

Broadening Geosciences Preparedness through a Cross-Campus Experiential Partnership

Adriane Jones¹, Diane Kim², Karla Heidelberg², Xiaomei Cheng¹, Jessica Dutton²

ajones@msmu.edu, dianekim@usc.edu

¹Mount Saint Mary's University of Los Angeles, ²University of Southern California Wrigley Institute for Environmental Studies

Motivation

Strengthening and diversifying the geosciences pipeline requires creative investments in effective evidence-based strategies to broaden access and reinforce retention. Geosciences fields, in particular, lack racial and ethnic diversity at doctoral levels and are cited as having the lowest diversity of all the STEM fields at all levels of higher education (National Center for Science and Engineering Statistics, 2015). In 2010, while 20% of all U.S. bachelor degrees were awarded to underrepresented minorities, fewer than 7% of geosciences bachelor degrees were awarded to the same groups (Stokes et al., 2014). These statistics highlight the need for innovative and inclusive strategies to broaden geosciences access and promote retention.

The Federal STEM Education Strategic Plan (2013) and the President's Council of Advisors on Science and Technology (PCAST) (2012) recommended a diversification of evidence-based teaching methods to engage all students—especially the 'underrepresented majority' (women and members of minority groups, who constitute ~70% of college students). Successful programs commonly employ the following: **1) Programs to help students, particularly underrepresented students, see themselves as STEM professionals, 2) Early research experiences, 3) Active learning in introductory courses, and 4) Membership in STEM learning communities.**

Partnership between MSMU and USC



Mount Saint Mary's University of Los Angeles, CA



USC/Wrigley Marine Science Center on Catalina Island, CA

The program forges a sustainable, scalable model partnership between a minority-serving geosciences-limited 2-year/4-year women's institution (MSMU) and a larger R1 university (USC).

As described in the 2011 report "*Expanding Underrepresented Minority Participation*" (National Academies, 2011), cross-institutional diversity represents a prime vehicle for addressing disparities in STEM participation and enhancing success across underrepresented groups. In 2017 Mount Saint Mary's University (MSMU) in partnership with the University of Southern California: (USC) Wrigley Marine Science Center (WMSC) was awarded a **National Science Foundation (NSF) Improving Undergraduate STEM Education in the Geosciences (IUSE Geopaths) grant (NSF #1700871)**.

Mount Saint Mary's University (MSMU):

Serves 1,561 undergraduates, primarily women, who make up 96% of the student population and 100% of STEM majors. As a federally designated Hispanic-Serving Institution, MSMU has a long-standing commitment to providing quality educational programs to underserved and financially disadvantaged populations.

University of Southern California: (USC) Wrigley Marine Science Center (WMSC)

USC has a strong commitment to inclusivity and increasing diversity in all of its academic programs. In 2016, the Wall Street Journal/Times Higher Education survey ranked USC 15th nationally overall in higher education, in large part because of the commitment to foster diversity. WMSC on Catalina Island provides a unique contrasting environment for studying land-ocean interactions when compared to the urbanized and human impacted coastal zone adjacent to Los Angeles.

Year Round Co-Curricular Programming

Spring

Fieldtrip-Griffith Park Observatory
Catalina: Research Experience: 5 days at USC/WMSC.
Introduction to Oceanography.
Workshop: Data Summit to prepare for first presentation.
Presentation: Oral presentation at MSMU Academic Symposium

Summer

Catalina Research Experience: 15 days at USC/WMSC.
Small group independent projects.

Fieldtrip



Field Trip Photo

Fall 2018

Fieldtrip-NASA Jet Propulsion Laboratory
Workshop: Geosciences Career Panel
Workshop: Personal Statement workshop and Graduate Student Panel
Presentation: Poster presentations at MSMU STEM symposium
Presentation: Poster presentations at Southern California Counsel for Undergraduate Research SCCUR

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Evaluator Beth E. Rabin Ph.D.

The students for their dedication, and openness to the challenge of something new.

Social Media



Website: <https://www.msmu.edu/resources-culture/iuse/>
<https://dornsife.usc.edu/wrigley/wmsc/>

Twitter: @echo_echo and @USCWrigleyInst
Instagram Hash tag: #atheniansingeosciences

Motivation

The GEOPATHS program is designed around four overarching goals:

- 1) Attract greater academic interest and awareness among entry-level MSMU students in geoscience and environmental fields**
- 2) Increase the retention of MSMU students in related STEM courses and minor/major tracks**
- 3) Facilitate post-program engagement in STEM and geoscience curricular, co-, and extra-curricular opportunities**
- 4) Create an institutional STEM training partnership between MSMU and USC to enhance undergraduate student opportunities in curricular and extracurricular data- and field-centric experiences**

The GEOPATHS program supports three annual cohorts (2018, 2019, 2020) of 14 students each in year-long scaffolded programming, in the form of extended research experiences, fieldtrips, workshops, and opportunities to present science while covering the disciplines of oceanography and earth sciences in the following ways:

- 1) Introduce oceanography and environmental science fields through project based learning at USC's WMSC Catalina campus**
- 2) Conduct field/laboratory studies mentored by USC and MSMU faculty and researchers**
- 3) Build expertise and confidence for subsequent participation in national programs and advanced geoscience courses at USC that are unavailable at MSMU**
- 4) Engage students in discussions about geoscience graduate school and workforce opportunities**

Assessment Tools

IRB approval was obtained to collect participant data. Assessment is conducted by an external evaluator

- Annual Pre- program Online Surveys (N=14 per year). Before the program begins each spring, participants complete an online survey (pre-test), about 15 minutes in length.
- Annual Post- program Online Surveys. Upon completion of the program each fall, students will complete a second online survey (post-test), about 25 minutes in length. Examining the change in students' responses from pre- to post-test will allow measurement of program impact.
- Retrospective Online Survey (N=42). After the program's third year, all program graduates will be contacted for career tracking purposes, and to reflect on how the program influenced their educational and career choices.

Results Cohort 1 (2018) and 2 (2019)

Table 1: Post-program survey responses for specific program elements. (Likert scale 0-10)

Program Element	Rating of 8, 9 or 10	
	2018 Cohort 1 (n=13)	2019 Cohort 2 (n=14)
Overall Program	100%	93%
One-Week Spring Break Research (WCMS)	92%	92%
Two-Week Summer Research WCMS	84%	79%
Presentations (Oral and Posters)	100%	93%
Professional Development Workshops	92%	92%
Field Trips	77%	84%



Photos from Cohort 1 during the GEOPATHS Program

References

- National Center for Science and Engineering Statistics. 2015. Women, Minorities, and Persons with Disabilities in Science and Engineering: Special Report NSF 15-311, National Science Foundation, Arlington, Va.
- Stokes PJ, R Levine, and KW Flessa. 2014. Why are there so few Hispanics in geoscience? *Geosciences Today* 24(1): 52-53.
- Federal Science, Technology, Engineering, and Mathematics (STEM) Education 5-Year Strategic Plan. 2013. A report from the Committee on STEM Education National Science and Technology Council. Executive Office of the President, National Science and Technology Council, Washington, DC.
- President's Council of Advisors on Science and Technology (PCAST). 2012. Report to the President. Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering and Mathematics. Washington DC.

Results Cohort 1 (2018) and 2 (2019)

Table 2: Pre-program and post-program survey data related to specific Environmental/Geoscience interests (Likert scale 1-5)

Environmental/Geoscience interests	2018 Cohort 1 (n=13)	2019 Cohort 2 (n=14)
	Pre/ Post	Pre/ Post
Environmental/geoscience is very interesting.	3.9/ 4.5	4.1/ 4.4
I feel comfortable with my level of environmental/geoscience knowledge.	3.2/ 3.7 *	3.1/ 3.9 *
I know the steps to take to pursue a career in environmental/geoscience.	2.4/ 3.9 **	2.6/ 3.7 **
Work in an environmental/geoscience lab in college (for pay or course credit)	4.2/ 3.5 *	4.4/ 3.6 *
Pursue a higher education degree in environmental/geoscience (Master's or Ph.D.)	3.1/ 2.8	3.6/ 2.9 *
Work in the environmental/geoscience field for the next step in my career	2.9/ 2.5	3.2/ 2.9
Work in a non-geoscience STEM field for my career that can incorporate environmental/geoscience.	3.7/ 3.4	3.8 / 3.6
Work in a STEM field for my career, outside of environmental/geoscience.	3.6 / 4.0	4.1 / 3.8

*p < 0.5, **p < 0.1

Table 3: Pre-program and post-program survey data related to self-confidence in specific STEM skills (Likert scale 1-5)

STEM Skill	2018 Cohort 1 (n=13)	2019 Cohort 2 (n=14)
	Pre/ Post	Pre/ Post
Pursue a STEM major in college	4.1/4.5	4.4/4.3
Taking upper-division science lab courses	3.9/ 4.5 **	3.9/ 4.1
Quantitative thinking and problem solving	3.9/ 4.2	3.9/ 4.0
Doing science literature searches	3.5/ 4.1 *	3.5/ 4.1 **
Writing up your scientific research results	3.8/ 4.0	3.6/ 4.1 *
Giving presentations of your scientific work	3.9/4.2	3.6/4.0
Communicating scientific concepts to the public	4.1/ 2.3	4.1/ 4.3

*p < 0.5, **p < 0.1

Participant Quotes

"It is a program unparalleled to any other. From the workshops to the team bonding and the research itself, it was an amazing and unique opportunity I really don't think I will find anywhere else. This program has definitely opened my eyes to all the STEM field has to offer."

"The program and this experience also taught me leadership skills and time management skills. This has allowed me to perform better in school and participate more in class discussions. Academic and educational wise I want to become the best version of me so that I can be able to guide someone one day like the program mentors guided me."

Conclusions

•The surveys collected quantitative data based on Likert scales and qualitative data as free responses. 100% of the students in Cohort 1 (n=13) and Cohort 2 (n=14) reported that the program met or exceeded expectations (avg. score = 9.4), and listed the opportunity to conduct authentic research and present their findings at professional meetings as the most valuable experiences. (Table 1)

•Comparing the pre and post surveys showed students entered the program with a high level of interest in geo/environmental science and left with an increased knowledge of both the disciplines and career pathways. This directly supports the program goal of introducing oceanography and environmental science fields through project-based learning. (Table 2)

•Students entered the program with high self-confidence in their academic skills. After the program, we measured a statistically significant increase in their self assessed abilities to give scientific presentations, take upper-division lab courses, and conduct scientific literature searches—skills that align with the project goal of preparing students for future success in the sciences. (Table 3)

•Surprisingly, we found the program did not change the students' desire to pursue a career in the geosciences, which remained low; however, their overall interest in pursuing a STEM career remained high. (Table 2)