, their knowledge of local field trip sites; (7) the SERC website; (8) textbook publisher provided materials and resources; and (9) scientific supply catalogs. Place-based resources created by instructors themselves are particularly required. What is clear from this discussion is that instructors use a wide range of techniques to find and adapt instructional materials.

> “Focus group members noted that when underrepresented students have the opportunity to participate in directed research and active learning, their engagement increases.”

Participants outlined several challenges associated with identifying these instructional resources and adapting them to local contexts. Most commonly, the Instructors reported a challenge of insufficient physical resources—namely, broken and outdated equipment, and insufficient space for storage. The Instructors also reported insufficient field tools along with challenges of accessibility and transportation to field sites. In general, the expense of needed resources proves problematic. Using place-based resources is a significant challenge because of the time and expertise needed to adapt these materials to the instructor’s local context. Challenges associated with using online resources included the time needed to find high-quality, relevant resources, the prevalence of outdated resources, and questions of how to know whether Internet resources are accurate and reliable. Many of the Instructors came from departments of one where isolation makes it hard to build a local network for sharing resources. Some participants mentioned a distrust of publishers who are perceived to be out to make a sale. In some instances, the instructor lacks the technical skills needed to merge resources with the institution’s course management software.

Several strategies were identified as being effective for engaging underrepresented students in the geosciences. Direct exposure to the workforce, including internships, was perceived as the most important and effective (but limited) strategy. Focus group members noted that when underrepresented students have the opportunity to participate in directed research and active learning, their engagement increases. Meeting participants identified a need for sufficient institutional support, for example, for tutoring and learning centers, to aid underprepared students. Ensuring

that needed resources are low cost (or no cost) is important both for instructors at small institutions and also for their students who have limited financial resources. Participants suggested strategies such as making course resources available at the library or for rent instead of purchase. Resources should be multilingual and easily available to students, such as on websites. Instructors can utilize course management analytics to verify that all students are capable of effectively using the institution's course management software. Many participants suggested that place-based learning techniques have been particularly effective for minority students, including urban field guides and connecting to local context/culture to the geoscience curriculum.

Participants noted that minority students need support to grow their network of role models and mentors who can support them through the college process. Successful alumni, near-peer mentors, and even videos (such as the Neil deGrasse Tyson series) can be used to spark interest and support students to success. Field trips to larger universities can provide exposure, information, and connections to minority students. Students often need help in building their support community (e.g., free bus passes, scheduling that fits needs, and daycare).

To summarize these discussion points, the Instructors expressed a need for support to tailor existing resources to their local community. Place-based learning techniques have been found to be effective for underrepresented groups. However, instructors are often working alone in small departments or in no department at all, leading to situations where there is insufficient time and/or funds to modify existing resources in this manner.

### 4.2.2 Contextualized Settings: Challenges and Opportunities

In an effort to foster rich discussions on shared challenges and opportunities, participants grouped themselves based on one particular situational context that they chose. Five groups formed: departments of one, urban colleges, suburban 2YCs, diverse four-year colleges, and adjunct-dominated colleges. Each group of at least three participants responded to the following prompts, with a recorder capturing notes on the private workspace:

- *What assets do your students bring to your classroom?*
- *How do the instructional resources that you utilize take advantage of these assets?*
- *What opportunities does your instructional setting provide? What challenges?*

Multiple situational challenges exist for MSI and 2YC geoscience departments. In general, the majority of students are nonmajors. There are a wide variety of different levels of student preparation and demands related student work/life balance. Students may not have adequate or accurate advising, and they do not feel connected to campus communities. Limited funding for equipment, field trips, and lack of administration support for instructors (particularly adjuncts) make it difficult to implement innovative teaching strategies that are most effective for minority students. The location of the institution itself poses challenges. Urban departments often lack local field trip sites and students are not familiar (and perhaps not comfortable) with the outdoors. Large suburban 2YCs often have a need for increased cultural sensitivity to attract more URM students.

Many times the institution itself presents both challenges and opportunities. Very small departments lack sufficient numbers of instructors to foster collaboration and growth. Many departments are dominated by adjuncts who must endure undependable workloads; at the same time, the department's quality and consistency of content can become threatened if dependent upon adjunct instruction. Adjuncts themselves have little power and are perceived as not being truly a part of the department. Small departments often have small classes, which can increase student engagement and consistency between lab and lecture with the same instructor. These small departments often have flexibility, particularly in 2YCs, to try new things and to set new curricula. Urban universities usually have sufficient technology and good instructional support. Some 2YCs have nicer facilities and lab space for the geosciences than their four-year counterparts. Four-year institutions need support for equipment and grant writing.

Participants identified several important assets that today's students bring with them to the classroom. Students are incredibly tech savvy and used to using smart phones and technology/media as a learning resource (e.g., YouTube videos or online pictures/images). Participants described their students as adaptable, enthusiastic, and task oriented. Some participants described their students as hard working while others did not. All agreed that students are willing to try new things. Students who are in our classrooms can be utilized as assets themselves. They may share their own geoscience experiences and personal stories in the classroom. Multinational/diverse student populations often bring geologic/environmental experiences that can be used to enrich instruction. Age diversity in students can also be beneficial because older students are perceived as being generally more motivated. All participants agreed that more experienced students can help others in the class.

In summary, the Instructors agreed that there is no "one size fits all." Needs are highly contextualized and strategies for meeting these needs must be specific to different population groups and different institutions. The principal needs

for instructors are not particularly curricular or pedagogic. They need stronger connections with the community and industry. Each geoscience professional has their particular area of expertise, interest, and influence. We must work together to identify others with similar interests in the region and discipline. This can be accomplished through direct, targeted, personal interactions. We must work together to build trusted relationships between geoscience professionals to establish and sustain diversity efforts.

### 4.2.3 Instructor Action Plans

At the end of the formal meeting program, the Instructors wrote responses to the following prompts (identical to the Administrator meeting prompts) in the private Web space:

- *What strengths do you and your setting provide to broaden participation in the geosciences?*
- *For yourself and your setting, in what areas would you like to see improvements for broadening participation in the geosciences?*
- *What do you see to be an "ideal" plan of action to make steps toward improvement at your institution?*
- *What are the remaining challenging issues that you would like to see addressed in upcoming workshops?*

Participants overwhelmingly said that the diverse student populations already enrolled at 2YCs and MSIs were a significant strength. Many also commented that the diversity of instructors and programs already existing at their institutions, some with ties to research facilities, four-year institutions, or state and federal agencies, was a strength. It was recognized that 2YCs and MSIs reach large numbers of students and furthermore have the flexibility to try new things in classrooms, departments, and across and outside of institutions. A few participants noted their close ties to local employers and their ability to respond to local employer needs. A final strength noted was an institutional (or departmental) commitment toward diversity that created a climate supportive of individual effort.

Instructor comments fell naturally into three major areas. First, participants were concerned with building stronger and more complete geoscience departments. This included improved management of enrollment and course offerings, increased academic support for underprepared students such as tutoring programs and/or individual mentoring, increased administrative support, and increased diversity of instructors with a focus on hiring instructors with a commitment to teaching. Second, participants recognized the need to build relationships both with other units on their own campus (including academic advising) and with other institutions in order to support their students and programs. Facilitating transition points (2YC transfer to 4YC, 4CY to graduate school, and minority serving to majority dominated) was recognized as a key step. Finally, the participants were concerned with the public image of the geosciences and how this image could be improved. They called for public relations and marketing campaigns at both the national level and within their own institutions and communities to reframe the geosciences as a profession that serves and betters the community.

> "[Participants] called for public relations and marketing campaigns at both the national level and within their own institutions and communities to reframe the geosciences as a profession that serves and betters the community."

Individual action plans revealed many specific steps that could be taken to address the three areas identified for improvement (improving institutions and departments, building internal and external relationships to facilitate student success, and improving the image of the geosciences). Suggested institutional changes to courses, curricula, or programs that can help to recruit and retain underrepresented minority students included:

- Offer additional courses related to student interests and job opportunities; for example, expand offerings to entice students to take more courses, or offer more basic geoscience courses within an existing environmental science program.
- Structure programs and support to accommodate the needs of URM students; for example, extend the duration of programs to account for family and work obligations of nontraditional students, provide mentoring for all students, provide math and writing tutoring in collaboration with other departments, and move more course offerings online to accommodate work schedules.
- Increase institutional and administrative support; for example, increase investment in the department (e.g., maintaining classroom and research space, hiring instructors, providing instructors with time and/or credit for curriculum development and recruitment activities), and persuade the administration to value geoscience as part of the STEM courses.

> “[M]any participants were concerned about the status of the geosciences in K–12 education and adequate preparation of K–12 Earth science teachers. It is important that students learn about geoscience and its professional opportunities from a young age.”

Building relationships to facilitate student success was largely reflected in action items pertaining to improved marketing of geosciences within the institution to recruit more students to existing programs. Participants identified the following actions that could be taken:

- Work with academic advising to promote geoscience courses and programs; for example, attend meetings with academic advisors to explain classes available and to promote job opportunities in the geosciences.
- Create new or leverage existing student opportunities; for example, create new student groups such as a geology club; interact with existing campus groups that support minority students and/or STEM students; and take advantage of existing campus opportunities to engage in special events and listen to guest speakers.
- Use students as ambassadors; for example, incorporate public outreach into classes so that students gain experience in speaking about their science to the community, and incorporate service learning into classes.
- Connect students to the major and profession; for example, use guest speakers or alumni to make students aware of opportunities in the profession, and set up a departmental advisory council of alumni to provide talks, outreach, and employment connections.
- Develop regional 2YC/4C connections; for example, connect students in 2YC programs with those who have successfully transferred to 4YC programs, and develop regional consortia of 2YCs, MSIs, 4YCs, research institutions, and state and federal agencies to share needs, desires, program offerings, research opportunities, events, field trips, etc.
- Make the department a welcoming place; for example, update displays, work with campus marketing to increase the department’s visibility, and create holistic departmental outreach, recruitment, and retention plans.

Finally, participants identified actions that would improve the image of the geosciences through marketing of geosciences to the community outside of the institution. The specific suggestions focused on community outreach activities and included:

- Actively recruit students from the surrounding (minority-majority) areas, for example, through departmental public speaking or community outreach events.
- Improve interactions with K–12 instructors and students; for example, organize outreach activities (summer camps, high school visits, mobile lab) both on campus and in K–12 schools, and provide workshops for local K–12 teachers to promote geosciences.

In summary, action is needed at the level of individuals, departments, institutions, and the professional community to address the continuing lack of broad participation in the geosciences. One solution is not sufficient; only a comprehensive approach that includes the broader educational system can effect the change that is needed.

Participants identified several lingering challenges that will need to be addressed to move action forward in this area. At the level of the individual, they identified personal challenges such as time management, a need for training in how to do effective outreach and mentoring, and support for grant writing to pursue funding opportunities. At the department level, they identified continued isolation (e.g., the “department of one”) as a significant challenge. A second departmental challenge is buy-in from colleagues skeptical (or outright hostile) to efforts to broaden participation. A final challenge identified is increasing the diversity of geoscience instructors so that role models are available for URM students.

At the institution level, participants identified the adjunct nature of many 2YCs (and 4YCs and MSIs) as preventing progress due to the lack of full engagement of adjuncts with the institution. They also identified increasing enrollment and increasing opportunities as a challenge; the geosciences has to compete effectively with other programs for students. Finally, some challenges require the community as a whole to solve; for example, many participants were concerned about the status of the geosciences in K–12 education and adequate preparation of K–12 Earth science teachers. It is important that students learn about geoscience and its professional opportunities from a young age. They were also concerned about the overwhelming diversity of instructional resources already available and the time needed to navigate these resources effectively. They saw a need to reach out to politicians to advocate for the geosciences, and to elevate the status of the geosciences as a viable STEM field and profession.

## 4.3 FINDINGS FROM RESOURCE PROVIDERS

### 4.3.1. Contexts and Current Efforts to Reach Minority Students

The first discussion among Resource Providers was aimed at highlighting the strengths and experiences of individuals attending the meeting. In a gallery walk format, participants addressed the following questions and recorded notes in the private Web space:

- *What are the primary goals or vision of your organization in this educational context?*
- *How do you identify what resources to create?*
- *What settings do you help facilitate (e.g., lab, field, classroom)?*

This activity led to a discussion on the collective skills and experience in the room as well as what was lacking. All of the organizations shared a mission of scientific education and outreach, though the targeted audience varied from K–12 teachers, to higher education faculty, to informal settings such as museums, to the general public (with some organizations targeting multiple audiences). Educational resource development is guided by the scientific mission of the provider, and in some of the organizations is facilitated by advisory boards and formal product evaluation activities. Resources include Web-based teaching and learning materials, face-to-face or virtual professional development, conferences, and student internships and other educational experiences. Specific challenges reported included prioritizing outreach efforts, growing the user base, maintaining virtual resources, and a lack of time and resources to conduct formal evaluation and reporting to the education literature.

To move the conversation more in line with the project goals, a second gallery walk activity focused specifically on resource providers' efforts to broaden participation in the geosciences. With a partner, participants wrote, discussed, and recorded in the online workspace responses to:

- *What has your organization done to improve diversity?*
- *What is on the horizon? What will your organization be doing or could be doing?*

In response to these prompts, a common theme was partnering with professional groups that already have diversity initiatives and programs in place. For example, working with GSA diversity initiatives, AMS, SACNAS, and NAGB (all of which offer opportunities for minority students such as conferences, student lunches, field trips, mentoring programs, and scholarships) were noted as organizations with significant diversity efforts. For organizations focused on K–12, aligning resources and professional development with the Next Generation Science Standards (http://www.nextgenscience.org) was a key priority. Finally, identifying ways to improve the public perception of geosciences as contributing to the community was a priority for some of the organizations.

The next group discussion focused on the use of place-based educational resources. Many researchers have shown the strength of place-based education in working with underrepresented groups (e.g., Semken, 2005; Riggs et al., 2007). However, most educational resource providers develop resources that are geared to the national, international, or sometimes regional and state scales. Therefore, we wanted to prompt resource providers to think about how their organization could help create or facilitate culturally relevant curricula. Using the guidelines laid out in Semken (2005), participants to work in pairs to discuss and list ways their organizations' resources can meet the following criteria:

- Its content focuses explicitly on the geological and other natural attributes of a place.
- It integrates, or at least acknowledges, the diverse meanings that place holds for the instructor, the students, and the community.
- It teaches by authentic experiences in that place, or in an environment that strongly evokes that place.
- It promotes and supports ecologically and culturally sustainable living in that place.
- It enriches the sense of place of students and instructor.

The discussion that followed turned to the appropriateness of these guidelines and how they may not be relevant in all contexts. Rather than address these questions directly, participants instead described guidelines and challenges for their organizations and tried to reframe place-based education to be more inclusive of many more educational settings. For example, they proposed that curricula could focus on the relevance of geoscience to societal issues, or could provide an overarching framework that could then be adapted to local contexts.

The final whole group discussion focused on assessment and evaluation of educational resources. One convener led the discussion, and the other recorded the conversation in the online workspace in response to the following prompts:

- *How is your organization currently evaluating materials?*
- *What assessment strategies will be most effective for determining what works best with URMs?*

Discussion varied greatly from easy to assess quantitative metrics such as graduation rates up to longitudinal and qualitative metrics. Several providers were concerned with questions about implementation fidelity—namely,

determining what metrics are valuable if instructors adapt rather than adopt curricula. This was one of the richest discussions of the meeting and is reported in full in a later section.

Throughout the meeting activities, a few key ideas continued to emerge across the Resource Provider discussions. In a broad sense, these conversations fell into three themes, addressed in the next report sections:

4.3.2 A change in marketing philosophy
4.3.3 Adaptability of educational resources
4.3.4 More longitudinal evaluation of products

### 4.3.2 A Change in Marketing Philosophy

The follow-up discussion with the guest speaker on how to increase the impact of educational programs initiated a dialogue on marketing of educational resources. The most important protocol that the Resource Providers thought they could adopt was to include their end users from the very first stage of resource development. Although this topic was brought up within the context of marketing, it was also identified as a solution to many of the challenges concerning educational resources. Including the end user in development is a shift in philosophy for many resource providers who normally see development and dissemination as two separate parts of what they do. In this new model, where users are involved in initial development, they will also be the most important advertisements for the final product. Even before the educational product is finalized, users will be able to test the product and share their experiences with the development team and also with their colleagues and other potential users.

> "The most important protocol that the Resource Providers thought they could adopt was to include their end users from the very first stage of resource development."

There are many benefits to involving the users early on that extend beyond increasing the implementation and use of an educational resource. Many participants shared stories of how after a product was released, the most used components were rarely the ones the developers had in mind. This disconnect leads to users asking for more information or support for features that were not originally meant to be sustained or supported. Having users involved at the start highlights the needs and wants of users so that time and funds can be more efficiently allocated. This method will also go a long way toward allowing the product to be adaptable to the goal of being locally relevant.

Participants discussed and described a series of steps they believed would crucial to making this new marketing strategy a reality in their organizations. The first and most important step is to create a development advisory committee made up of potential users. This will allow the resource developers to assess the needs of users before development begins. Many participants noted that products have been developed with users involved in the process, but usually at a later stage of development. However, they all noted that this method would be extremely beneficial if they could put together the right advisory board. This process could be aided by allowing chosen advisory board members to suggest other potential users who could advise development at the beginning or later stages. This could also include field testing of the material in different settings.

The next step would be to create modular resources that could be broken into parts, rearranged, or have parts removed or added without compromising the integrity of the product. For example, if a series of online activities using real-world data is created, students should be able to complete those activities in any order or skip some entirely with minimal burden. Not only will this make products more marketable to a wider audience, it could also leverage multiple products or even multiple resource providers and increase use across the board. For example, an instructor teaching about the natural hazards of California may want to use modules from educational resources on earthquakes and also modules on drought and fire risk. One resource provider may not have material on all the subjects, and the other resource provider may have more information and activities about earthquakes than the instructor has time to cover. By having stand-alone, scalable modular resources, both of these challenges could be addressed.

### 4.3.3 Adaptability of Educational Resources

This next topic stemmed from the input of the Instructor meeting where community college faculty demonstrated that they knew of many of the resources available to them, but were overwhelmed with the breadth of content and activities offered by so many different organizations. Along with this seemingly overabundance of resources, the issue is that the most sought out activities are place-based case studies. If the instructor is from a nearby location or similar environment to the creator of the resource, the activity might work well. However, if that it not the case, it would require significant time for the instructor to modify the activities to be relevant to their own students. As a result,

the instructor may decide to develop his or her own lessons rather than use existing resources.

The way resource providers sought to mitigate this issue, as well as increase the likeliness of adoption for their resources, was to intentionally make resources adaptable. These future lessons or activities could be thought of as Mad Libs, where resources are developed around a general topic with an overall structure, but they contain blank spaces where instructors can utilize their own resources and place-based knowledge to fill in the relevant materials for their students. Some topics that were identified that would be highly transferable to nearly all environments are streams, environmental justice, brown fields, and natural hazards and resources. It should be noted, however, that the topic-specific, large-scale resource providers identified the problem that not all topics they cover are always applicable. For example, earthquake data are going to be much more common and relevant based on geologic setting, and oceanography resources will be difficult to adapt to landlocked areas. However, state surveys and more local resource providers added that partnerships between regional and national providers could help smooth the adaptation when scaled to the local level.

In addition to designing modular, adaptable content, the Resource Providers focused on what instructors should be teaching. They distinguished activities that teach skills versus those that give knowledge, based on Instructor meeting input. All participants agreed that skill-based educational resources are more widely adaptable and are needed for helping diverse students along a pathway toward geoscience careers. Many of the skills discussed are sometimes known as "soft skills," such as analytical thinking, critical observation, and scientific argumentation. However, there is also room for teaching geoscience-specific skills that cut across the disciplines, such as interpretation of visualizations, three-dimensional reasoning, and modeling of systems that operate on geologic time scales.

Lastly, Resource Providers discussed a type of adaptable resource that can have a very relevant impact on not only students, but their communities. This type of resource was called event-based education, or rapid response curriculum. Especially in the categories of natural hazards or environmental disasters, resource providers could have pre-built curriculum and activities based on different hazards that could be quickly adapted and adopted by state surveys or local faculty immediately following a newsworthy event. This would efficiently and effectively utilize the instructor and resource providers resources and have a meaningful impact after sometimes difficult situations. This also allows local experts to directly communicate with affected communities instead of relying on outsiders.

> "These future lessons could be thought of as Mad Libs, where resources are developed around a general topic with an overall structure, but they contain blank spaces where instructors can utilize their own resources and place-based knowledge to fill in the relevant materials for their students."

### 4.3.4 Longitudinal Evaluation of Products

The third major theme arising from discussions by Resource Providers was how to measure the effectiveness of new resources, especially when looking at their impact on the diverse student populations served. This evaluation can be especially challenging for resource providers who have little direct contact with students and instead rely on the users (instructors) for feedback. All participants agreed that the most basic information is necessary, and some are already collecting it. These sorts of longitudinal data would include graduation and retention rates, and enrollment for programs, courses, and institutions that utilize their resources. Resource Providers also all agreed that these data would not be sufficient to adequately assess the state of the community and help them guide resource development.

Resource providers are most interested in collecting longitudinal data on instructors who have received professional development or other training in their resources. The participants are confident based on end-of-training feedback that they are successful in helping instructors initially adapt materials. In the long term, however, they rarely have ongoing communication with instructors to know how the content was adapted, how it was received, or even if instructors continue to use the educational resources year after year. This lack of follow-on information undermines resource providers' ability to measure the fidelity of their materials over time. If they are truly going to implement and create highly modular and adaptable content, they need to see how their resources evolve. This is not only an issue of quality control. These data are also used as a guidepost for future endeavors and to build a community of practice among their users.

Possibly the most challenging aspect to measure is whether or not the learned skills are being transferred to other settings. This would require not only continued communication with instructors, but also the students. Many of

> “One educational challenge repeatedly identified was the fact that many pathways into the geoscience pipeline exist in the form of research experiences and internships, but that most of these experiences are reserved only for the best and the brightest students, or only those students who can afford to take the time to travel or work in the field or lab.”

the soft skills should be usable by geoscience majors and nonmajors alike, but how could the resource providers measure this transference into other classes, programs, or even the workplace? Going forward, these questions are prime targets for future research on educational infrastructure.

### 4.3.5 Remaining Challenges Identified

One educational challenge repeatedly identified was the fact that many pathways into the geoscience pipeline exist in the form of research experiences and internships, but that most of these experiences are reserved for only the best and brightest students, or only those students who can afford to take the time to travel or work in the field or lab. Family and economic constraints make these opportunities very difficult to pursue, especially for underserved communities. A possible solution would be to develop short-duration research opportunities that would not put as much of a burden on students with family obligations or financial responsibilities. Not only should these experiences be available, but participants agreed that they need to be marketed and accessible, possibly through a searchable online clearinghouse for just these types of opportunities. For example, a student could choose a disciplinary focus, search by location, and filter by duration of the experience.

Another challenge identified by the Resource Providers, which mirrors discussions in other focus group meetings, is that the geosciences have an image issue, specifically, a lack of awareness issue, both in the larger society and even within scientific and diversity organizations. A solution could be for Resource Providers' organizations to sponsor student and researcher awards at diversity organizations where many other scientific fields are already represented. An example is the geoscience field trips at SACNAS.

### 4.3.6 Resource Provider Action Plans

At the conclusion of the meeting, each participant reflected on their experience and wrote an action plan that they believed their individual organization could develop and implement. The specific prompts were:

- *Based on this focus group, what ideas will you bring back to your organization in order to increase the effectiveness of your resources and support for underserved communities?*
- *Based on this focus group, what specific resources do you feel you and your organization can provide to help facilitate the needs identified by the instructors and administrators?*
- *Specifically, what support can your organization provide to faculty that wish to engage their local communities and community leaders?*
- *What sort of buy in and funding will you need from institutions and other organizations in order to provide the resources and support you described above?*
- *What specific collaborations will you need to develop and deliver those resources and support?*
- *What specific collaborations will you need to evaluate those resources and support?*

Unlike many of the other meeting participants, the represented resource provider organizations do compete for funding and stake in the geoscience community, so specific details from each organization have been left out of this report. The following action plans are those that were mentioned in some way by multiple participants or are new ideas not previously captured in the meeting discussion.

There was call to action for mentoring and training specifically for faculty who teach URMs. There is a need to mentor these faculty in the use of educational materials and also to partner with URM community educators and representatives to train faculty on how to best adapt and implement the resources in their specific community. The type of training discussed varied from participant to participant, but there was consensus that face-to-face training, where resource providers send a representative into local institutions for training, is valuable. Some training is best done in the field, and the Resource Providers discussed how to make these field experiences or laboratory visits more accessible for URM-serving faculty.

Along with more specific efforts to train faculty, participants commonly included the establishment of internships as part of their action plan. These paid internships would be directed exclusively toward URM students. Some mentioned that recruitment success and program completion require communication with the students' local faculty. This step is needed to make sure that students are prepared for the internships, and more importantly, are assisted in implementing the acquired skills and knowledge back in

their own classrooms and communities. Because they will greatly complement each other, faculty professional development and internship experiences for students should be part of the same initiatives.

The third most common action plan theme was the need to bring in external evaluators during educational resource development. Many of the organizations use internal evaluators to ensure content quality and functionality. External evaluators would be able to work with the internal experts to ensure that materials will be successfully implemented in a wide range of educational and demographic settings. This partnership will also permit resource providers to begin collecting and analyzing longitudinal data.

A question that appeared throughout the participants' reflections on the meeting was: what role can resource providers play in bridge programs between 2YCs and university research laboratories? This question was never fully answered at the meeting, and it remains important for future investigations and bridge programs to explore. Resource providers represent a wealth of knowledge, materials, and experiences, but may currently be underutilized by those working on increasing diversity in the geosciences. While this became somewhat apparent when instructors and administrators did not include resource providers as stakeholders for their ideal models, the Resource Providers took this as a sign that their role was to implement infrastructure and support mechanisms that would allow the other stakeholder connections to exist.

## 4.4 FINDINGS FROM EDUCATION RESEARCHERS

### 4.4.1 Locating the Researcher

The first discussion at the Education Researcher meeting, drawn from traditions of qualitative inquiry, was designed to convey the perspective the researcher brings to their work (e.g., Patton, 2002). Participants placed themselves on a continuum between "evaluation" and "research" to represent their work (Figure 7).

The purpose of this activity was to engage the group in developing shared definitions of evaluation and research, as well as to introduce participants to one another. Since the planned activities may call upon the strengths of some participants more than others, we wanted everyone to be cognizant of their fellow participants' perspectives and minimize their use of specialized jargon. The participants placed themselves on the line, demonstrating that the focus group included people with a range of experiences and perspectives.

### 4.4.2 Identifying the Knowledge Base

Six categories were chosen by the meeting leaders to be the main topics around which participants would catalog the existing literature through a series of gallery walk activities: (1) recruitment and retention programs, (2) student success in the classroom, (3) evaluation metrics, (4) theory and research, (5) departmental and institutional culture,

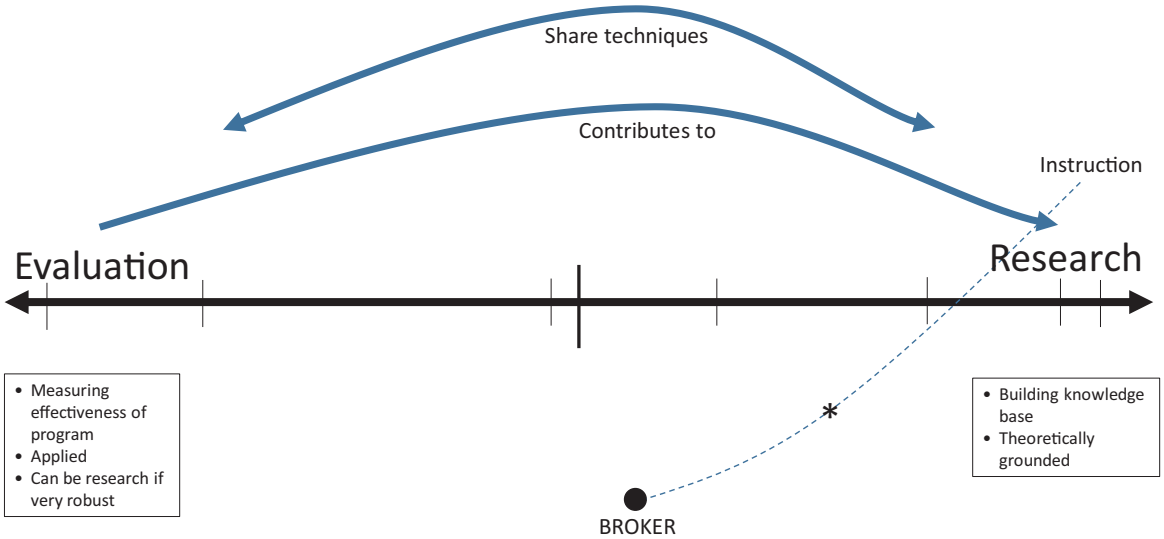



Figure 7. Participants self-identified their professional roles with respect to evaluation and research.

and (6) other. Following this activity, participants were asked to identify gaps in the literature, understudied topics, and new ideas to pursue. A brief summary of the major themes emerging from each gallery walk and subsequent discussion, along with suggestions for areas of further research, follows.

**[1]** The participants' ideas for what works in terms of recruitment and retention focused on support for the whole student. This theme included opportunities to: integrate social, academic, and professional activities; access quality mentoring and peer-assisted learning; validate academic achievements; and, generally, implement a holistic approach to building an environment that supports the whole student. A second theme was enhancing student-centered experiences or pedagogy, including developing strong ties between academic and workforce programs; ensuring clear articulation between 2YC, four-year college/university, and workforce needs; providing opportunities for students to engage in research during high school or at particular times of the year; and implementing student-centered teaching practices. The third theme focused on personal and responsive recruitment. It included building long-term relationships with communities that can feed into geoscience programs, building relationships with introductory students, recruiting students from diverse student organizations, and organizing social activities that expose students to the geosciences and geosciences research (e.g., GSA's On To the Future program).

The group identified several directions for future research on recruitment and retention. First, they identified a need for longitudinal studies that track students and study a range of issues from identity and social support, to academic and career aspirations. Participants were curious about the outcomes of programs that provide financial support for participation in STEM. Participants pointed out the need to approach diversity from an asset perspective rather than a deficit perspective. A significant concern was the need for more research on how to support students through traditional gatekeeper courses such as calculus, physics, and chemistry. Participants recognized the need for a meta-analysis of successful programs to help identify the common features of successful programs. The field would also benefit from understanding the intensity of treatment in a successful intervention program (i.e., how many hours of mentoring are necessary to produce an outcome?). Beyond this, one approach may be to test interventions that focus on the individual student versus departmental change mechanisms to evaluate which may be more effective.

**[2]** Participants identified several research-based, successful classroom strategies. From a curricular perspective, there is strong evidence that activities that are culturally, locally, or societally relevant are successful. Additionally, hands-on, active learning approaches and service learning within communities have been shown to promote student success. The classroom environment was also discussed as important for promoting student success. There has been research to support a focus on creating community within the classroom, discussing career opportunities, and using universal design to ensure the classroom is accessible to all. Participants acknowledged the great importance of institutional support systems that are external to the classroom to promote student success. For example, tutoring centers, cultural centers, and campus life activities are essential to facilitating student participation and success in STEM.

Several topics that were acknowledged in the discussion of the literature base also appeared in the discussion of where more research is needed. In some cases, this overlap was because the strategies that have been successful with STEM disciplines have not been rigorously tested in the geosciences. In particular, participants felt that more research is needed on the impact of early undergraduate research experiences and service learning experiences in the geosciences. A new topic that appeared in this discussion was the need to broaden awareness of successful strategies among geoscience faculty. In particular, how can the community elevate the prestige of research on learning and teaching so that heads and chairs of departments become engaged in the conversation? Likewise, there is a major need and opportunity to improve pedagogical training of graduate students and future faculty to implement the well-researched strategies for classroom success.

**[3]** Participants identified a variety of study designs, methods, and metrics that are appropriate for studying diversity in the geosciences. There is a need for literature reviews to understand what components of programs have been successful and to identify how best to scale up particular aspects of those programs. This would facilitate the community in determining what aspect and intensity of a program's treatment is critical for success. To make progress as a community, successful program attributes must be scaled up and implemented using randomized control trials, which are the gold standard in education research. There is also a need for a cost-benefit analysis of program interventions and their outcomes. Likewise, after funding for a program has ended, there needs to be a mechanism to collect ongoing data with former participants and to study those students who have left the geoscience pipeline as well as those who persist. To help the geoscience

education research community continue to grow, participants identified the need for standardized instruments and metrics that can be used across the community, and to publish in science education journals outside of the discipline to share our findings and learn what has been successful for other STEM fields with similar problems of underrepresentation.

**[4]** Participants gathered a list of theoretical frameworks that have been applied to research on underrepresentation in STEM, such as critical race theory, transfer shock, stereotype threat, and intersectionality (Appendix D). The most critical aspects of the group's conversation about theoretical frameworks focused on helping the community use frameworks effectively. Participants suggested that geoscientists need to build collaborations with those familiar with the frameworks to determine how to use the framework effectively to guide research, translate research into practice, and not get lost in theory. Identifying models of such partnerships and collaborations may help members of the community recognize the value of utilizing the frameworks. Within this discussion, participants identified a few specific topics that are understudied: mentorship, cohort and team relationships, and the value of field learning in the geosciences. These topics relate to existing frameworks, but the community would benefit from studying these topics using theoretical frameworks.

**[5]** A few topics emerged that focused on students and the influence of bridge programs, advising, flexible scheduling, a transfer-friendly environment, and other student-oriented features on their success in geology departments. However, most of this discussion centered around faculty awareness and reward structures. Participants discussed the need for faculty to educate themselves on implicit bias, stereotype threat, and cultural and religious practices of different groups to promote a positive environment for all students. An important concept that arose from this conversation is the need to challenge students without enacting a "sink-or-swim" mentality. Training should reflect the collaborative nature of science. Further, if faculty efforts in promoting community and diversity are not rewarded for tenure and promotion, then change will continue to happen slowly.

There are important questions that remain understudied with respect to departmental and institutional culture. Participants considered the need to better understand faculty mindset toward programs, such as mentoring undergraduate researchers from underrepresented backgrounds, to clearly identify the source of their beliefs. The participants would also like to see evaluation results of how programs, such as NSF's ADVANCE, remain influential after funding has ended and how its effects trickle down through institutions. The discussion again acknowledged the institutions' role in building in reward structures that support faculty who promote practices that increase diversity. A key aspect of this topic is how to ensure research on departmental and institutional culture is made relevant for faculty in such a way that they can use it to help their departments. The participants suggested colloquia speakers on these topics would increase awareness.

> "[I]f faculty efforts in promoting community and diversity are not rewarded for tenure and promotion, then change will continue to happen slowly."

**[6]** In case there were important topics that participants did not believe were appropriate for the existing four categories, we had a category for "other." The activity seemed to inspire so much conversation within the existing categories that there was little time for thinking beyond those topics. Nevertheless, participants identified transfer and articulation agreements, college readiness, and career pathways as important areas of study. They also discussed context, an aspect of working with underrepresented students in STEM related to collectivist cultural framing. Some cultures are high context, where personal interaction beyond academic topics is paramount. In other cultures, the persistence of people in STEM fields does not require such interactions. This discussion of context was related to another topic that was brought up at the meeting. Participants wondered whether comparative studies with countries such as Mexico, Caribbean countries, and African countries might provide some insight into U.S. issues.

### 4.4.3 Meeting the Needs of 2YCs and MSIs

Participants in the Education Researchers focus group only briefly discussed the topic of meeting the needs of 2YCs and MSIs. An hour-long conversation, with notes recorded in the private Web space, focused on the prompt:

- *What are the barriers to doing culturally appropriate researcher with 2YCs/MSIs and underrepresented minority students?*

> “Participants acknowledged that although faculty have done wonderful work in creating and running successful programs, partnerships with social scientists who study recruitment and retention in higher education would support quality scholarship.”

Participants discussed several questions about what is known in terms of participation of minorities in STEM. For example, have there been studies comparing successful programs at majority- and minority-serving institutions to understand what setting-specific strategies are beneficial? A critical concern about conducing research with 2YCs and MSIs to understand the system within which students are underrepresented is the way data are gathered. Some hurdles to doing large meta-analytic research include: data on completion rates are only available at four-year college/universities; many 2YCs do not have specific programs, so tracking students is problematic; data are not always publicly available; and data on students who leave the discipline are lacking. The participants acknowledged that MSIs have higher URM student recruitment, retention, and matriculation rates than majority institutions, and wonder what can be learned from this. Likewise, building trust and confidence between education researchers and the geoscientists who want to improve their programs is an important aspect to solving this problem. An important component of this discussion was acknowledging the need to build trust between majority, four-year college/universities, and 2YCs and MSIs. Collaborations should demonstrate respect for each other as equal partners in working toward solutions. Some successful programs have not yet been studied from a research perspective, and building trust between education researchers and geoscientists can be beneficial to both communities. Finally, the participants discussed that URM students are busy, over scheduled, and often selected to be representatives on committees due to their status. Research should be mindful of this burden and respectful of their time.

### 4.4.4 Researcher Action Plans

As with the other focus groups, participants in the Education Researchers focus group were charged with reflecting on the community needs and developing an action plan. The prompts given to the participants were:

- *Based on what emerged from the discussion on the gaps in the knowledge base, what does the geoscience community need to make progress on research about broadening participation?*
- *What types of collaborations do we need to effectively study issues associated broadening participation?*
- *What institutional structures are needed to support research on diversity in the geosciences?*
- *What types of novel funding opportunities could promote research on diversity in the geosciences?*
- *What resources do you, in particular, need to move forward with your work on diversity in the geosciences?*
- *How might you incorporate aspects of this workshop into your next steps?*

General themes arising from the action plans are described below.

The participants identified several strategies to help the geoscience community make progress on diversity. The community would benefit from review papers that identify what strategies generally are and are not successful, with a focus on the context (e.g., regional vs. national) of those strategies that are successful. To build the research capacity of the community, people engaged in diversity work should consider publishing beyond the geosciences to ensure communication with broader higher education research on diversity. To that end, the researchers would benefit from a data clearinghouse that captured information on students throughout their path from K–12, through community college, four-year college, graduate school, and careers.

In terms of strategies that work for improving diversity, participants identified efforts to support the whole student through additional student services, student-centered experiences and pedagogy, and personal and responsive recruitment as techniques that are ready to be employed today. The need to promote the geosciences to the public was a focus of discussion that overlapped with other focus groups.

Another dissemination idea that was common across the action plans was the need to promote successful strategies to geoscience departments. Participants proposed a few mechanisms to facilitate this effort, such as developing white papers focused on geoscience departments and inviting speakers to departmental seminars. Departments need to raise the profile of geoscience education as scholarly work worthy of merit for tenure and promotion. Additionally, participants emphasized the need for prestigious institutions to be leaders in recognizing the merit of this type of scholarship.

Participants acknowledged that although faculty have done wonderful work in creating and running successful

programs, partnerships with social scientists who study recruitment and retention in higher education would help support quality scholarship. One challenge is identifying researchers who are available for such collaborations and who are not overcommitted. A list of interested collaborators would help geoscience faculty connect with researchers outside of the community.

Other types of collaborations that the participants stressed are equal partnerships between two- and four-year colleges or major research universities. These relationships require both partners to recognize the opportunities and constraints of the institution structure and to build trust in the partnership. This is also true with respect to MSIs. An important collaboration for researchers who wish to study underrepresented students is with the organizations that track data. In some cases, features of students' demographics, course choices, or programs are not well captured in existing reporting metrics, limiting the ability for longitudinal tracking. Another important collaboration that could contribute new knowledge to this issue is between geoscience departments and organizational change researchers. Focusing on how to adjust departmental practices to improve recruitment and retention rather than focusing strictly on funding or programs that directly support URM students is an important next step for the community.

On the individual level, many participants reported that literature reviews and summaries of what works to diversify STEM fields would clarify what we have and have not tried in the geosciences. A recurrent theme was the need to understand why some students leave the geosciences and also the subtle differences between successful URM students and majority students. Since many successful diversity efforts in STEM are associated with MSIs, the participants were curious about the role culture and identity play in student retention. This question is particularly critical since most geoscience departments are majority white.

## 4.5 FINDINGS FROM THE IDEAL MODEL

### 4.5.1 Analysis of the Ideal Models

Participants in the Instructor and Administrator meetings came to consensus on eight key stakeholder groups: faculty, students, administrators/institutional commitment/staff, employers, community (interested public and taxpayer investment), geoscience community (professional societies), funding agencies/foundations, and geoscience research partners (e.g., USGS, national labs). Ideal models were then constructed by individual participants who connected these eight stakeholders with arrows and described these connections in an ideal state (Figures 5 and 6). Presentation and discussion of individual models across the four meetings yielded hundreds of existing or possible connections between these stakeholder groups. Overall, these connections can be broadly categorized into two themes: (1) funding and logistical support, and (2) training and information support. Across all four workshops, participants created and labeled or discussed potential connections in both directions between all stakeholders. Many of these connections, however, are existing connections (first third ideas) that are largely irrelevant to expanding the exposure of URM students at 2YCs and MSIs to the geosciences. Based on follow-up discussions with participants during the workshop, we narrowed down the most relevant connections and present them here in Figure 8.

### 4.5.2 Funding & Logistical Support

Figure 8A shows the most relevant funding and logistical support connections between stakeholders. The "existing" funding and logistical connections (labeled in orange) represent traditional roles that stakeholders already play; they should continue but otherwise are not seen as needing overhaul or expansion. These roles include support, such as incentives given to faculty by their institutions for excellent teaching or community outreach, foundations or grants from local community members to their local institutions, geoscience industry support of geoscience society programs, and the obvious grant money from funding agencies to geoscience researchers.

> "One common suggestion was that geoscience community organizations like AGU, GSA, and AAPG could do more to support faculty and students at MSIs and 2YCs."

The "expand" funding and logistical connections (green arrows in Figure 8A) are those that participants felt have existing infrastructure but could be fine-tuned, expanded, or overhauled in order to better meet the goal of promoting the geosciences among URMs at 2YCs and MSIs. For example, one common suggestion was that geoscience community organizations like AGU, GSA, and AAPG could do more to support faculty and students at MSIs and 2YCs. While some of these organizations already have scholarships

and grants for URM students and researchers, participants believed that more could be done to incentivize a broader range of participating students (not just the very highest achieving). They also suggested that additional support was needed for 2YC and MSI educators with outstanding records of bringing diverse students into the field.

Participants also called to expand connections between employers, institutions, funding agencies, and local communities (green arrows in Figure 8A). While many geoscience employers already have internships and scholarships available to students, participants believed that more could be done to specifically target URM students from the local communities in which those employers operate. A possible positive impact of such a program on the sponsoring company is that students would bring local knowledge to their work that the company might otherwise not have from employing people from other regions. Many colleges and universities already have financial aid available for students, but more could be done to specifically target students interested in studying geoscience in settings where geoscience is an important economic industry. This is also another avenue for employers to aid the institutions. Finally, although funding agencies support MSI faculty research, particularly at doctoral research institutions, many instructor participants from 2YCs discussed how their typical responsibilities, and sometimes lack of a grants office, make it difficult to apply for larger grants. If funding agencies could find other mechanisms to support research at 2YCs and undergraduate-focused MSIs, such as working with institutions to provide course release time, more faculty at these institutions could be enticed to pursue externally funded research.

The "build" funding and logistical connections (blue arrows in Figure 8A) are those that participants do not believe currently exist, or are not being utilized to achieve the goal of broadening participation in the geosciences. Many participants referred to these connections as the gaps in our current pipeline. These missing connections were mainly located between geoscience employers or local communities and the other stakeholders. For example, participants felt that more direct links between employers and the communities in which they operate were needed. Examples might include scholarships for local high school students, or hosting of geoscience activities and events that make the geosciences more transparent to the public. As previously discussed, most participants recognized that the general public is unaware of the geosciences. These sorts of connections attempt to address this lack of awareness. Some of our MSI and 2YC instructor participants described how they have had very positive, if rare, experiences working with local geoscience employers. If geoscience employers could incentivize a bridge between faculty and their company, the faculty could better prepare students to work in the industry, and students would see the more direct connection between geoscience and their career. Participants also felt the communities themselves had a role to play in promoting more student awareness of geoscience. Scholarships for local students pursuing geoscience degrees, or internships in local government that may work with urban planning, water, or energy, were suggested as initiatives. On the other side of the spectrum, participants described a need for geoscience researchers at four-year universities and labs to similarly reach out to MSI and 2YC faculty and incentivize partnerships. Many MSIs,

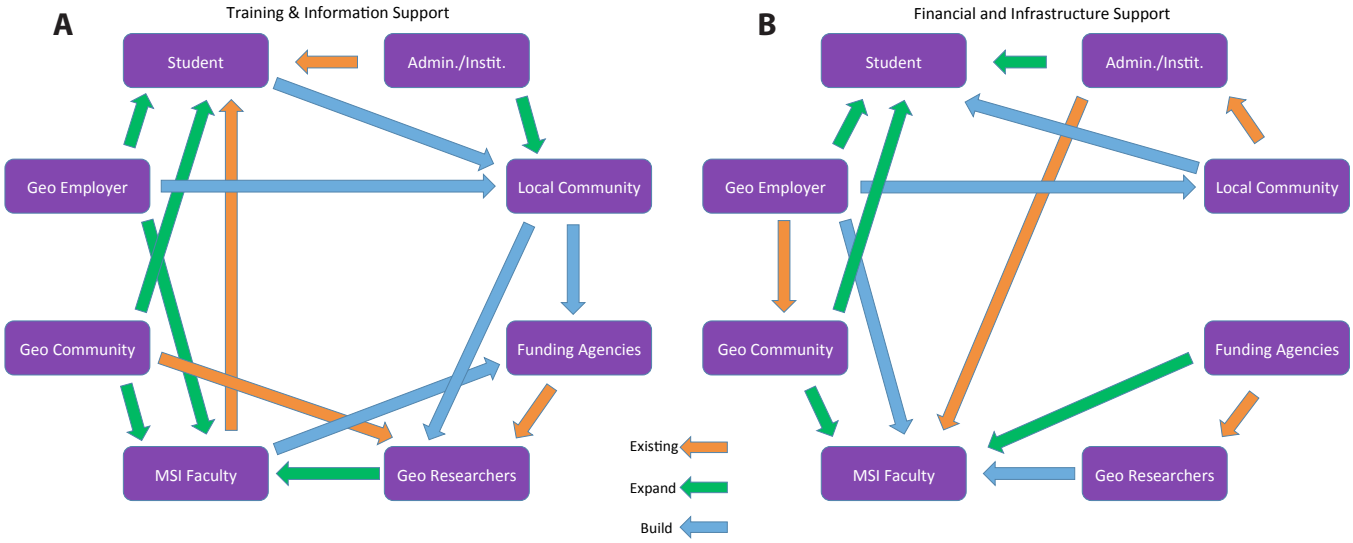



Figure 8. Synthesized ideal model of connections between stakeholder groups identified by participants across all four focus group meeting for (A) financial and infrastructure support, and (B) training and information support.

and particularly 2YCs, do not have the scientific resources available to conduct cutting-edge geoscience research. By partnering with four-year institutions, they could improve the geoscience experiences of 2YC/MSI faculty and students alike.

### 4.5.3 Training and Information Support

Training connections already "existing" (orange arrows in Figure 8B) include the regular work of instructors and institutions, such as mentoring and training students, or providing students with career training and internship placement. In addition, funding agencies and geoscience professional organizations already have a number of programs designed to increase success and diversify the community of geoscience researchers at universities and laboratories. Participants were very clear that the geosciences are already doing a good job in these areas, but more incentives would always strengthen these efforts.

Areas to "expand" (green arrows in Figure 8B) include connections from the geoscience employment industry as well as those from the geoscience community of professional societies and organizations. The training and professional development of students and faculty are just as important as, if not more important than, the financial support that employers provide to students. For students, this support may include internships, but employer support could also include working with MSI and 2YC instructors to develop site visits, providing students and instructors with real-world data for their classes, and having students present findings back to the community and employers. Many of these partnerships exist in small pockets around the country, but a more comprehensive and intentional effort on the part of employers could greatly expand the impact of geoscience in URM communities. In very similar scenarios, participants felt that the geoscience professional community could provide similar activities and training for URM students and 2YC/MSI faculty. The geoscience organizations and societies could build upon existing programs and field trips to specifically target MSI/2YC faculty and students.

The second major area to expand from geoscience researchers to 2YC/MSI faculty was similar to financial support, in that research-focused universities and labs could provide more research support for 2YC/MSI faculty (green arrows in Figure 8B). It is important to note that our 2YC/MSI instructor participants did not feel they needed additional scientific training from researchers, but instead wanted their students to have access to equipment and data they cannot provide at their institution alone. Lastly, many 2YCs and MSIs have strong connections with their local communities that could be used to promote geoscience in these local communities. Through events, speakers, and demonstrations, instructors, administrators, and their institutions could promote the importance of geoscience in a way that is locally relevant and ongoing.

The connections that participants identified as needing to be "built" (blue arrows in Figure 8B) nearly all relate to the local community. This mimics the discussion of financial and infrastructure support highlighting the importance of geoscience to the local community. Many participants felt that if geoscience employers reached out to their local communities, they would make a significant contribution to broadening participation in the geosciences. Participants admitted that this is probably already happening in some places, but none had personal experience with such an activity. Outreach from students back to their own communities could be an effective way for students to share their knowledge gained from research or internships and get others excited in possibly pursuing geoscience as a career. A second area of potential community involvement was through crafting connections between communities, funding agencies, and geoscience research labs. As an example, if local communities had a say in what research they thought was important to their community, and the funders and researchers were more transparent and accessible with their work at all stages, institutions (which are generally funded by tax dollars) would have more buy-in from the communities. As another example, tied to the place-based learning discussion earlier in this report, input from local communities could provide valuable local knowledge not otherwise attainable for geoscience researchers. Developing these connections may take time and would first require some basic connections to be expanded or built. These connections would be longer term and less direct than many others described by participants, but the geoscience community needs to actively build them.

> "If geoscience employers could incentivize a bridge between faculty and their company, the faculty could better prepare students to work in the industry, and students would see the more direct connection between geoscience and their career."

> “Our 2YC/MSI instructor participants did not feel they needed additional scientific training from researchers, but instead wanted their students to have access to equipment and data they cannot provide at their institutions alone.”

Overall, these two new connections would tackle the major repeated issue of the four workshops: the public does not know what geoscience is and why it is valuable to society.

The final new connection to be built is a flow of information from MSI and 2YC faculty to the funding agencies (blue arrows in Figure 8B). This connection would be necessary for successful implementation of the reverse arrow in Figure 8A from funding source to MSI/2YC faculty. Information that could flow in this direction could include geoscience topics that are most important to local communities, as these faculty may have a better sense than their research counterparts. More important, however, would be data, knowledge, and experience about working with URM students that could better guide future funding opportunities. In a way, this connection was the main goal of Geo-Needs as a whole: to learn from the stakeholders in the trenches about what is really needed and what types of programs funding agencies should be looking to support in the future in order to broaden participation in one of the least diverse STEM fields.

### 4.5.4 Limitations of the Ideal Model

Analysis of the 30+ individual ideal models created across the four workshops was an arduous task, and the full richness of ideas presented could not be contained in this single report. For this reason, we distilled the key themes that emerged and were most commonly discussed across the workshops. Future reports may be forthcoming that dig deeper into the over 600 connections described in individual models across the workshops.

Some key assumptions had a large impact on the development of these synthesized models (Figure 8). First, meeting participants decided that “faculty” was a critical stakeholder group (this group connects to nearly all others in the ideal model). However, the faculty stakeholder group was not further defined; this term was used by participants to variably mean teaching faculty/instructors at 2YCs and MSIs, geoscience researchers teaching diverse students at all types of institutions, and members of geoscience community organizations and professional societies. For this reason, we analyzed the ideal models assuming that “faculty” meant “2YC and MSI faculty” in the context of teaching these students. Connections that referred to research faculty or activities that would be done at the professional society level were analyzed with those respective stakeholder groups.

As noted in the ideal model methods section (3.3), educational resource providers and education researchers were not identified by participants in the Administrator – Instructor meeting as one of the eight key stakeholder groups. However, these were two key stakeholder groups identified by the project team and invited to focus group meetings. When we asked the Administrator – Instructor meeting participants if these two groups should be part of the list, there was unanimous response that they were not direct stakeholders, but instead could facilitate and evaluate aspects of the ideal model. We then told the Resource Provider – Education Researcher participants to construct and discuss their ideal models from this perspective.

# 5. Evaluation

## 5.1 GOALS OF THE EXTERNAL EVALUATION

The goals of the external evaluation were to (1) provide an independent, objective view as to how well the project management is functioning as a team, (2) evaluate the extent to which the needs assessment meetings are reaching the project goals, and (3) to review stakeholder reports and the project team's final report for accuracy and completeness. The focus of this section, written by the external evaluator Emily Ward, is on the outcomes of the needs assessment meetings.

## 5.2 EVALUATION PROCEDURES

Evaluation activities included focus group observation as well as daily road checks (formative assessment) and surveys (summative assessment) for participants related to the focus group goals (see Table 1). Thematic content analysis of the qualitative responses from participants highlighted common themes among the focus groups and are reported as paragraph summaries specific to the individual meetings.

## 5.3 KEY FINDINGS AND RECOMMENDATIONS

### Key Findings of the Overall Evaluation

- The majority of participants in the focus groups enjoyed the meeting activities and appreciated the small group discussions and networking opportunities.
- The Administrators and Instructors felt that the goals related to identifying instructional resources and understanding their importance were addressed in the focus group. The goals related to student preparation and instructional support for those teaching out of field still needs to be addressed.
- The Education Researchers and Resource Providers felt that the goals related to identifying areas for future research and methods for disseminating resources were met at the focus group sessions. The resource providers felt that the goal related to designing resources that incorporate knowledge and habits of mind important to employers still needs to be addressed.
- In the open-ended feedback, participants indicated that the focus group content sometimes lacked specificity in addressing the issue of minority participation and did not fully identify action items to tackle after the meeting.
- Recruitment was difficult in terms of getting minority participation and a diverse representation of MSIs.
- The ideal model activity encouraged participants to think about the issue of broadening participation from a systems perspective. The models are useful tools for the geoscience community to address issues related to increasing minority participation.
- The participants noted that the focus groups were well organized and facilitated and encouraged all voices to be heard.

### Key Recommendations

- The three-day Geo-Needs focus group meetings were ambitious, and there was not enough time to tackle all of the goals that they set out. The evaluation recommends that the project management team consider a follow-up meeting with participants. At the follow-up, the Geo-Needs project team can target the remaining goals using information gleaned from the ideal model and from participant reporting.
- All participants noted that having examples of what works and what does not would be useful for developing their own action plans that address the issue of underrepresented student participation. Consider reconnecting with meeting participants to generate lists of exemplary programs that can be shared among participants.
- Employ the brainstorming/superhero technique with participants in a follow-up meeting to generate a list of short-term and long-term goals to address the issue. This list could also be used to help identify subareas of the issues surrounding broadening participation.
- Participants indicated that the focus groups were great places for networking and starting new research collaborations. Consider formalizing working groups from the meetings so that collaborators could identify short-term and long-term goals to address issues related to broadening participation.
- Identify a few specific issues related to the larger issue of broadening participation for working groups to investigate. Develop goals and action items for these specific subareas.

## 5.4 FOCUS GROUP DATA AND OBSERVATIONS

Participants provided feedback to the evaluator with respect to their satisfaction with the interaction among focus group participants and their agreement on whether the goals of the focus groups (see Table 1) were met. They provided information on how the focus group influenced their thinking about diversity issues, and how they plan to apply what they learned to their own work at their institutions. The participants also provided feedback on logistics, facilitation, and individual focus group activities and content.

### 5.4.1 Participant Interaction

Focus group participants were asked to rank their level of satisfaction with their interactions with other meeting participants (Figure 9). Administrators (n=6) and Instructors (n=13) were to ranked their interactions with other participants in the same focus group and in the concurrent focus group. Administrators were more satisfied with their interactions with Instructors than Administrators from their own focus group. Instructors were more satisfied with their interactions with other Instructors than their interactions with Administrators. Education Researchers (n=10) and Resource Providers (n=8) were to rank their interactions with other participants in the same focus group and in the concurrent focus group. Education Researchers were more satisfied with their interactions with other Education Researchers than with Resource Providers. Resource Providers only ranked their interactions with other Resource Providers, and found them satisfactory.

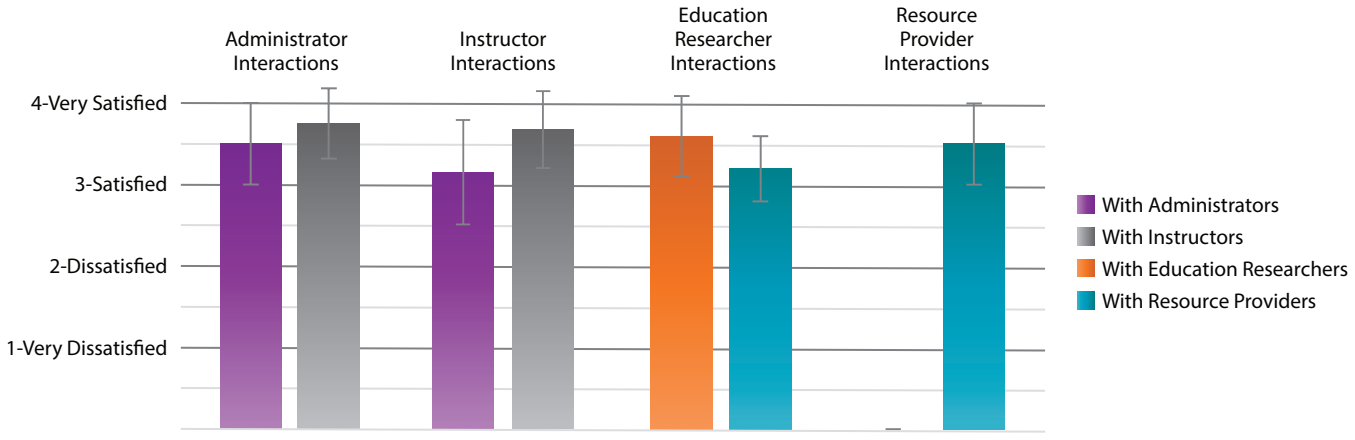
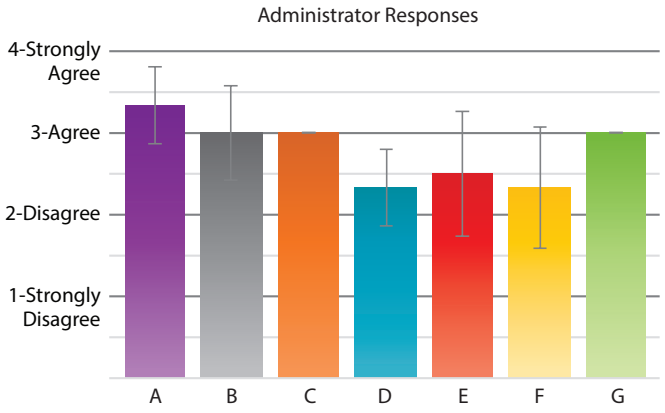



Figure 9. Participant satisfaction with their interactions with other meeting participants. (1-Very dissatisfied, 2-Dissatisfied, 3-Satisfied, 4-Very satisfied; standard deviation represented by error bars).

### 5.4.2 Meeting Goals

Participants were asked to rank the extent to which they believed specific goals were met at each meeting. Administrators (n=6; Figure 10) agreed that the focus group met the goals related to determining instructional opportunities, discussing how geoscience offerings enhance the institutional mission, determining how to best inform students about workforce possibilities, and identifying resources needed by institutions to establish/sustain geoscience programs. Administrators felt that the focus group did not meet the goals related to determining how to prepare students for careers, how to serve the communities in which 2YCs/MSIs are situated, and what programs would enhance career opportunities.

Instructor (n=13; Figure 11) responses varied more than Administrator responses. Overall, the Instructors agreed that the focus group met the goals related to identifying instructional resources, barriers to use of innovative resources, and support mechanisms that help instructors introduce students to career opportunities, and determining administrative supports for instructors. Instructors felt that the focus group did not meet the goals related to identifying professional development programs, classroom resources for startup programs, delivery and support mechanisms for innovative curriculum, and sustainability needs.




A. Determine why opportunities for instruction are important in the geosciences at 2YCs and MSIs.

B. Determine what the geosciences can offer to enhance the institutional mission.

C. Identify successful ways to inform students from underrepresented groups about geoscience workforce possibilities.

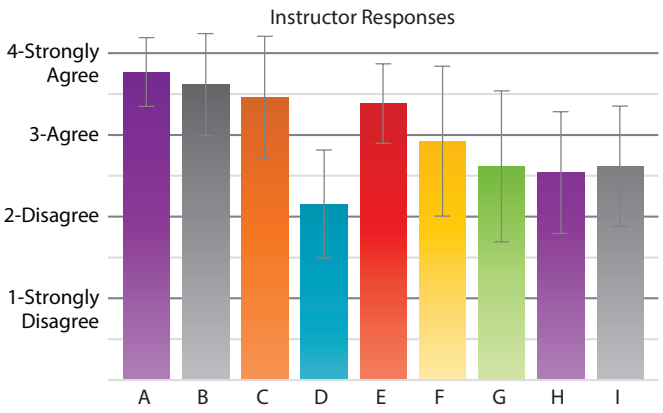
D. Determine how to prepare students from underrepresented groups for career opportunities in the geosciences.

E. Determine how the geosciences can serve the communities in which they are situated.

F. Identify desirable certification/accreditation programs to enhance career opportunities in the geosciences.

G. Identify resources that institutions need to establish and sustain a program of study in the geosciences.

Figure 10. Administrators' (n=6) agreement with how well specific meeting goals were met during the focus group meeting (1-Strongly disagree, 2-Disagree, 3-Agree, 4-Strongly agree; standard deviation represented by error bars).




A. Identify instructional resources that are currently used by 2YC and MSI instructors in geoscience courses and programs.

B. Identify barriers to utilizing innovative resources for instructors at 2YCs/MSIs.

C. Identify support mechanisms that are needed to help instructors develop courses and curricula designed to introduce and recruit students to career possibilities in the geosciences.

D. Identify what can be done to support instructors who may not have specific training in the geosciences, and thus, have to teach "out of field".

E. Determine what supports are needed from administrators at 2YCs and MSIs to help utilize innovative resources.

F. Identify professional development programs will help support these instructors.

G. Identify classroom resources that are needed to initiate and deliver new courses of study in the geosciences.

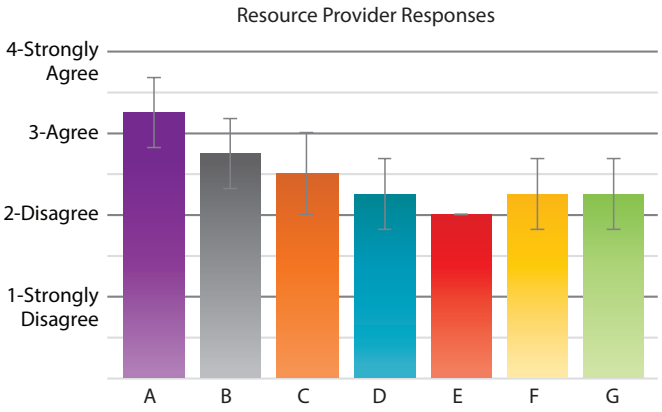
H. Determine possible delivery and support mechanisms for these innovative classroom resources.

I. Identify what is needed to sustain new programs, curricula and resources after development.

Figure 11. Instructors' (n=13) agreement with how well specific meeting goals were met during the focus group meeting (1-Strongly disagree, 2-Disagree, 3-Agree, 4-Strongly agree, standard deviation represented by error bars).

Resource Providers (n=9; Figure 12) agreed that the focus group met the goals related to determining how providers can disseminate materials and communicate to potential users. Resource Providers were less in agreement about whether the focus group met the goals related to how to identify what is needed by the community, the roles of 2YC/MSIs in resource development, strategies for developing dynamic materials to meet a changing workforce and society, and how to develop resources for knowledge gains, skills, and habits of mind.

Education Researchers (n=10; Figure 13) agreed that the focus group met the goals related to determining the future work needed to better understand the pathways and preparation for the workforce. Education Researchers were less in agreement about whether the focus group met the goals related to determining mechanisms for research, uncovering barriers to research, identifying mechanisms to promote research, and exploring how research and evaluation can inform geoscience education.




A. Determine how resource providers disseminate their products and communicate to potential users.

B. Determine how resource providers identify what curricula or materials are needed by the geoscience community.

C. Identify the roles of 2YCs and MSIs in the development of culturally responsive curricula.

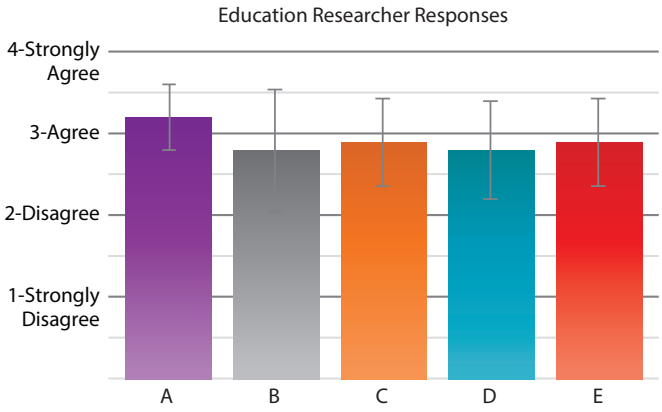
D. Identify ways in which curricula and materials can be designed to support not only knowledge gains but also the development of skills desired by employers.

E. Identify ways in which curricula and materials can be designed to support not only knowledge gains but also habits of mind desired by employers.

F. Identify strategies for continual creation of new education materials to meet the changing needs of the workforce and society.

G. Identify strategies for longterm maintenance of educational resources.

Figure 12. Resource Providers' (n=9) agreement with how well specific meeting goals were met during the focus group meeting (1-Strongly disagree, 2-Disagree, 3-Agree, 4-Strongly agree, standard deviation represented by error bars).




A. Determine the future work needed to be8er understand the pathways and preparation of these students for the workforce.

B. Determine mechanisms for how research on workforce preparation of underrepresented students can inform teaching practices at 2YCs and MSIs.

C. Uncover potential barriers to conducting research at 2YCs and MSIs, and determined how might these barriers be overcome.

D. Identify mechanisms to promote greater quantity and quality of research on the issues presented in the workshop.

E. Explore how research and evaluation activities in the context of geoscience programs that broaden participation can inform one another.

Figure 13. Education Researchers' (n=10) agreement with how well specific meeting goals were met during the focus group meeting (1-Strongly disagree, 2-Disagree, 3-Agree, 4-Strongly agree, standard deviation represented by error bars).

### 5.4.3 Evaluation Findings

*How has this meeting influenced your thinking about the issues surrounding diversity in the geosciences?*

Administrators came away from the focus group with a feeling that there is still a lot of work to be done regarding diversity in the geosciences, and that the issues surrounding diversity are complex. They recognized that while minority students have an interest in the geosciences, some students require supplemental coursework in reading and math in order to meet the requirements of some of the geoscience classes. The Administrator group felt that there needs to be more research into the factors that affect diversity in the geosciences, and that these findings need to be used to increase academic institutions' awareness of the barriers that keep minority groups from the geosciences. The Administrators identified the importance of cultural literacy and sensitivity in recruitment and retention of minority students, and that public opinion may help/hinder participation from these student groups.

Instructors felt that the focus group brought an awareness of the concerns related to diversity in the geosciences, and that the group identified some realistic solutions to some of the problems posed (though the solutions were not one size fits all). The Instructors liked that the focus group made the participants think about the big picture surrounding diversity issues. They appreciated learning new things, finding new resources to use, and networking with other instructors and administrators, and they plan to share what they learned with their colleagues. This group stressed the importance of the public in recruitment and retention of diverse students.

Resource Providers thought that the focus groups did not add new insights but did reaffirm/reinforce the importance of the diversity issue. The meeting raised awareness and helped these participants to see new possibilities and make new contacts. The ideal model helped the Resource Providers understand where they fit in to the connections among Administrators, Instructors, and Education Researchers and helped to identify the priorities for minority-serving institutions.

Education Researchers found that the focus groups provided insight to the issue of diversity, introduced the participants to the published research on the topic, and highlighted the need to think outside the box to come up with solutions. The Education Researchers found that the ideal model helped pull together many aspects of broadening participation and helped them visualize the connections and relationships on the topic among stakeholders. They noted that the geoscience community is invested in broadening participation, but little progress has been made on the issue to date. Some felt that the focus group did not necessarily influence their thinking on broadening participation, but reinforced what they already knew and broadened the scope of the issue.

*How will you use and/or apply what you learned at the meeting in your own work with underrepresented minority students?*

Administrators identified useful resources in the focus group and plan to share the information with faculty at their home institutions. Some administrators left the focus group wanting to expand the geoscience programs on their campus and planned to use the website Building Stronger Geology Departments (http://serc.carleton.edu/departments) to help them to that. They planned to develop procedures to address diversity and inform recruitment strategies at their institution.

Instructors identified items that faculty members could act on at their home institutions to address recruitment and retention. They planned to use the resources from SERC and also share them with their colleagues. The Instructors noted the importance of community outreach, making relationships with other institutions and collaborating on grants as potential next steps. They enjoyed the focus group activities and planned on using them in their classes.

Resource Providers came away with a greater awareness of the issue and the resources that are available to assist in addressing the issue of broadening participation. One participant indicated that they would look into "market segmentation" to help disseminate their resources. Some mentioned that they would involve minority-serving institutions/diverse communities and the Geo-Needs website in the resource development process. The Resource Providers plan to look into the research for ideas on reaching diverse audiences, and came away with new ideas for collaborations and projects.

Education Researchers planned to get faculty at their home institution to discuss diversity issues, apply what they learned from the meeting to programs that they run, and research what resources are available at their home institutions. They wanted to become informed about the best practices for mentoring and came away with the understanding that trust between faculty and students takes time to develop. They found utility in the ideal model and would keep it in mind when thinking about these issues. The Education Researchers felt that the meeting helped establish (and re-establish) connections with issues surrounding broadening participation and research. Many found the presentation about validation theory particularly useful and hope to see how they can apply it to their own research. They hope to move the research

agenda forward by following up with the contacts they made at the meeting and would like to partner with other researchers who attended.

*What challenges (if any) do you foresee having to overcome in your efforts to use or apply what you have learned at the meeting?*

Administrators indicated that lack of time and resources are always a challenge for implementation. They also noted the need for qualified faculty and the need to address structural problems with the alignment of campus programs to help with implementation. They mentioned that faculty resistance/lack of buy in might also hinder the use of resources to help with recruitment and retention of minority students.

Instructors noted lack of time, resources, administrative support, and buy in from colleagues as obstacles to applying the knowledge gained at the meeting. Instructors have difficulty navigating the structure of their home institutions in order to implement changes to help address diversity issues.

Resource Providers were hoping to have more case studies highlighted in the meeting to know what works and why. They also listed lack of time, money, and other resources as an obstacle to change. Developing partnerships with new stakeholders was also listed as an obstacle to implementation.

Education Researchers identified lack of departmental support, time, energy, and maintaining focus as obstacles to implementing change at their institutions. They also suggested that change would require altering the traditional perspective on what geoscience education looks like. Another noted that having a limited network of collaborators on the topic of broadening participation and difficulty making new research relationships as an obstacle to moving forward.

*Please comment on the facilitators' sensitivity to the diversity (e.g., political viewpoint, race, ethnicity, national origin, gender, sexual identity, and disability) of the participants attending the meeting.*

Participants from all of the focus groups meetings noted the professionalism and sensitivity of the meeting facilitators. They found the facilitation respectful of the diversity of meeting participants' viewpoints. Many noted that deciding on a common set of group norms set the tone for the interactions among faculty, and that the mix of small group activities and large group discussion allowed for greater participation.

### 5.4.4 Participant Satisfaction

All participants were satisfied with the format of the meeting activities, the facilitators, the accommodations, and the meeting venue (Figure 14).

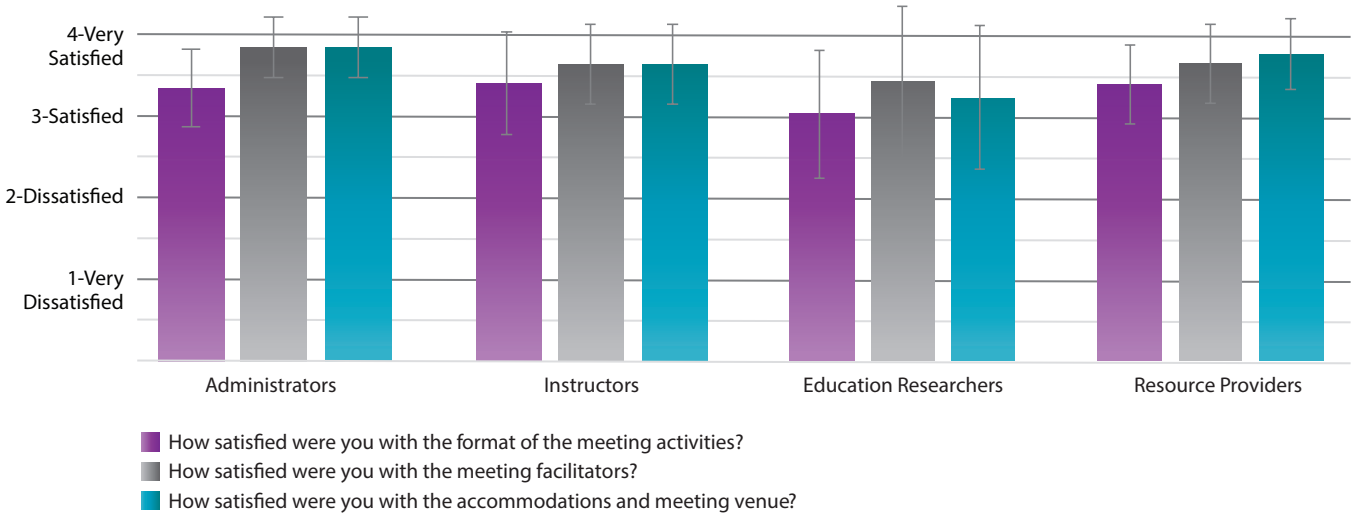



Figure 14. Participant satisfaction (4-Very satisfied, 3-Satisfied, 2-Dissatisfied, 1-Very dissatisfied; standard deviation represented by error bars).

### 5.4.5 Logistics and Facilitation

*What kinds of activities and/or topics would you liked to have seen included that were not addressed?*

Administrators would have liked to have identified solutions and developed specific plans for recruitment and retention. They would have appreciated a summary of the education research findings that inform the recruitment and retention strategies and to have looked at successful programs to help guide them in their future efforts.

Instructors indicated that instructor training in new technologies and information to help broaden participation would have been useful. They, too, would have liked more information on successful programs and concrete examples of what works. Some noted that the ultimate goal of the Geo-Needs project was unclear and should have been clarified. Others suggested building more time into the meeting agenda for networking among the participants. Lastly, Instructors wanted more discussion about cultural sensitivity, ideas for grant collaborations, and next steps.

The Resource Providers would have liked more discussion about what works and identified short-term and long-term goals to successfully broaden participation. They wished for more interaction among Education Researchers and Resource Providers. They felt confined by the ideal model that was created by the Instructors and Administrators and would have liked to have the opportunity to come up with their own. They indicated that the place-based theoretical framework may not be applicable to Resource Providers because very little of what they do is curriculum development. Another participant wished to have had more of a discussion of the K–12 community.

Education Researchers wanted to identify what works and what does not with regard to recruitment and retention. They wanted more time to focus on tangible products from the meeting or perhaps an activity or specific problem for the group to work on. They wished that the discussion was more on 2YC/MSI institutions rather than four-year institutions. Education Researchers felt that the participants were eager to collaborate but did not come away with a prioritized list of action items after the meeting. At times, the participants felt that the group did not have a shared concept of the [diversity] problem, and that too much of the focus was at the large scale and not at breaking the problem into smaller pieces. They suggested that the brainstorming activity (superhero) could have been used to come up with short- and long-term goals related to diversity in the geosciences.

All participants were satisfied with the logistics and execution of the focus group (Figure 15). All participants consistently highly ranked the opportunity to actively participate in meeting activities and the execution of meeting logistics. Participants ranked the discussion slightly lower than other statements regarding execution and logistics. Most

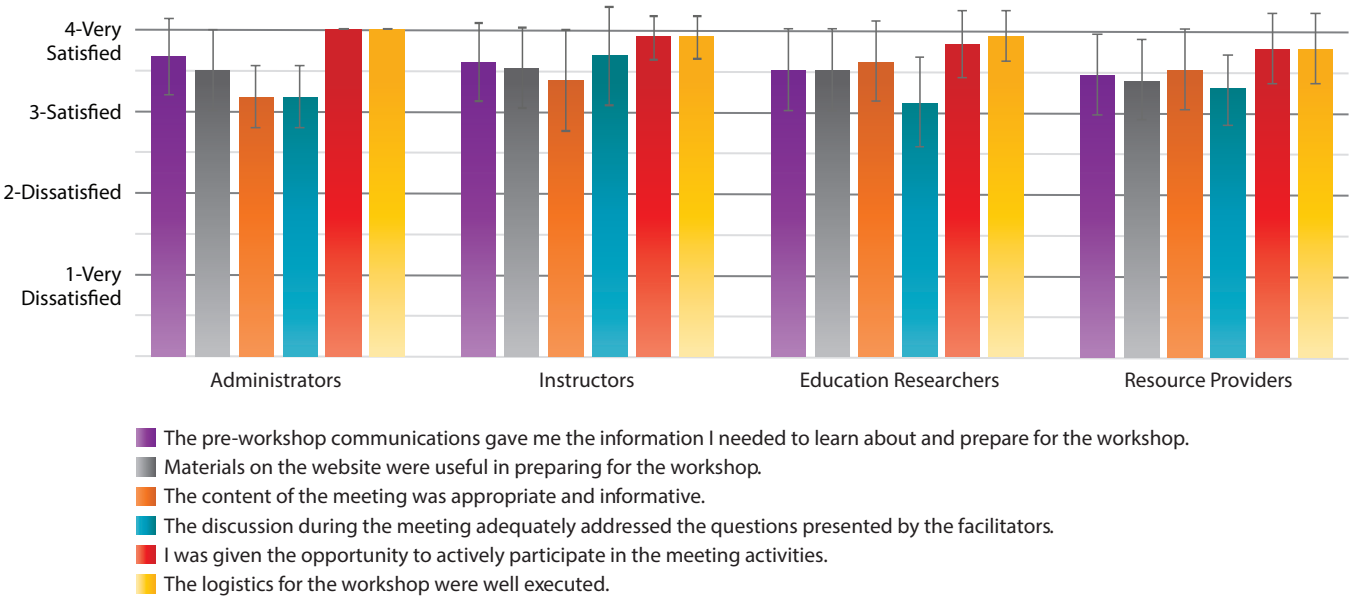



Figure 15. Participant satisfaction with the logistics and execution of the focus group (4-Very satisfied, 3-Satisfied, 2-Dissatisfied, 1-Very dissatisfied; standard deviation represented by error bars).

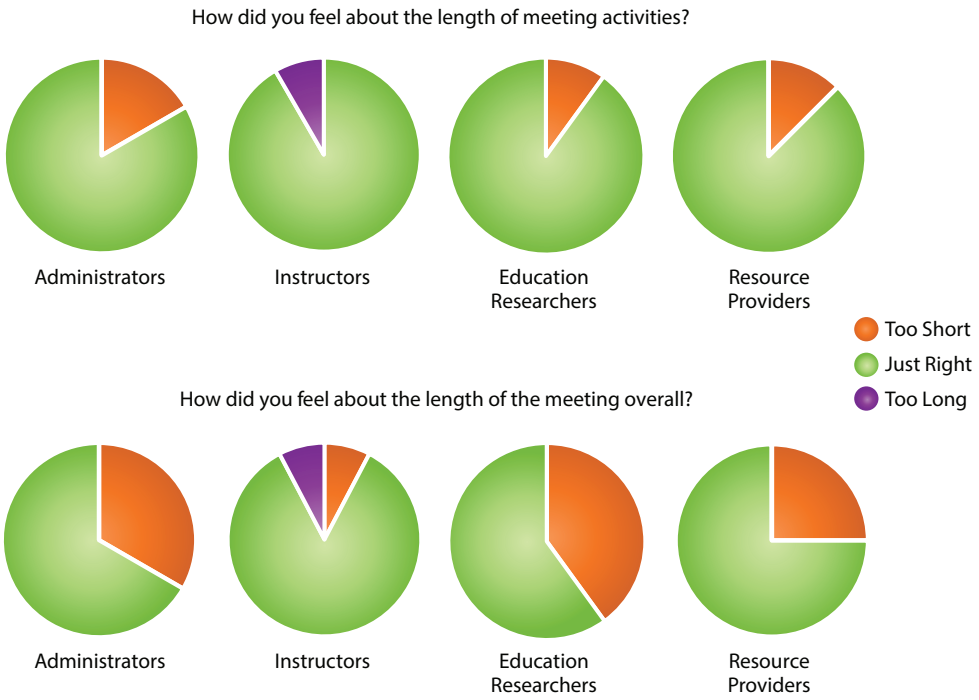



Figure 16. The upper set of pie charts represent how participants felt about the length of the meeting activities. The lower set of pie charts represent how participants felt about the length of the meeting overall.

participants felt that the length of the meeting activities, as well as the meeting overall, were "just right." (Figure 16). Only a small percentage felt that the activities and meeting overall were "too long." (Figure 16).

*What did you like most about the meeting content and activities? Why?*

Administrators enjoyed collaborating and networking with people who had a range of perspectives on the issue of broadening participation. They also enjoyed the free association (superhero) and synthesis exercises and the relational diagramming exercise (ideal model). Instructors appreciated the focus on recruitment and retention, public relations, and the increased awareness of the issues affecting minority students. They also enjoyed the opportunity to network and the organization of the focus group. They highlighted the concept mapping (ideal model) exercise as useful and liked getting out of their comfort zone.

Resource Providers enjoyed the interactions with new people and the wide range of organizations represented at the meeting. They found the meeting informative and inclusive as well as well organized and facilitated. They found the smaller group format was best for rich discussion. Educational Researchers enjoyed the mix of activity types (small group work and thinking outside the box activity). They appreciated meeting new, potential collaborators with a range of expertise. They found the debriefing sessions after activities especially useful.

*What did you like least about the meeting content and activities? Why?*

Administrators felt that, at times, there were too many participants to have all voices heard. While some liked the ideal model activity, others did not. They felt that previous research on the topic of broadening participation had not informed the meetings. They felt that the talk from the program officer at NSF was unnecessary as they can get the information online. Some indicated that they felt like they were reinventing the wheel when they needed to be building on successes. They wanted the focus to be on the recruitment and retention of minority groups.

Instructors had difficulty with the unstructured nature of some of the activities and thought that there might have been too much brainstorming on the big picture rather than on the nitty gritty. They wished they had more time to focus on specific (data-driven) strategies for improvement. Some felt that the group work was unproductive and wanted more time to discuss points with the Administrators. Some indicated that the activities and strategies presented were not specific to URMs. They, too, noted that the NSF

information is easy to find online.

Resource Providers thought that the ideal model activity was unclear. They came away with a feeling that not much was accomplished. They wished that there were more geoscience subdisciplines represented in the room. They thought that the meeting felt disjointed at times and was nonspecific on the topics.

Education Researchers felt rushed through some of the activities. They suggested that the meeting focus on fewer topics but discuss them more deeply. Some felt like there was an overwhelming amount of information presented and felt a little out of their depth. At times, the focus of the discussion moved away from 2YC/MSIs and was dominated by a few voices (particularly on Day 3). The smaller group discussion and report out structure was more participatory. They wished that the facilitators would have set up groups to continue working outside of the meeting and hope for a follow-up. They thought that the ideal model activity could have used more context (e.g., What was the model scale? Why were those stakeholders selected? What is the intended goal/utility of the model?). Because there was a range of expertise in the room related to the topic of broadening participation, the discussion about what is known/not known with regard to research on the topic was ineffective. Some participants felt that the discussion should have focused on what was actionable.

*In what ways could this meeting be improved?*

Administrators felt that having fewer people (or more small group discussion) and providing more time for brainstorming and networking would be preferable. They wanted the meeting to focus on detailed plans and clearly tie these plans to URMs. They wanted to involve other stakeholders in the discussion but did not specify who these stakeholders would be.

Instructors wanted the meeting to focus more specifically on the topic of URMs, with examples of successful programs and issues related to cultural sensitivity. They suggested more time for action plans than on the ideal model. They also wished they had more time for networking with their peers on the first night of the meeting.

Resource providers wanted the meeting to present findings from research to show what works and what does not. They wished that there was more interaction between the Education Researchers and the Resource Providers groups. They wanted a more diverse group represented. They suggest that the facilitators identify next steps and action items so that the work can continue outside of the meeting.

Education Researchers indicated that they would have liked to have heard about success stories from each participant. They wished they could have had more interaction with the Resource Providers. They suggest that the group have a follow-up meeting so that these new collaborations can become more concrete. At times, the participants felt that the meeting lacked focus and suggest that the facilitators identify specific questions to address rather than focus on the broad topic. They also would have liked more expert researchers in this field to help mentor the more novice researchers in the room.

*Please provide any additional suggestions or comments.*

*I had a positive experience and enjoyed interacting with everybody. I would have loved to spend more time interacting with everybody learning more about their interesting work! I commend the facilitators for a well-organized and well-facilitated meeting. It took a tremendous amount of work to develop and facilitate this meeting and to navigate the challenges of doing that organization/facilitation as a team. Also, it is challenging to have thoughtful discussions about diversity with a large group of people. The facilitators did an excellent job of navigating the challenges in a respectful and professional manner. I hope that the facilitators found the meeting helpful!* — Education Researcher

## 5.5 EVALUATION PARTICIPANT DEMOGRAPHICS

Out of the 41 individuals who participated in the focus group meetings, 37 participated in the evaluation. While participants were well represented by gender, the racial diversity of participants was limited (Figure 17). The majority of participants were white, with two participants self-identifying as Hispanic or Latino.

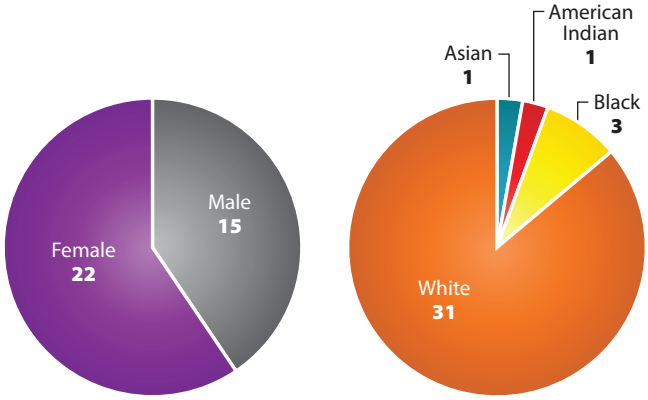



Figure 17. Gender and racial/ethnic diversity of meeting participants who completed the evaluation.

## 5.6 EVALUATION CONCLUSIONS

Overall, the Geo-Needs project was guided by the goals of using of existing instructional resources to engage URMs in the geosciences and developing an ideal model to help stakeholders address this issue. Feedback collected from participants via open-ended and Likert-scale surveys indicate that the focus group goals were important but were perhaps too ambitious for the three-day focus group sessions. Because of the nature of the focus groups, the facilitators wanted the participants to contribute their knowledge and expertise to address the issues at hand, while the participants had hoped for more concrete action plans as a product of the focus groups. The facilitators did a tremendous job navigating the complexity of the issues and allowing voices to be heard. Because of this, the discussion often brought about important topics related to the goals of the overarching project, but perhaps not the individual focus group. This likely contributed to the participants' comments of a "lack of focus" to some of the focus group content. The larger-scale discussion of broadening participation brought up important topics related to recruitment and retention at MSIs. The Geo-Needs project can use the information gleaned from the ideal models and from participant discussions to shape the focus of future work. The project is, after all, a needs assessment. With the products from the focus groups this summer, the project management team has a framework for future work. Those goals that were not fully met in the focus group sessions can be addressed in a follow-up meeting where participants can work within the ideal model framework to identify specific goals related to the issue and develop action plans to address those goals. The ideal model alone is an important product of the focus groups and can be disseminated to programs throughout the geosciences to help utilize existing resources for increasing minority participation.

# 6. Concluding Thoughts and Recommendations

## 6.1 SYNTHESIS OF THEMES RELATED TO PROJECT GOALS

The structure of the four focus group meetings allowed participant voices to be collected in response to specific activities and prompting questions. The facilitators aligned these activities to the overall meeting goals. Here, we discuss findings that cut across the four meetings and address our two overarching goals:

- Identify and clarify barriers and opportunities for better use of existing instructional resources that engage underrepresented students in the geosciences at 2YCs/MSIs.
- Explore with stakeholders what an ideal model of resources, partnerships, professional development, and ongoing support for faculty and institutions might look like.

### 6.1.1 Using Existing Resources to Engage Students at 2YCs and MSIs

Barriers and opportunities to instructing minority students in the geosciences at 2YCs and MSIs fell into five major themes across the four meetings: (1) a misalignment between minority student needs and institutional cultures and structures, (2) use of place-based instructional resources, (3) uneven dissemination of what works for minority recruitment and retention in the geosciences, (4) the importance of trust and personal relationships, and (5) improved marketing of the geosciences.

All meeting participants were concerned that students, especially those from underrepresented groups, are increasingly underprepared for college, let alone for the rigor of a geoscience program. Math and cognate science courses (e.g., physics and chemistry) as well as upper-level coursework can deter students from a geoscience study program. Furthermore, degrees needed to enter the workforce (typically a BS or MS) may seem out of reach for minority students, many of whom are the first in their families to attend college. These barriers speak to an opportunity to redefine how we see students and how we prepare them for a broad and interdisciplinary geoscience workforce. Across all of the meetings, participants recognized the need to move from a "deficit" model of students (i.e., a focus on what they lack) to an "asset" model that recognizes the skills and strengths that they bring to the educational setting. Traditional metrics of program success, such as time to degree, need rethinking to accommodate the diverse pathways these students take to the geoscience workforce. And rather than focus on a singular pathway from a geoscience degree to employment in the traditional geoscience sectors such as oil and gas, mining, environmental consulting, and academia, we can emphasize the utility of a geoscience course of study in related fields such as planning, education, and business.

Instructors and resource providers, in particular, focused some of their discussion on challenges and opportunities in using place-based instructional resources. Instructors were largely concerned about the time and expertise needed to adapt resources to their local contexts. Resource providers traditionally focus on materials that serve a national market. Both groups recognized a persistent need for a significant investment in professional development and support for instructors to prepare materials relevant to the lives and local situations of their students.

"Across all of the meetings, participants recognized the need to move from a "deficit" model of students (i.e., a focus on what they lack) to an "asset" model that recognizes the skills and strengths that they bring to the educational setting."

A strong theme from the Education Researcher meetings echoed in other focus groups is the uneven dissemination of "what works" in recruiting and retaining minority students in the geosciences. The Education Researchers recognized that snapshots of successful interventions, as well as theoretical frameworks that support and explain success, are available in the literature. However, systemic review and broader communication of this literature is needed. Our project evaluation revealed that the other

stakeholder groups (Administrators, Instructors, and Resource Providers) had little knowledge of specific strategies or programs supported by empirical research. This finding suggests there is a need to engage researchers directly with the creators and users of instructional material. Conversations could be facilitated to tighten the relationship between research and practice.

> "We suggest creating "action briefs" or "spotlights" of successful programs and/or specific strategies across different contexts and disseminating them via mail or email directly to institutions and instructors."

One of the strongest themes emerging from all four meetings was the need to establish personal relationships and trust to move forward efforts to broaden participation in the geosciences. Education researchers emphasized that trust is needed between researchers and the 2YC/MSI contexts in which studies are conducted; the research must serve both the researcher and the institution in which it takes place. Resource Providers emphasized that end users from 2YC and MSI contexts need to be partners in the curriculum development process—not only in testing developed products but also in initial product design. This can help to ensure that instructional materials are usable in these contexts. Administrators and Instructors recognized the need to individually reach out and promote the geosciences. Building collaborations between higher education and K–12 schools, between 2YCs/MSIs and four-year institutions, and between institutions and local employers is essential.

The second, yet perhaps most pervasive, theme emerging across all four meetings was the need for more proactive marketing of the geosciences. In short, students do not know who we are and what we do. Students need access to information about possible career pathways in the geosciences that are meaningful and relevant to their interests and lives. They need to understand the coursework and professional skills required for these career paths. All participants recognized that they could do a better job marketing their courses and degree programs both on and off campus. Reaching out to existing structures, such as campus academic advising and recruiting offices, may be a critical first step. Off-campus outreach to local K–12 schools and community groups can also enhance the image and accessibility of the geosciences. Finally, all participants recognized the value of including students and alumni as ambassadors of the geosciences.

### 6.1.2 Exploring the Ideal Model

The final take-home message of the ideal model activity is that the geosciences have a number of opportunities to better connect the various stakeholders in order to increase diversity. Figure 8 outlines some of those that our Geo-Needs participants felt were most important. The "expand" arrows (green) may represent easy-to-tackle connections since the infrastructure and connections already exist. STEM diversity efforts can be expanded to include geoscience. Geosciences recruitment, retention, and public awareness efforts can be expanded to emphasize diversity.

The "build" arrows (blue) are new pathways that the community, researchers, educators, and funding agencies should explore. Each of these arrows could be a large undertaking. Future projects could include (1) focused workshops in the style used by Geo-Needs that explore more targeted 2YC/MSI issues, (2) analysis of existing programs in other STEM and non-STEM disciplines that have successfully established funding, and (3) establishing pilot programs that build training and infrastructure connections between specific stakeholder groups in a local region, followed by scale-up feasibility studies.

## 6.2 RECOMMENDATIONS FOR FUTURE WORK

Meeting activities and discussions covered a wide variety of issues related to the larger challenges associated with strengthening diversity. Our participants come from institutions large and small, urban and rural. They represented national to local organizations that create and disseminate instructional resources and opportunities. They self-identified as administrators, instructors, geoscientists, education and diversity researchers, and providers of education and outreach resources. The range of voices reflects the need for diverse strategies and approaches to address minority participation in the geosciences. Institutions and organizations are almost universally underfunded, which will necessitate working creatively and innovatively to solve this problem with static, or even decreasing, resources. Strategies must be developed to optimize resources, both human and physical, to put in place structures, programs,

and opportunities that will recruit and retain students in the geosciences and ensure their academic success.

One step that would move these issues forward is improved dissemination of "what works," both in terms of empirically tested models and theory. While dissemination in the academic literature is important, it also needs to reach individual administrators (e.g., department chairs and deans) as well as faculty and instructors engaged in the day-to-day work of educating students. Broader dissemination will not only provide viable models for URM student recruitment and retention that departments or individual instructors can adopt, but may also bring the issue of underrepresentation to broader attention. We suggest creating "action briefs" or "spotlights" of successful programs and/or specific strategies across different contexts and disseminating them via mail or email directly to institutions and instructors.

A second recommendation arising from the focus group meetings highlights a need for additional support for ongoing collaborations between stakeholders. As facilitators, we deliberately recruited regional participants for these focus group meetings, with an underlying goal of fostering collaborations. Regional networks of 2YCs, MSIs, and four-year institutions have the potential to dramatically increase access to the geosciences for minority students. Our evaluation data suggest that the Resource Providers and Education Researchers would benefit from sustained collaboration, as would Education Researchers and Instructors. Ongoing support could be facilitated through professional organizations (e.g., SAGE 2YC and NAGT Geo2YC Division), in a virtual format, or at regional conferences.

Finally, a natural follow-on to our meeting would be additional meetings focused on specific contexts and actionable plans. It is clear to the facilitators that while a conversation about increasing access to the geosciences across 2YCs and MSIs has been fruitful, these conversations need to drill down into specific institutional contexts, needs, and opportunities. The actionable strategies for a lone instructor at a suburban 2YC trying to attract more minority students to his/her classes may be quite different from actions needed to bring a degree program in the geosciences to an established MSI. Furthermore, we recognize that not all MSIs have similar contexts; the needs of HBCUs, HSIs, and TCUs vary tremendously. Future meetings should explore specific institutional contexts (e.g., a meeting for tribal colleges trying to establish geoscience programs, a meeting for increasing minority student participation at urban 2YCs). Bringing together individuals facing a common problem might generate lasting solutions.

It is clear that the issue of access to the geosciences for 2YC and MSI students is a complex one. The Geo-Needs meeting used the voices of Administrators and Instructors from these institutions as well as those of Resource Providers and Education Researchers to explore this issue. Findings and recommendations shared here are only the start; sustained effort from the entire geoscience community will be needed to achieve our goal of a broad, diverse, and well-prepared geoscience workforce.

# 7. References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# 8. Appendices

## APPENDIX A. ACRONYMS AND ABBREVIATIONS

2YC ..... Two-year technical or community college (granting associate's degree only)

4YC ..... Four-year college or university (granting bachelor's and associate's degrees)

AAPG ..... American Association of Petroleum Geologists (http://www.aapg.org)

AGI ..... American Geosciences Institute (http://www.americangeosciences.org)

AGU ..... American Geophysical Union (http://sites.agu.org)

AMS ..... American Meteorological Society (https://www2.ametsoc.org/ams)

EarthScope ..... http://www.earthscope.org

ENGAGE ..... Encouraging Networks between Geoscience and Geoscience Education (https://www.iris.edu/hq/workshops/2015/01/engage_workshop)

GIS ..... Geographic information system

GSA ..... Geological Society of America (http://www.geosociety.org)

HBCU ..... Historically Black Colleges and Universities (http://www.ed.gov/edblogs/whhbcu/one-hundred-and-five-historically-black-colleges-and-universities)

HSIs ..... Hispanic Serving Institutions (http://www.hacu.net/assnfe/CompanyDirectory.asp?STYLE=2&COMPANY_TYPE=1,5)

InTeGrate ..... Interdisciplinary Teaching about Earth for a Sustainable Future (http://serc.carleton.edu/integrate)

IODP ..... International Ocean Discovery Program (http://www.iodp.org)

IRIS ..... Incorporated Research Institutions for Seismology (https://www.iris.edu/hq)

MSI ..... Minority-serving institution

NABG ..... National Association of Black Geoscientists (http://nabg-us.org)

NAGT ..... National Association of Geoscience Teachers (http://nagt.org)

NAGT Geo2YC Division ..... The Two-Year College Division of the National Association of Geoscience Teachers (http://nagt.org/nagt/divisions/2yc)

NASA ..... National Aeronautics and Space Administration (https://www.nasa.gov)

NOAA ..... National Oceanic and Atmospheric Administration (http://www.noaa.gov)

NSF ..... National Science Foundation (http://www.nsf.gov)

NSF EHR ..... NSF Directorate for Education and Human Resources (http://www.nsf.gov/dir/index.jsp?org=EHR)

NSF-IUSE ..... National Science Foundation – Improving Undergraduate STEM Education (https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505082)

On the Cutting Edge ..... http://serc.carleton.edu/NAGTWorkshops

SACNAS ..... Society for the Advancement of Chicano and Native Americans in Science (https://sacnas.org)

SAGE 2YC ..... Supporting and Advancing Geoscience Education in Two-Year Colleges (http://serc.carleton.edu/sage2yc)

SERC ..... The Science Education Resource Center at Carleton College (http://serc.carleton.edu)

TERC ..... https://www.terc.edu/display/HOME/Home

TCU ..... Tribal Colleges and Universities (http://www.aihec.org/who-we-serve/index.htm)

UCAR ..... University Corporation for Atmospheric Research (http://www2.ucar.edu)

UNAVCO ..... https://www.unavco.org

URM ..... Underrepresented minority

USGS ..... U.S. Geological Survey (http://www.usgs.gov)

| Focus Group | Department | Institution |
|---|---|---|
| **ADMINISTRATORS** | | |
| Steven Esling | Geology | Southern Illinois University Carbondale |
| Scott Ishman | Geology | Southern Illinois University Carbondale |
| Keith Schimmel | Energy & Environmental Systems | North Carolina A & T State University (HBCU) |
| Lorrie Stahl | Earth Science/Geology | Waubonsee Community College (2YC, HSI) |
| Ken Voglesonger | Earth Science | Northeastern Illinois University (HSI) |
| **INSTRUCTORS** | | |
| Erica Barrow | Science | Ivy Tech Community College (2YC) |
| Antony Berthelote | Hydrology | Salish Kootenai College (TCU) |
| Thomas Byl | Agriculture and Environmental Science | Tennessee State University (HBCU) |
| Catherine Etter | Environmental Science and Technology | Cape Cod Community College (2YC) |
| Thomas Feldman | Natural Sciences | Joliet Junior College (2YC) |
| Elisabet Head | Earth Science | Northeastern Illinois University (HSI) |
| Amber Kumpf | Math and Physical Sciences | Muskegon Community College (2YC) |
| Adriana Martinez | Geography | Southern Illinois University Edwardsville |
| Ademe Mekonnen | Energy & Environmental Systems | North Carolina A & T State University (HBCU) |
| Sadredin Moosavi | Science | Rochester Community Technical College (2YC) |
| Roy Plotnick | Earth and Environmental Sciences | University of Illinois at Chicago (HSI) |
| Sian Proctor | Geology | South Mountain Community College (2YC) |
| Jennifer Sheppard | Physical Science | Moraine Valley Community College (2YC) |
| Paul Sirvatka | Meteorology | College of DuPage (2YC) |
| David Voorhees | Earth Science/Geology | Waubonsee Community College (2YC, HSI) |
| Karen Yip | Physical Sciences | Houston Community College System (2YC, HSI) |
| **RESOURCE PROVIDERS** | | |
| Lisa Anderson | MSU Extension | Michigan State University |
| Kathy Atchley | Advanced Energy Technology Initiative | Illinois State Geological Survey |
| Donna Charlevoix | Education & Community Engagement | UNAVCO |
| Sharon Cooper | Education | International Ocean Discovery Program |
| Michael Hubenthal | Education and Public Outreach | IRIS Consortium |
| Tamara Ledley | Center for STEM Teaching and Learning | TERC |
| John McDaris | | SERC at Carleton College |
| Robert Ridky | | U.S. Geological Survey |

| Focus Group | Department | Institution |
|---|---|---|
| **EDUCATION RESEARCHERS** | | |
| Lorenzo Baber | Education Policy | University of Illinois at Urbana-Champaign |
| Caitlin Callahan | Geology | Grand Valley State University |
| Tina Carrick | Geological Sciences | The University of Texas at El Paso (HSI) |
| Kathy Ellins | Jackson School of Geosciences | The University of Texas at Austin |
| Raquel Gonzalez | Education | American Institutes for Research |
| Lisa Hammersley | Geology | California State University-Sacramento |
| Kaatje Kraft | Science | Whatcom Community College (2YC) |
| Suzanne O'Connell | Earth & Environmental Sciences | Wesleyan University |
| Julie Sexton | Mathematics and Science Teaching Institute | University of Northern Colorado |
| Stefany Sit | Earth and Environmental Sciences | University of Illinois at Chicago (HSI) |
| Eboni Zamani-Gallaher | Education Policy | University of Illinois at Urbana-Champaign |

Number of participants from 2YCs: 13
Number of participants from 4YCs: 21
Number of participants from MSIs: 12
Number of participants from an institute with a geosciences program: 21

## Pre-Meeting Preparation

| **Administrators** | **Instructors** |
|---|---|
| Please review these websites and reports for some foundational information about undergraduate geoscience programs and workforce opportunities:<br>• National Association of Geoscience Teachers (NAGT) *Building Strong Geoscience Departments Program*<br>• Read the Geological Society of America position statement on *Expanding and Improving Geoscience in Higher Education*<br>• Website that showcases *Programs Supporting Minority Students in Geoscience*<br>• Watch the five-minute video on career opportunities for students in the geosciences: *Be a Geoscientist*<br>• Take a look at the AGI report on *Critical Needs for the Twenty-First Century The role of the Geosciences* | Please read the following reports and prepare brief answers to the following questions.<br><br>Readings to consider:<br>• *Designing Effective and Innovative Courses*–from the On the Cutting Edge program<br><br>From the InTeGrate program found on the SERC website, there are many documents and essays that you may find beneficial, but we strongly suggest you become familiar with the following:<br>• *Strengthen Workforce Preparation in your Program*<br>• *Why Focus on Diversity* |
| **Prepare background information about your institution**<br>Please be prepared to share information about your institution with the other participants:<br>• If your institution has a geoscience program or department, what challenges does it face? What opportunities would improve the participation of minority students?<br>• If your institution does not have a geoscience program or department, what types of opportunities would be feasible to provide instruction leading to geoscience careers for your students? | **Please bring answers to the following questions to the start of the meeting.**<br>Questions to consider about your own programs:<br>• What instructional resources do instructors utilize?<br>• How do instructors identify/find resources?<br>• What are the challenges associated with the resources that instructors are utilizing?<br>• What resources have instructors found that are effective for underrepresented groups? |

## Day 1 (Travel Day/Evening arrival)

| | |
|---|---|
| 5:00 pm | Registration and welcome at Granite City Grill and Brewery |
| 5:30 pm | Icebreaker - Our students, our institutions, and why we are here |
| 6:00 pm | Dinner |
| 7:00 pm | Convener introductions, meeting overview, goals, logistics, and review of pre-meeting assignments |

## Day 2 (Full day)

6:15 am Breakfast
8:30 am Welcome, team norms, soapbox, parking lot, review of agenda and goals, logistics

| **Administrators** | **Instructors** |
|---|---|
| 9:00 am Think-Pair-Share Discussion: Institutional missions and workforce needs<br>• Report on the mission of your institution, its setting, profile of student body<br>• Who are your students? Where do your students come from, what are their needs?<br>• What are the workforce needs in your region?<br>10:15 am Group Discussion: Envisioning the ideal state<br>• How is geoscience (or environmental science) taught at your institution?<br>• How can instruction in geoscience contribute to your institutional mission and the success of your students?<br>• What are your needs in staffing, resources, etc.?<br>• What can we do to help? | 9:00 am Think-Pair-Share Discussion: Existing instructional resources<br>• What existing resources do you utilize to help with your instruction?<br>9:30 am Think-Pair-Share Discussion: Institutional contexts<br>• What are the opportunities/challenges for your institution? |

10:45 am Break
11:00 am Guest speakers: David Voorhees (Instructor) & Lorrie Stahl (Administrator), *Geology at Waubonsee Community College*
12:00 pm Lunch
1:00 pm Developing Ideal Models – Third Third Ideas
- Group brainstorming: Thinking beyond the expected (superpowers)

1:30 pm Developing Ideal Models – Envisioning the Ideal State
- Individual brainstorming on posters: Imagine you have unlimited resources, time, etc. (except that you cannot change the characteristics of your students). What would it take to achieve the goal of increasing the number of skilled geoscientists entering the workforce, or increasing appreciation and awareness of geoscience among non-geoscience students?

1:45 pm Developing Ideal Models – Ideal state gallery walk feedback on posters
2:15 pm Developing Ideal Models – Ideal state group discussion
2:45 pm Break
3:00 pm Developing Ideal Models – Identifying Stakeholders
- Individual brainstorming: Identify other stakeholder needed to make this idea happen (who aside from instructors do you need on your team?)
- Group discussion: Create exhaustive list of stakeholders needed, narrow down to consensus list

3:30 pm Developing Ideal Models – Connecting the Pieces
- Individual brainstorming: Connect the stakeholders with arrows annotated to describe the type of collaborations or contacts needed to achieve skilled geoscientists and informed citizens

4:15pm Ideal Model Presentations: Each person adds new information to previous presentation
6:00 pm Dinner

## Day 3 (Evening Departure)

6:15 am Breakfast Available–Hotel
8:30 am Revisit goals, conveners present synthesis of ideal model

| **Administrators** | | **Instructors** | |
|---|---|---|---|
| 9:00 am | Feedback and refinement of ideal models – Your place in the model<br>• Small group brainstorming: Identify challenges and solutions for each connection in the ideal model | 9:00 am | Feedback and refinement of ideal models – Your place in the model<br>• Small group brainstorming: Identify challenges and solutions for each connection in the Ideal Model |
| 10:00 am | Feedback and refinement of ideal models<br>• Group discussion: Share challenges and connections | 10:00 am | Feedback and refinement of Ideal Models<br>• Group discussion: Share challenges and connections |
| 10:30 am | Break | 10:30 am | Break |
| 10:45 am | Reflection and action planning: Applying the ideal model to your institutional context | 10:45 am | Reflection and action planning: Applying the ideal model to your institutional context |

12:00 pm Lunch
1:30 pm Guest speaker Jill Karsten, National Science Foundation, *NSF Funding Opportunities for Broadening Participation*
2:15 pm Wrap-up discussion/thank you/exit survey
3:00 pm Dismissal

## APPENDIX C-2: DETAILED RESOURCE PROVIDER AND EDUCATION RESEARCHER MEETING AGENDAS

### Pre-Meeting Preparation

| **Resource Providers** | **Education Researchers** |
|---|---|
| Please read the following short reports before you come to the meeting and prepare answers to the following questions:<br><br>**Readings:**<br>*Designing Educational Innovations for Sustained Adoption*<br>O'Connell and Holmes (2011)<br><br>**Questions:**<br>• What efforts has your company/organization made that specifically have targeted underrepresented groups? What were the successes, the challenges?<br>• What role do you think educational researchers should play in increasing the effectiveness of your quality educational resources at minority serving institutions?<br>• What role do you think geoscience employers should play in the effectiveness and use of you your quality educational resources at minority serving institutions? | Please review these articles and informational sheets on the diversity in the geosciences:<br>• O'Connell and Holmes (2011)<br>• Sexton et al. (2014)<br>• Baber et al. (2010)<br>• *Two Year College Minorities*<br>• *Challenges in Degree Completion*<br><br>**Prepare Background Information About Your Work**<br>Please be prepared to share information about your work with the other participants:<br>• Where would you place your work on a continuum between pure evaluation and pure research?<br>Evaluation ⟷ Research<br><br>• How do you define yourself? Do you identify mainly as a geoscientist, education researcher, etc.?<br>• What are the overarching goals for your work? (e.g., recruit more students to geoscience, build the literature on particular topics, etc.) |

### Day 1 (Travel Day/Evening arrival)

| | |
|---|---|
| 5:00 pm | Registration and welcome at Granite City Grill and Brewery |
| 5:30 pm | Icebreaker - Our students, our institutions, and why we are here |
| 6:00 pm | Dinner |
| 7:00 pm | Convener introductions, meeting overview, goals, logistics, and review of pre-meeting assignments |

## Day 2 (Full day)

6:15 am Breakfast
8:30 am Welcome, team norms, soapbox, parking lot, review of agenda and goals, logistics

| **Resource Providers** | **Education Researchers** |
|---|---|
| 9:00 am Guest Speaker: Jeff Froyd, Texas A&M University. *Increase the Impact*<br>10:00 am Break<br>10:15 am Gallery Walk: Getting know our organizations, sharing strengths and knowledge<br>• What are the primary goals or vision of your organization in an educational context?<br>• How do you identify what to create/build?<br>• What settings to you help facilitate classroom, lab, field, online, and outreach<br>11:00 am Gallery Walk: Utilizing our resources to improve diversity in the geosciences<br>• What has been done?<br>• What is on the horizon? | 9:00 am Group discussion: Locating the researcher<br>• Identify where your falls on the evaluation-research spectrum and provide a two-minute introduction to the group.<br>9:30 am Guest Speaker: Lorenzo Baber, University of Illinois-Urbana Champaign. *Bridging research and evaluation in geoscience recruitment and retention programs*<br>10:15 am Break<br>10:30 am Gallery Walk: Identifying the Knowledge Base<br>• Topic #1: What program attributes lead to successful recruiting or retention of diverse students?<br>• Topic #2: What pedagogical or curricular techniques facilitate success, particularly with diverse students?<br>• Topic #3: What are the best practices for program evaluation? What metrics matter the most?<br>• Topic #4: What theoretical frameworks apply to research on diversity in the geosciences? What methods and designs can move this field forward?<br>• Topic #5: What institutional practices support URM student success in the geosciences?<br>• Topic #6: Ideas not captured in the other themes<br>11:00 am Guest Speaker: Caitlin Callahan, Grand Valley State University. *Social Capitol Theory as a Framework for Studying Diversity in the Geosciences* |

12:00 pm Lunch

| Resource Providers | Education Researchers |
|---|---|
| 1:00 pm Think-Pair-Share Discussion: Creating culturally relevant resources<br>• What are characteristics of place-based education resources?<br>• How can resource providers help create/ improve place-based resources?<br>2:00 pm Group Discussion: Assessment and evaluation of materials and programs<br>• Describe your current techniques for assessment and evaluation of resources<br>• How to evaluate: What works for underrepresented student success?<br>• What role do/could educational researchers have?<br>2:45 pm Break | 1:00 pm Conveners synthesis and report of knowledge base gallery walk<br>1:15 pm Group Discussion: Gaps in the knowledge base<br>• What are the gaps in the knowledge base?<br>1:45 pm Small Group Discussion and Report Out: Filling the gaps<br>• Is there research, theory, programs, or other opportunities from domains outside of geoscience that would inform this topic?<br>• What would you most like to know about this topic? What burning questions remain?<br>2:45pm Break |

3:00 pm Guest Speaker: Jill Karsten, National Science Foundation. *NSF Funding Opportunities for Broadening Participation*
4:00 pm Developing Ideal Models – Third Third Ideas
• Group brainstorming: Thinking beyond the expected (superpowers)
4:30 pm Review and refinement of the ideal model - Introduction of results from the Administrator-Instructor meeting
4:45 pm Road Check- Preview of tomorrow
6:00 pm Dinner

## Day 3 (Evening Departure)

6:15 am Breakfast
8:30 am Revisit goals, recap model

| Resource Providers | Education Researchers |
|---|---|
| 9:00 am Review and refinement of ideal model - Gallery walk:<br>• How to facilitate the ideal model? The role of resource providers | 9:00 am Review and refinement of ideal model - Gallery walk:<br>• Identify where education research fits into the model<br>• Proposing changes to the ideal model<br>9:45 am Group Discussion: Building consensus |

10:15 am Break
10:30 am Review and refinement of ideal model - Share-out between researchers and resources
• Which arrows can be facilitated, which can be researched?
11:00 Review and refinement of ideal model – Group discussion
• How can researchers and resource providers work together to make the ideal model a reality?
12:00 pm Lunch

| Resource Providers | | Education Researchers | |
|---|---|---|---|
| 1:00 pm | Individual Reflective & Action Plans<br>• Based on this focus group, what ideas will you bring back to your organization in order to increase the effectiveness of your resources and support for underserved communities?<br>• Based on this focus group, what specific resources do you feel you and your organization can provide to help facilitate the needs identified by the instructors and administrators?<br>• Specifically, what support can your organization provide to faculty that wish to engage their local communities and community leaders?<br>• What sort of buy in and funding will you need from institutions and other organizations in order to provide the resources and support you described above?<br>• What specific collaborations will you need to develop and deliver those resources and support?<br>• What specific collaborations will you need to evaluate those resources and support? | 1:00 pm | Individual Reflection & Action Plan<br>• Based on what emerged from the discussion on the gaps in the knowledge base, what does the geoscience community need to move forward?<br>• What resources do we need in terms of researchers or collaborations?<br>• What resources do we need in terms of institutional support?<br>• What resources do we need in terms of financial support? What would those funding opportunities look like?<br>• What resources do you, in particular, need to move forward with your work?<br>• How might you incorporate aspects of this meeting into your next steps? |
| 1:30 pm | Sharing Action Plan Highlights | 1:45 pm | Report out on Action Plans |

2:15 pm Wrap-up discussion/thank you/Exit Survey
3:00 pm Dismissal

# APPENDIX D: REFERENCE LIST FROM EDUCATION RESEARCHER MEETING


## Borderland Theory

Anzaldúa, G. (1999). *Borderlands: La frontera: The new mestiza*. San Francisco, CA: Aunt Lute Books.

Bhabha, H. K. (1990). DissemiNation: Time, narrative, and the margins of the modern nation. In *Location of Culture* (pp. 139–170). London, New York: Routledge.

## Capital Theory

Bourdieu, P. (1986). The forms of capital. Cultural theory: An anthology, 81–93.

Coleman, J. S. (1988). Social capital in the creation of human capital. American journal of sociology, S95–S120.

Putnam, R. D. (1995). Bowling alone: America's declining social capital. *Journal of Democracy*, *6*(1), 65–78.

## Critical Feminist Theory

Collins, P. H. (1998). Fighting words: Black women and the search for justice (Vol. 7). University of Minnesota Press.

## Critical Race Theory

Bell, D. A. (1995). Who's afraid of critical race theory. University of Illinois Law Review, 893.

Crenshaw, K. (1995). *Critical race theory: The key writings that formed the movement*. The New Press.

Ladson-Billings, G., & Tate IV, W. (1995). Toward a critical race theory of education. *The Teachers College Record*, *97*(1), 47–68.

Tate, W. F. (1997). Critical race theory and education: History, theory, and implications. *Review of Research in Education*, *22*, 195–247.

## Critical Theories

(in order: Critical Theory, LaCrit Theory, Critical Race Feminism, Critical Disability Theories)

Collins, P. H. (2002). *Black feminist thought: Knowledge, consciousness, and the politics of empowerment*. Routledge.

Horkheimer, M. (1976). Traditional and critical theory [1937]. In *Critical Theory: Selected Essays* (pp. 188–243). New York: Continuum.

Solorzano, D. G., & Yosso, T. J. (2001). LACRIT V SYMPOSIUM; CLASS IN LATCRIT: THEORY AND PRAXIS IA WORLD OF ECONOMIC INEQUALITY; LACRIT IN NEW CONTEXTS; Maintaining Social Justice Hopes Within Academic Realities: A Freirean Approach to Critical Race/LatCrit Pedagogy 1. *Denver University Law Review*, *78*, 595–1249.

Hosking, D. L. (2008, September). Critical disability theory. A paper presented at the 4th Biennial Disability Studies Conference at Lancaster University, UK.

Wing, A. K. (1997). *Critical race feminism: A reader*. New York: NYU Press.

## Intersectionality

Charleston, L., Adserias, R., Lang, N., & Jackson, J. (2014). Intersectionality and STEM: The role of race and gender in the academic pursuits of African American women in STEM. *Journal of Progressive Policy & Practice*, *2*(3), 273–293.

## Microaggressions

Sue, D. W. (2010). Microaggressions in everyday life: Race, gender, and sexual orientation. John Wiley & Sons.

Sue, D. W., Bucceri, J., Lin, A. I., Nadal, K. L., & Torino, G. C. (2007). Racial microaggressions and the Asian American experience. *Cultural Diversity and Ethnic Minority Psychology*, *13*(1), 72–81.

## Organizational Change Theory

Armenakis, A. A., & Bedeian, A. G. (1999). Organizational change: A review of theory and research in the 1990s. *Journal of Management*, *25*(3), 293–315.

## Social/Academic Engagement/Integration Theory

Tinto, V. (1975). Dropout from higher education: A theoretical synthesis of recent research. *Review of Educational Research*, *45*, 89–125.

Tinto, V. (1987). *Leaving college: Rethinking the causes and cures of student attrition*. Chicago, IL: University of Chicago Press.

## Social Cognitive Career Theory

Lent, R. W., Brown, S. D., & Hackett, G. (2002). Social cognitive career theory. *Career Choice and Development*, *4*, 255–311.

## Social Role Theory/Role Congruity Theory

Eagly, A. H. (1987). *Sex differences in social behavior: A social-role interpretation*. Psychology Press.

Eagly, A. H. (1997). Sex differences in social behavior: Comparing social role theory and evolutionary psychology. *American Psychologist*, *2*(12), 1380–1383.

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## Stereotype Threat Theory

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PUBLIC COMMUNITY
funding
ADMIN/ INSTIT COM/ STAFF
teaching + learning
support - logistics + funding
funding/support: ed resources, materials (e.g. writing, math, geosci tutoring)
STUDENT
FACULTY
teaching + learning
field + lab opportunities
teaching + research funding
research support/ funding
teaching support/ funding
conference, workshop support/experiences
internships, jobs, collaborations
internships, jobs, collaborations
conferences, workshops
FUNDING AGENCIES
EMPLOYERS
GEOSCIENCE RESEARCH PARTNERS (USGS, NATLABS)
GEOSCIENCE COMMUNITY (PROF SOC)

# Geo-Needs

Stakeholder Needs Assessment
for Broadening Participation
in the Geoscience Workforce

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