Engaging Undergraduates in the New York City S-SAFE Internship Program: An Impetus to Raise Geoscience Awareness

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ABSTRACT

To engender and raise awareness to the geosciences, a geoscience research project and a corresponding geoscience internship program were designed around plume dispersion dynamics within and above the New York City subway system. Federal, regional, and local agencies partnered with undergraduate students from minority-serving institutions to conduct the largest plume dispersion study ever done in a complex, dense, urban-coastal metropolis. The students were engaged in an array of geoscience activities within the confines of geoscience learning communities. Assessment results indicate that the geoscience exposure and experience helped to stimulate and proliferate geoscience awareness and knowledge among the undergraduates. © *2015 National Association of Geoscience Teachers*. [DOI: 10.5408/14-040.1]

Key words: geoscience program design, underrepresented minorities, STEM, field campaign, undergraduate internship

INTRODUCTION

Better understanding of Earth as a system of interrelated subsystems is critical to meet global and regional demands for natural resources, environmental health and sustainability, and resilience to natural disasters. The connections and feedback mechanisms that link the complex systems of Earth (cryosphere, atmosphere, lithosphere, biosphere, and hydrosphere) determine the nature, state, and quality of energy, soil, water, atmospheric, ecological, and coastal and oceanographic resources. The management and proper usage of these geophysical resources, in turn, govern many aspects of global livelihood—from food security, health, and climate change impacts to potential regional conflicts over scarce, diminishing, or emerging natural resources. Therefore, in the context of a sustainable Earth, integrative geoscience is a pivotal concern and need, and for the United States, it is a matter of national security.

Unfortunately, amid these grave concerns, the United States continues to struggle to fulfill its need for a highly skilled geoscience workforce, particularly one that reflects the nation's demographic makeup. Table I highlights the troubling racial and ethnic divide and disparity within the geosciences. In 2010 (when the geoscience enrollment and degrees seem to indicate some resurgence among students; American Geological Institute, 2010a), 20% of all bachelor degrees in science, technology, engineering, and mathematics (STEM) were awarded to underrepresented minorities (African American and Hispanic). However, this group garnered a little over 7% of the bachelor's degrees conferred in the geosciences (National Science Foundation, 2013). In their studies, Chan (2013) and Velasco and deVelasco (2010) extol the importance, the need, and the benefits of diversity and the awareness of racial and ethnic cultures in the development of a strong and vibrant geoscience workforce.

The U.S. geoscience enrollment and workforce problem is rooted in a formal and informal geoscience educational structure that is inadequate. The National Center for Education Statistics (2012) reported that only about 28% of high school graduates successfully received credit for completing a geology or Earth Science course. A recent, revealing press release from the American Geosciences Institute (2013a) highlights that throughout the United States, Earth and space sciences do not receive the same prominence and status as life sciences, physical sciences, engineering, and technology. In establishing clear aims for the subject, the Next Generation Science Standards (2013) states that Earth and space sciences should have equal status with life sciences, physical sciences, technology, and engineering. However, the report shows that school districts and other organizations fail to assign Earth Sciences this status. Only 1 of the nation's 50 states requires a yearlong Earth or environmental science course for high school graduation, whereas 32 states require a life science course and 27 states require a physical science course, according to the report. Only 6 states require that students are taught Earth Science concepts as part of their graduation requirements. Unfortunately, this lack of emphasis on the geosciences carries over to the college level. Many colleges do not accept high school Earth Science courses because: (1) these courses do not fit the traditional definition of a laboratory course, (2) Earth Science does not have an advanced placement exam, and (3) there is a perception that Earth Science courses lack the rigor of traditional courses like biology, physics, and chemistry (American Geological Institute, 2011a).

This approach to geoscience education and to replenishing and enhancing the nation's geoscience workforce is fraught with problems. The geoscience pipeline is both leaking and clogged at the inlet and throughout. At the undergraduate level, students lack the necessary preparation

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TABLE I: U.S. 2010 race and ethnicity geoscience composition.

Race/Ethnicity	Percentage of U.S. Population[1]	Percentage of Geoscience Bachelor's Degrees Awarded[2]	Percentage of Geoscience Master's Degrees Awarded[3]	Percentage of Geoscience Doctoral Degrees Awarded[4]	Percentage of Geoscience Workforce[5]
Caucasian	64%	82.6%	82.2%	82.1%	87%
African American	12%	2.1%	1.3%	1.0%	1%
Hispanic	16%	5.2%	3.7%	3.3%	4%
Asian/Pacific American	5%	3.4%	3.1%	3.1%	7%

[1]Does not include the racial/ethnic category Others. (Source: http://www.nsf.gov/statistics/wmpd/2013/pdf/nsf13304_digest.pdf.)
[2]Does not include American Indians, Others. (Source: http://www.nsf.gov/statistics/wmpd/2013/pdf/tab5-6_updated_2014_05.pdf.)
[3]Does not include American Indians, Others. (Source: http://www.nsf.gov/statistics/wmpd/2013/pdf/tab6-6_updated_2014_05.pdf.)
[4]Does not include American Indians, Others. (Source: http://www.nsf.gov/statistics/wmpd/2013/pdf/tab7-7_updated_2014_05.pdf.)
[5]Does not include multiracial data. (Source: http://www.nsf.gov/statistics/wmpd/2013/pdf/tab9-6_updated_2013_11.pdf.)

and training, and institutions may lack the necessary foresight, innovation, and funding to implement creative solutions for geoscience education. Under these conditions, the nation's geoscience workforce will continue to experience serious shortfalls in diversity, expertise, and number of employees with the requisite computational, analytical, critical-thinking, and problem-solving skills and experience needed to better understand and harmonize with the systems and subsystems of a dynamic, active, sustainable Earth.

To make matters worse, this gloomy state of the geosciences exists at a time when, according to the American Geological Institute (2011b), American Geosciences Institute (2013b), and Perkins (2011), most of the current geoscience workforce is within 15 years of retirement age and their younger replacements are 50% fewer in number. Therefore, the geoscience workforce of the future may only be half of its current size. Concurrently, according to the Bureau of Labor Statistics (2014), employment opportunities for geoscientists are expected to grow by 16% during the 2012–2022 decade. This rate of increase outpaces the national average for occupation growth.

EXAMPLES OF INNOVATIVE GEOSCIENCE STRATEGIES

To assist in ameliorating the nation's geoscience plight, several geoscience ''best practices'' innovations have been tried and suggested. Levine et al. (2007), for example, created a geoscience pipeline model for underrepresented minorities that emphasizes both theoretical and practical applications to the geosciences. Buddington and Graver (2003) discovered that a geoscience lecture series that also provided students with access to top geoscientists who shared their experience and passion for the geosciences motivated student interest in the subject area.

Via the Geosciences Awareness Program, a partnership between Ohio State University and Columbus State Community College, Adetunji et al. (2012) found that interest in the geosciences among underrepresented minority students heightened when the relevance of the geosciences to society and their daily livelihoods was directly addressed and highlighted. The students also were drawn to the geosciences when they were given examples of distinguished minority geoscientists and made aware of the lucrative salaries of geoscientists. For Hispanic geoscience majors, Stokes et al. (2014) found that more informal outdoor geoscience experiences enhanced the students' learning of and interest in the geosciences. These Hispanic students typically had fewer outdoor geoscience experiences than their Caucasian counterparts. The American Geosciences Institute (2013b) Student Exit Survey also revealed that recent geoscience graduates ranked outdoor field experience highest among their reasons for choosing to major in the geosciences. To draw minority students to the geosciences, O'Connell and Holmes (2011) argued that providing exposure to geoscientists and promoting geoscience careers, particularly among the students' families, would pay huge dividends in the students' decisions to pursue the geosciences.

Topical studies by the American Geological Institute (2010a) pointed out that increasing minority participation in the geoscience workforce is predicated on increased minority participation in geoscience academic programs, effective recruitment programs, targeted retention efforts, internship experiences, and assistance for these students to transition into geoscience careers. In a recent appraisal of the nation's dire geoscience conundrum (American Geosciences Institute, 2012), the geoscience community recommended several solution strategies. These strategies included (1) funding for public outreach and informal geoscience education at national parks, museums, and other public places and (2) providing scholarships, internships, grants, and fellowships for undergraduate geoscience majors.

In redressing the geoscience plight, the New York City College of Technology (City Tech) of the City University of New York (CUNY, as part of its National Science Foundation's Opportunity for Enhancing Diversity in the Geosciences grant, Grant No. 1108281) forged external partnerships with federal and local agencies and undergraduate students. This nexus was used to focus on a major, critical, public geoscience research project that was instrumental in raising geoscience awareness among undergraduate students in New York City. Many aspects of the sample strategies outlined earlier were employed in this geoscience internship program, and the key components of the program are outlined in the sections that follow.

SUBWAY-SURFACE AIR FLOW EXCHANGE INTERNSHIP PROGRAM

The components of the 3-week Subway-Surface Air Flow Exchange (S-SAFE) internship program are outlined in two sections: (1) program design and operations and (2) program evaluation. Both sections are described here.

Program Design and Operations

The summer 2013 S-SAFE research project was a joint initiative by the New York City Police Department (NYPD), the U.S. Department of Energy's Brookhaven National Laboratory (BNL), Argonne National Laboratory (ANL), the New York City Metropolitan Transit Authority, and Battelle (a nonprofit applied science and technology organization). The research project focused on the potential risks posed by airborne contaminants if they were released as chemical, biological, and radiological weapons in the New York City metropolitan area. The research project was the first of its scale to study airflow and possible airborne contamination of above- and belowground (subway) locations in a dense urban environment. One primary goal of the S-SAFE program was to use the data generated from this research project to optimize security and first-responders' emergency deployment for New York City's 5 million daily subway travelers.

From the outset, this project was rife with geoscience applications (including environmental data sampling and collection, urban–coastal micrometeorology, air pollution, plume dispersion modeling, and geoscience policy for security), and it was seized upon as a unique entree for students to become both aware of and involved with the geosciences. The participation of undergraduate students in the S-SAFE research project also allowed for the provision of resources and funds to create a comprehensive 3-week geoscience internship program that targeted undergraduates who were underrepresented minorities in STEM. A main goal of the S-SAFE internship program was to raise the awareness of the geosciences among undergraduates majoring in the STEM disciplines. Partnerships formed with government agencies and higher-education institutions provided the key elements needed to create an internship that had the following three components: (1) geoscience field campaigns, (2) geoscience seminars, and (3) geoscience activities. These three components are described next.

Geoscience Field Campaigns

The S-SAFE research project provided an opportune platform to expose undergraduate students from a large metropolitan area to the geosciences by having them work side by side with geoscience experts on a project never undertaken in such scope and magnitude in New York City. The project consisted of 3 field days of study in July 2013 with a core group of BNL staff members, student interns, and collaborators from ANL and Battelle forming teams headed by leaders responsible for securing samplers within designated New York City gridded areas. The sample area encompassed New York City's five boroughs, with particular focus on the heavily trafficked Manhattan areas from 59th Street to the Battery.

Perfluorocarbon gases were used as tracers to detail the path of airflow in the subway stations and at corresponding street levels. Perfluorocarbons are nontoxic, odorless, and invisible gases that possess a unique chemical signature allowing for their exclusive tracing. Following the release of the tracer gases, their dispersion and concentration were tracked by a network of approximately 200 air samplers that were deployed in targeted sample areas throughout New York City at various timed intervals over a 6-h period for each of the 3 d of the field campaign. Samples were gathered and analyzed by researchers. The data obtained were used to plot the concentrations of each tracer gas with respect to space and time. The effects of wind speed and direction were also taken into account using measurements obtained from several building-top sonic anemometers in the sample area.

Lab researchers used the comprehensive dataset to create an empirical modeling tool that can be applied to any contaminant once the physiochemical properties of that specific chemical are taken into consideration. Based on the guiding structure created by the researchers, simulation models were used to validate the movement of contaminants, as well as to optimize existing transport guidelines and emergency management strategies in real-time crisis situations.

The student interns received hands-on instrumentation, tracer technology, and safety training from BNL and ANL geoscientists. During the first week of the internship, students were trained to properly care for, install, secure, and use the sampling instruments to take measurements and to collect and record data. They were also trained on how to communicate the purpose and the science of the project to the public. Practice trial runs were conducted before the field campaign occurred. The days for each field campaign depended on predicted atmospheric conditions, and the students were informed a day in advance of a potential field campaign event. These undergraduate students, therefore, played a pivotal role in data sampling, collecting, and recording and in communicating the critical implications of this geoscience project to the curious and concerned public. To assuage the fears and to satisfy the curiosity of New Yorkers about seeing sampler boxes and equipment above ground and in the subway system (traveling in trains and placed under or attached to benches on platforms), the students and their team leads—professors from the participating colleges—trained to be versed in explaining the project to the public. In addition, the project worked in tandem with the mayor's office and the NYPD so that police officers were assigned to each sampler unit on each field day event. This arrangement tremendously helped to calm the public's fears (New York City has remained on high alert since the 11 September 2001 terror attacks) and assured them that the study was safe and authentic.

Geoscience Seminars

The partnerships formed with national and local government agencies and higher-education institutions provided a comprehensive and diverse cohort of expert lecturers in the geosciences. These geoscientists facilitated 1.5-h-long geoscience seminars for the undergraduate students on the following five topics: exploring the geosciences, dispersion meteorology, subway air pollution modeling, contaminant transport, and remote sensing and climate change. In their geoscience seminars, faculty scientists from the CUNY (City Tech, Medgar Evers College, and Bronx Community College) also shared their expertise and perspectives on a variety of geoscience issues from fracking to Super Storm Sandy. In addition, the NYPD engaged students in a special geoscience counterterrorism workshop. This comprehensive suite of geoscience workshops provided the undergraduates with the unique

TABLE II: Number of college participants per institution.

College	Total Participants (n = 89)
Carnegie Mellon University	1 (1.1%)
CUNY Bronx Community College	17 (19.1%)
CUNY City College of New York	6 (6.7%)
CUNY College of Staten Island	2 (2.2%)
CUNY Medgar Evers College	14 (15.7%)
CUNY City Tech	41 (46.1%)
Iona College	1 (1.1%)
Long Island University	3 (3.4%)
Nassau Community College	1 (1.1%)
Suffolk County Community College	1 (1.1%)
SUNY New Paltz[1]	1 (1.1%)
SUNY Potsdam[1]	1 (1.1%)

[1]SUNY = State University of New York.

opportunity of interacting with a diverse group of geoscientists at national, regional, and local levels.

Geoscience Activities

The entire S-SAFE project lasted for a full 16 d. Of these, 3 d were field campaign days, and the other 13 d were spent in training sessions and geoscience seminars and in working on geoscience team projects that were supervised by BNL scientists and CUNY faculty. Altogether, there were 21 student–scientist and student–faculty teams, and each team was assigned the task of selecting, researching, studying, and presenting one of the following geoscience topics:

- Air pollution and atmospheric stability
- Analyzing the sources of renewable energy in the United States
- Climate change and public policy
- Climate change impacts on health
- Climate change impacts on water resources
- Earthquake geology, plate tectonics, and seismology (life cycle, monitoring, and impacts)
- Fracking (pros and cons)
- Greenhouse gases and global warming
- Heat waves
- Hurricanes (life cycle, monitoring, and impacts)
- Ozone layer: Why is it crucial to our survival?
- Recovery from natural disasters (poor versus rich countries)
- Remote sensing of greenhouse gases
- The Amazon rain forest
- The effect of the sun's energy on the atmosphere and the ocean
- The ring of fire
- The urban heat island of New York City
- Tornadoes (life cycle, monitoring, and impacts)
- Tsunamis (life cycle, monitoring, and impacts)
- Volcanoes (life cycle, monitoring, impacts, and types)
- Water becoming the new oil

A student team captain for each group was selected to coordinate the team's project activities. The team captain met and frequently interacted and reported to the team's faculty mentor or research scientist. It was the duty of the faculty member or research scientist to oversee and guide the project, review the student researched information for accuracy, and give final project approval. At the end of the internship, each team made an oral presentation of its selected geoscience topic, and each team also made a poster presentation at the Raising Geoscience Awareness symposium that was held during the closing ceremony of the internship. The event was open to and attended by the public. Feedback from the poster presentation was provided to the students via direct discussions with the attendees of the symposium and from the faculty and scientists who guided the projects.

The 21 geoscience topics that were selected from the preceding list were highlighted as a product of the S-SAFE internship program. These 21 projects (two pages per topic) were compiled into a geoscience informational brochure (this supplemental file can be found online at http://dx.doi.org/10.5408/14-040s1) that was freely given to the public at the symposium and made available on the project's Web site.

TABLE III: Number of participants by race or ethnicity.

Race/Ethnicity	Total Participants (n = 89)
African American (non-Hispanic)	46 (51.7%)
Asian/Pacific Islander	16 (18.0%)
Hispanic	14 (15.7%)
Caucasian	8 (9.0%)
Other	5 (5.6%)

TABLE IV: Number of participants by STEM major.

STEM Major	Total Participants (n = 89)
Engineering/engineering technology	34 (38.2%)
Biology	15 (16.9%)
Computer/computer technology	9 (10.1%)
Chemistry	8 (9.0%)
Applied mathematics	7 (7.9%)
Environmental science/geoscience	5 (5.6%)
Liberal arts and sciences	5 (5.6%)
Biomedical	2 (2.2%)
Biochemistry	1 (1.1%)
Forensic science	1 (1.1%)
Nursing	1 (1.1%)
Undeclared	1 (1.1%)

The S-SAFE Internship Program Student Participants

Universities affiliated with the educational programs at the BNL, particularly those minority-serving institutions within the CUNY system, were invited to participate in this program. The participants of the S-SAFE internship program, therefore, included undergraduates who were mainly recruited from the following five senior and community colleges of the 23 campuses of the CUNY system: City Tech, Medgar Evers College, City College of New York, College of Staten Island, and Bronx Community College. From each of these institutions, STEM students were recruited from extant undergraduate STEM research programs. For example, from City Tech, students were recruited from the Black Male Initiative and the Honors Scholars programs. These students had to meet the minimum criterion of a 2.7 grade point average, and they had to participate in a formal application–selection process that included the evaluation of their resumes, personal statements, and letters of recommendations. Nine students from non-CUNY colleges were also selected as participants in the internship program. These students, along with two from the College of Staten Island, came from the New York State Collegiate Science Technology Entry Program (CSTEP). A total of 89 undergraduate STEM students were selected, and all were compensated with a stipend of $1,200 for their participation. These students were divided into 21 teams, and each team had an average of four students. Table II details the number of participants per institution.

The cohort of 89 geoscience interns consisted of 63 (70.8%) males and 26 (29.2%) females. Among the students, 67.4% of the interns were from underrepresented minority groups in STEM (Table III). Their academic majors encompassed various STEM disciplines (Table IV), and the participants were predominantly sophomores, juniors, and seniors (Table V). A survey completed by participants on the first day of the program showed that approximately a third of them were first-generation college students. From a total of 85 responses, 82 (96.5%) students stated that they have plans to continue their education beyond the bachelor's degree. Approximately 43% of them plan to go to graduate school for a doctoral or medical degree.

Program Evaluation

Assessments were conducted to ascertain whether the internship was effective in raising the awareness of the geosciences among the undergraduates. To measure whether geoscience knowledge was gained from the internship, a pretest and a posttest on geoscience concepts were administered during the first and the last day of the internship, respectively. The tests were composed of 10 multiple-choice questions (Table VI) that covered basic geoscience concepts; these questions were provided by the internship's seminar speakers. Only results from students who completed both pre- and posttests were included in the analysis. A paired t-test was used to determine whether the internship experience significantly increased the students' basic geoscience knowledge.

To evaluate whether there was a change in students' attitudes toward the geosciences, a presurvey and a postsurvey were also administered on the first and the last day of the internship, respectively. Students stated how much they agreed or disagreed on statements regarding their geoscience self-efficacy (Bong, 2002) and task values (Bong, 2004). A paired t-test was used to determine whether

TABLE V: Number of participants by academic year.

Academic Year	Total Participants (n = 89)
Freshman	9 (10.1%)
Sophomore	31 (34.8%)
Junior	25 (28.1%)
Senior	22 (24.7%)
Recent graduate	2 (2.2%)

TABLE VI: Questions from the multiple-choice geoscience knowledge test.

1. What is the primary source of energy that creates winds?
a) Earth's rotation
b) Sun's radiation
c) Moon's gravity
d) Earth's core heat
e) Condensation of water vapor
2. What physical process influences dispersion in an urban area located near the ocean?
a) Building wake effects
b) Land–sea breeze
c) Vertical advection
d) Boundary layer evolution
e) All of the above
3. Why is ozone primarily important in the troposphere?
a) Its concentration is a sign of volcanic activity globally
b) It absorbs so much harmful solar radiation
c) It is the cause of global warming
d) It is a pollutant, affecting vegetation and respiration
e) It is replacing stratospheric ozone
4. Which three gases constitute most of the gas (over 98%) in the atmosphere near the Earth's surface?
a) Carbon dioxide, nitrogen, oxygen
b) Argon, water vapor, nitrogen
c) Methane, carbon dioxide, water vapor
d) Helium, argon, oxygen
e) Nitrogen, argon, oxygen
5. Name the four atmospheric layers (from lowest to highest) that are distinguished by their temperature profiles.
a) Troposphere, stratosphere, mesosphere, thermosphere
b) Troposphere, tropopause, mesopause, ionosphere
c) Stratosphere, troposphere, mesosphere, thermosphere
d) Troposphere, mesosphere, thermosphere, stratopause
e) Troposphere, stratosphere, mesosphere, ionosphere
6. Which atmospheric layer contains the ozone layer?
a) Troposphere
b) Mesosphere
c) Ionosphere
d) Stratosphere
e) Tropopause
7. In the Northern Hemisphere, the longest day of the year occurs on
a) March 22
b) June 21
c) September 22
d) December 21
e) October 10
8. Compared to polar orbiting satellites, geostationary satellites move
a) Always at the same speed
b) Always faster
c) Always slower
d) Slower at first and then faster

TABLE VI: continued.

e) Faster at first and then slower
9. In the Northern Hemisphere, the Coriolis force is a deflecting force that moves large-scale motion
a) Left
b) Right
c) Upward
d) Downward
e) North
10. Rainfall occurs via a phase change process called
a) Evaporation
b) Deposition
c) Condensation
d) Sublimation
e) Conduction

there were statistically significant changes in geoscience attitudes before and after the internship.

To evaluate the overall program, a satisfaction survey was given on the last day of the internship. Questions were asked to elicit (1) the extent to which the students' attitudes toward the geosciences have changed; (2) how helpful the S-SAFE geoscience internship experience was in developing their writing, research, and presentation skills; and (3) students' feedback on their team leaders.

RESULTS

The main goal of the S-SAFE internship program was to raise the awareness of the geosciences among undergraduates majoring in the STEM disciplines. The results from this program were positive overall. In analyzing the students' geoscience knowledge before and after the internship, there was a small, statistically significant gain from an average of 3.94 correct items to 5.22 correct items ($p < 0.001$). However, even with this gain, students answered barely half of the items correctly.

To evaluate the impact of the internship program on students' geoscience self-efficacy and task values, responses from attitudinal surveys completed before and after the internship were compared. There were no significant differences in geoscience self-efficacy (Table VII). However, the two geoscience task value statements (Table VIII), "I think geoscience is a useful discipline" and "I find geoscience interesting," showed statistically significant increases. Tables VII and VIII are modeled from the work of Bong (2002) and Bong (2004) respectively.

The geoscience internship satisfaction survey given at the end of the program measured how helpful the S-SAFE geoscience internship experience was in developing the students' writing, research, and presentation skills and the students' feedback on their team leaders. The results showed students felt the internship provided the most help in designing a research poster presentation (Table IX).

The evaluation of the S-SAFE geoscience faculty mentors and team leaders showed highly favorable results from the students. They strongly felt their leaders were professional, organized, and communicated clearly. They also felt that the community created by each team leader provided a supportive environment in which they felt comfortable asking questions (Table X).

Potential Implementation Limitations

The S-SAFE internship program was used as a vehicle to garner and increase student awareness of and participation in the geosciences. It may well be a program that could be replicated nationally. However, the following limitations should be considered before replication is undertaken.

First, multiscale or multilevel (public–private partnerships among federal, regional, and local agencies, coupled with

TABLE VII: Pre- and postsurvey results for geoscience self-efficacy.

Geoscience Self-Efficacy[1] ($n = 79$)	Mean Pretest	Mean Posttest	Sig. (Two-Tailed)[2]
1. I'm certain I can understand the ideas taught in the geoscience internship.	5.94	6.15	0.162
2. I am sure I can do an excellent job on the problems and tasks assigned in the geoscience internship.	6.25	6.34	0.476
3. I know that I will be able to learn the material presented in the geoscience internship.	6.30	6.33	0.858

[1]1 = strongly disagree; 7 = strongly agree.
[2]Sig. = significant.

TABLE VIII: Pre- and postsurvey results for geoscience task values.

Geoscience Task Values[1] ($n = 79$)	Mean Pretest	Mean Posttest	Sig. (Two-Tailed)
1. I think what I learn about geoscience is important.	6.29	6.44	0.295
2. I think geoscience is a useful discipline.	6.18	6.48	0.043[2]
3. I find geoscience interesting.	5.92	6.34	0.009[3]
4. The geosciences is relevant to my life.	5.99	6.24	0.130

[1]1 = strongly disagree; 7 = strongly agree.
[2]Significant (Sig.) at the 0.05 level (two-tailed).
[3]Sig. at the 0.01 level (two-tailed).

academic institutions) engagement rarely converges on a single geoscience project. Therefore, wholesale adoption and portability of this program may be limited. However, the program is designed so that it can be compartmentalized and components from it may be used as stand-alone geoscience awareness-building tools. For example, students could participate in developing geoscience brochures that culminate in poster sessions, oral presentations, or both, or students may be intrigued by participation in outdoor geoscience activities.

Second, all student participants of the S-SAFE internship program received stipends. This may be cost prohibitive, so other types of incentives may be needed. Finally, this 3-week program does not lend itself to a proper longitudinal study about sustained geoscience interest and participation.

DISCUSSION

The S-SAFE internship program provided an opportunity to spotlight the importance to—and to raise students' awareness of—the geosciences. Using a real-world, highly relevant, 3-week, multiagency project, the program produced evidence to indicate that (1) underrepresented minority STEM students found geoscience to be a useful discipline and (2) these same students found the geosciences to be interesting. The program also produced strong evidence that students liked their faculty mentors and team leaders. This factor may be a reason they found the geosciences useful and interesting. Keen, comprehensive programmatic observations; subjective evidence; and experiential intuition seem to indicate that a multiscale, "all hands on deck" (public–private partnerships among federal, regional, and local agencies, coupled with academic institutions) approach to the advancement of the geosciences may be a viable paradigm in marshalling people, resources, and facilities to unclog the leaky geoscience pipeline.

The S-SAFE internship program also seems to indicate that providing outdoor geoscience experiences (on the streets, in the subway, etc.) may raise awareness, stimulate interest, and reinforce the importance of the discipline. Anecdotal student feedback suggested that the internship program made the geosciences and its impacts more relevant to their lives and that it may be a critical stimulus to raising the awareness and the importance of the geosciences.

From the program, there also may be clues that a structurally sound, well-designed geoscience internship may be used to attract students to the geosciences and that direct contact with geoscientists stimulated student learning of the geosciences. Moreover, there may be evidence that by participating in geoscience activities, students felt they had a better understanding of the geosciences, they better understood the research process, and they better understood how knowledge is constructed. The program showed evidence that geoscience activities can provide students with the skills (writing, verbal, research, and presentation) necessary to succeed in the wider STEM arena. Finally, the program structure and outcomes suggest that for the geosciences, partnerships between community colleges and 4-year institutions may serve to enhance (1) cross pollination of ideas and team work, (2) racial and ethnic diversity, and (3) academic diversity.

IMPLICATIONS AND CONCLUSIONS

With the geosciences struggling at all academic levels (and across racial and ethnic groups) to take a sustained foothold in the United States, it is imperative that new, innovative strategies be introduced and administered to raise geoscience awareness and to expose students to this vital and lucrative field of study. Projects like the S-SAFE internship program outlined here may be catalysts for change in attitudes, perceptions, and participation in the geosciences. By combining known elements of best practices with new strands of innovation, the geosciences may be renewed, revived, and made attractive to the next generation of scientists.

This multiagency project has officially ended. However, semblances of it may be adapted by others elsewhere. For example, in a quest to engage students in the geosciences, smaller groups may participate in local geoscience projects and mimic portions of the S-SAFE internship program that are practical and suited to their needs.

TABLE IX: Mean responses on the helpfulness in developing writing, research, and presentation skills.

Statement[1]	Mean (SD)[2]
Writing abstracts for research projects ($n = 83$)	4.08 (1.14)
Advancing Internet/library research techniques ($n = 83$)	3.89 (1.22)
Developing and delivering effective research presentations ($n = 83$)	4.09 (1.03)
Designing a research poster presentation ($n = 82$)	4.42 (0.88)

[1]1 = not helpful at all; 5 = extremely helpful.
[2]SD = standard deviation.

TABLE X: Mean responses regarding faculty mentors and team leaders.

Statement: Faculty Mentors and Team Leaders[1]	Mean (SD)[2]
My team lead's manner was courteous and professional. ($n = 84$)	4.71 (0.63)
My team lead was organized and prepared. ($n = 84$)	4.63 (0.72)
I received the quality and quantity of help I needed from my team lead. ($n = 85$)	4.59 (0.76)
I felt comfortable asking questions. ($n = 85$)	4.64 (0.67)
I felt comfortable asking for help when needed. ($n = 85$)	4.66 (0.61)
My team lead communicated clearly and effectively. ($n = 84$)	4.67 (0.72)
I felt my team lead was motivated to help me finish my S-SAFE project. ($n = 84$)	4.47 (0.95)
I would highly recommend my team lead to my friends. ($n = 82$)	4.62 (0.91)

[1]1 = strongly disagree; 5 = strongly agree.
[2]SD = standard deviation.

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