Diversity and Service Learning in the Geosciences: Opportunities for Exploration

Suzanne OConnell
Department of Earth & Environmental Sciences & Faulty Director of McNair Scholars
Wesleyan University

The Situation

Service learning and community-based learning have been incorporated in courses across the curriculum and multiple studies demonstrate that it benefits students beyond the classroom (e.g. Batchelder and Root, 1994, Vogelgesang and Astin, 2000, Astin et al., 2000, Celio et al., 2011, Matthews et al., 2015). "Qualitative findings suggest that service learning is effective in part because it facilitates four types of outcomes: an increased sense of personal efficacy, an increased awareness of the world, an increased awareness of one's personal values, and increased engagement in the classroom experience." (Astin et al. 2000). This approach to education allows students to develop skills that are not part of many lecture-style or even laboratory class format, such as problem solving, scientific communication, group work and reflection. Service learning requires students to move to the upper level Bloom's taxonomy of cognitive skills: analyzing, evaluating, and creating. (Bloom et al., 1956, Anderson and Krathwohl, 2001). It also provides students an opportunity to interact with an aspect of the discipline that is relevant to their lives and the people in their community. Geoscience has a tremendous opportunity to incorporate service learning into the curriculum because so much of our discipline involves finding solutions to societal problems such as coastal erosion due to rising sea level and more intense storms to the expense and the quality of the water we drink (e.g. Tedesco and Salazar, 2006, Balazs and Morello-Frosch, 2013). Students can contribute to data collection, problem solving and understanding these issues with out advanced degrees making them ideal for undergraduate projects. Reflecting on this activity, an integral part of service learning has been documented as a powerful component of the experience (Astin et al. 2000).

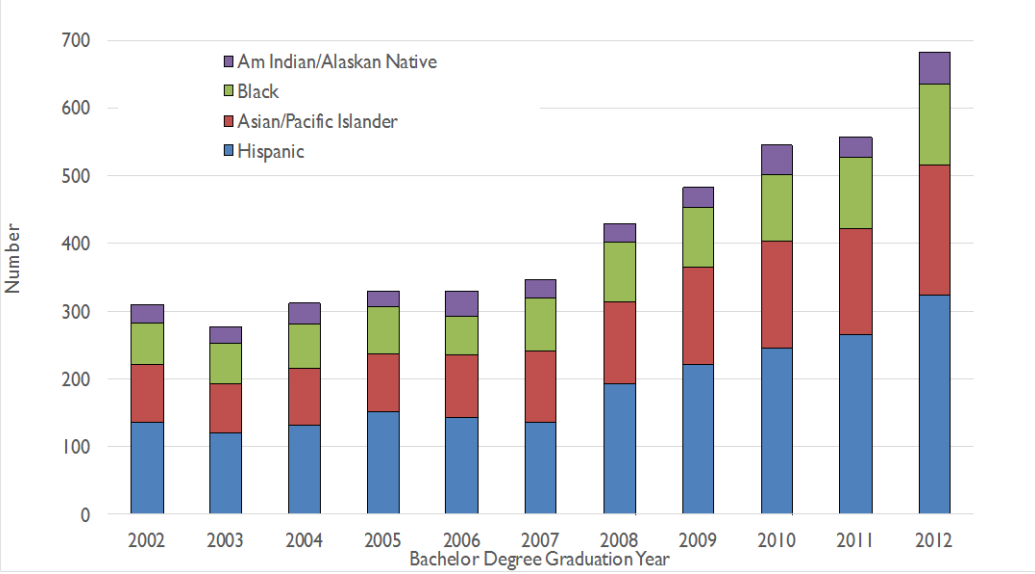

Figure 1. Number of URM bachelor recipients in geoscience (NSF, 2015)

From this perspective it is surprising that the geosciences have not attracted a more diverse student body and workforce. It hasn't. In fact, at the end of the twentieth century the "whiteness" of geoscience was a major concern and is a situation that still needs to be addressed. At that time, underrepresented minorities (African-Americans, Hispanic-Americans, Pacific Islanders, Native-Americans/Native-Alaskans (URMs)) were earning 15% of science and engineering bachelor degrees, but in geoscience the percentage was a dismal 4.6% (Prendeville and Elton, 2001). This realization led the NSF Directorate for Geosciences to convene a workshop to develop strategies to increase the participation of underrepresented groups. The response of the geoscience community has been remarkable. Students from these groups accounted for approximately 18 percent of the bachelor degree recipients in 2011 and 2012 (NSF data), averaging over 600 bachelor degree recipients in those years (Figure 1).

As part of the effort to diversify the geosciences, considerable research focused on why students from underrepresented groups were not pursuing geoscience degrees (e.g. Whitney et al., 2005, Huntoon and Lane, 2007, Levine et al., 2007, Hoisch and Bowie, 2010, Velasco and Velasco, 2010, Stokes et al., 2015). Multiple reasons were identified and include that URM students (and/or their parents)

- lack of exposure to geoscience and especially the employment opportunities,
- where not attracted by the out-of-doors emphasis that was a draw for many white students,
- wanted to pursue a career with more prestige and name recognition, and
- didn't think geoscience was relevant to their lives.

These are generalization and quite possibly different URM groups would rate the reasons differently for lack of participation differently, which may require different interventions to increase their representation.

Diversity in Service Learning

Many studies about service-learning have diversity in the title (e.g. Jones and Hill, 2001, Holsapple, 2012, Mitchell et al., 2012, and Bocci, 2015) or have a reference to diversity of racial relations in the text (Austin et al., 2000). However, these studies do not look at the ethnic component of the learners, instead they focus on students' integration into a community with which they may not have had much previous contact and explore the positive and negative benefits of such interaction.

Service Learning and URM Undergraduate Completion

In a national study, Swail et al., (2003) found that of the students who enrolled in four-year institutions in the fall of 1995 with the goal of completing a bachelor's degree, only 46% of African Americans and 47% of Hispanics had completed a bachelor's degree within six years, while 67% of white and 72% of Asian students graduated during the same period of time. URM students are more likely to come from lower-income families and even with the availability of financial aid, students from low-income families are less likely than those from higher-income families to earn a bachelor's degree (Swail et al., 2003). Could service learning improve this ourcome?

There are few studies that look at ethnicity in service learning courses. The Lockerman and Pelco (2013) study is one that does. Their research looked *ex post facto* at a cohort of 3,458 undergraduates at a four-year state institution in Virginia. Their "findings demonstrate that the impact of service-learning on degree completion is substantial, even when traditional predictors for graduation are also considered." One of the factors contributing to higher graduation rates was higher average GPA and number of credits for the service learning than the for non-service learning students. In their study black students were proportionally more likely to take a service learning course (Table 1) and thereby benefit from the higher graduation rates. This could be especially important because of the lower graduation rates of URM students.

	Non-SL Students		SL Students			
Characteristic	*n*	%	*n*	%	$\chi^2(df)$	*p*
Gender					6.54(1)	.011
Male students	1074	41	299	36		
Female students	1548	59	536	64		
Race/Ethnicity					25.34(4)	.000
White	1556	59	433	52		
Black or African American	487	19	203	24		
Hispanic or Latino	96	4	27	3		
Asian	291	11	122	15		
Other	193	7	50	6		
Residency					2.59(1)	.107
In-State	2345	89	763	91		
Out-of-State	278	11	72	9		
Documented Financial Need					19.56(1)	.000
Students Without Need	1198	46	307	37		
Students With Need	1428	54	525	63		
Financial Aid					30.51(1)	.000
Students Without Financial Aid	637	24	126	15		
Students With Financial Aid	1989	76	706	85		
Pell Grant Support					4.03(1)	.045
Students Without Pell Support	1897	72	571	69		
Students With Pell Support	729	28	261	31		
Degree Completion Within Six Years					163.51(1)	.000
Non-completers	1373	52	224	27		
Completers	1250	48	611	73		

Table 1. Characteristics of students who took service learning courses (n = 832) and students who did not take service learning courses (n = 2,626) (Lockerman and Pelco, 2013)

The 2011 National Academy Press report Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads, rated as the number one priority "Undergraduate Retention and Completion" in STEM fields. Can service-learning in the geosciences be a component of this top priority, attracting URM students and be a positive intervention towards their graduation? The answer should be yes because factors service-learning has been shown quantitatively (Ting, 2003, Lockerman and Pelco, 2013) and qualitatively (Yeh, 2010) to promote retention in college.

Houlton (2010) suggested critical incidents (Flanagan, 1954) and self-efficacy (Bandura, 1986) were important components in attracting students to the geosciences. Both can clearly be part of any service-learning course. Callahan et al., (2015) described the importance of social capital theory, "the idea that membership in a group creates opportunities to acquire

valuable information and resources from other group members," as another key component to diversifying the geosciences. Considering that the major attractor to geoscience, for a student not planning to major, is an experience in an introductory course (Holmes and OConnell, 2005), utilizing both or either of these approaches are likely to contribute to geoscience diversity and can be incorporated into service learning courses.

Despite the lack of published data about diversity in service learning courses many schools have this data. For example, at Wesleyan University, a selective liberal arts college in New England, between 2006 and fall 2016, across the university, black students (U.S. citizen or permanent resident) enrolled in service learning courses at a higher rate, relative to their overall enrollment numbers, than any other group (Table 2). This was not true of the Earth & Environmental Sciences (E&ES) department. There, Hispanic students enrolled in the service learning courses at a higher rate. In such a small department with limited service learning course offerings and a small number of diverse students (Figure 2), the enrollment differences may be due to both the availability of courses and students. Only two service learning courses are regularly taught in the department (Environmental Geochemistry (https://www.youtube.com/watch?v=rCkH13bgcp4) and Geographic Information Systems). Service-learning does not get a special course designation, so it isn't known if that opportunity was part of the motivation for taking the class. In fact, determining why some students, especially URM students, take service learning classes would be an important research question.

Race/ethnicity	%,All, undergrads	%,SL, enrollments	%,E&ES,SL, enrollments	All, undergrads	Enrolled, SL	Enrolled, E&ES,SL
Nonresident*alien	7.4	5.9	7.1	769	104	19
Black*or*African*American	6.1	7.3	2.6	633	128	7
Am.*Indian*or*Alk.*Native	0.1	0.1	0	6	1	0
Asian	7.8	6.3	3	803	110	8
Hispanic	9.2	10.2	8.2	945	178	22
White	56.4	55.7	57.7	5,820	976	154
Unknown	7.5	9.1	14.6	771	159	39
Nat.*Hawaiian/Other*Pac.*	0	0	0	5	0	0
Two*or*more*races	5.5	5.5	6.7	571	96	18
Total	100	100	100	10,323	1,752	267

Table 2. Wesleyan University (WU) enrollments in all service learning (SL) courses and Earth & Environmental Sciences (E&ES) as percentage and number. (WU Institutional Research data.)

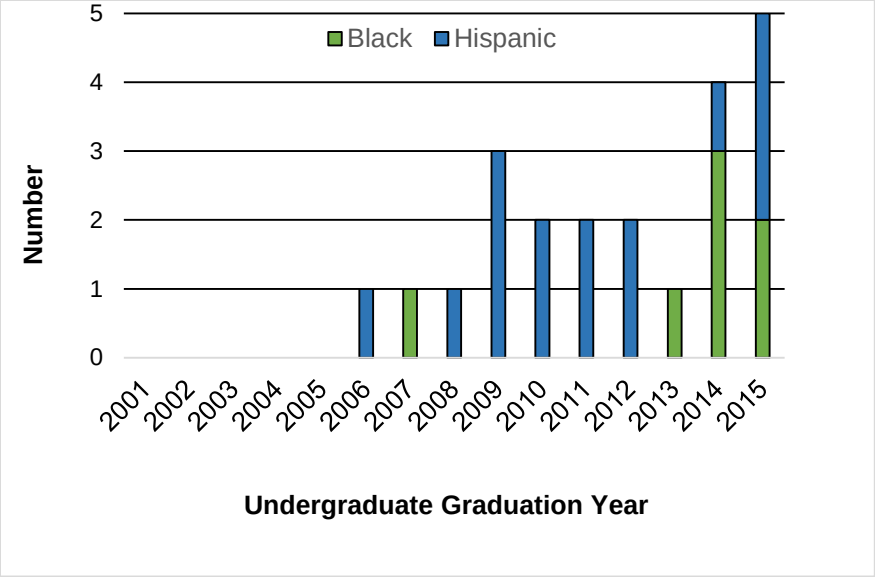

Figure 2. Diversity of Wesleyan University Earth and Environmental (E&ES) majors who are U.S. citizens or permanent residents from 2001 to 2015 by graduation year. From 2001-2005, no URM student majored in E&ES. (WU Institutional Research data.)

This summary leaves us with many questions about the role of service learning in increasing diversity and the diversity of students enrolling in service learning courses. Many of the questions posed by Hansen and Fortner (2016) could be amended to address the diversity aspect of service learning.

Some additional questions include:

During undergraduate education

1. Are URM student's motivations for enrolling in service learning courses different than majority students?

2. Are URM students more likely to enroll in geoscience service learning courses than their white or Asian counterparts?

3. What types of service-learning activities are more likely to further URM student interest in and completion of a geoscience major?

Austin et al., (2000) found that providing an opportunity to process the service experience is an important component of the experience. This included class discussion about the experience and faculty connecting the service activity to the learning material.

4. Does the subject and timing (when in a student's education) of the service learning course impact persistence of URM students?

The Lockerman and Pelco (2013) study showed that taking a service learning course in the third, fifth and sixth year "*of enrollment was a significant predictor of graduation for students in this cohort who persisted until the third year.*"

5. What is the role of the instructor in facilitating the incorporation of URM students into a service learning class?

Austin et al. (2000) identified the importance of faculty connecting the service activity and the learning material, but does the importance vary by gender, socioeconomic background and ethnicity?

6. How do institutions identify service learning courses?

   At Wesleyan University courses may be searched for in a variety of ways, subject, cluster, time of day, but not service learning. Therefore, if a student was specifically looking for a service-learning experience, he or she would need an analogue way to identify such a course.

7. Could a service-learning module in an introductory course contribute to attracting higher numbers of URM geoscience majors?

After graduation

It is surprisingly difficult to find studies that track the impact of a service learning experience post graduation. Korfmacher (1999) asked alumni who took an environmental problem solving course at Brown University between 1980 and 1995 to reflect on their experience. Thirty-eight of 209 alumni responded and no distinction was made for gender, economic background or ethnicity. Although students identified many positive benefits, most had not done not "service in the community before" and the highest rated response was that "I would have learned more from this class if there had ben more time spent in the classroom instead of doing service in the community."

Matthews et al., (2015) provide the first empirical study of employment data collected on 44 pairs of comparable students, (undergraduate major, graduation date, gender, and academic performance.) None of the students were science majors and ethnicity and economic status was not considered. They found "significantly higher starting salaries and significantly shorter time to receive a first raise for graduates with service-learning experience." But no significant difference in the length of time to be hired or receive a first promotion. Since job prospects are important in many URM families, this component of taking a service learning course could be important in attracting diverse student to the geosciences.

8. Are URM students who take a geoscience service learning course more likely to continue in geoscience?

9. What aspects of service learning courses contribute to or detract from persistence?

References

Anderson, L. W. and Krathwohl, D. R., et al. (Eds.), 2001. A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives. Allyn & Bacon. Boston, MA (Pearson Education Group).

Astin, A. W., Vogelgesang, L. J., Ikeda, E. K., & Yee, J. A., 2000. How service learning affects students. Higher Education. Paper 144.

Astin, A. W., Sax, L. J., & Avalos, J., 1999. Long term effects of volunteerism during the undergraduate years. Review of Higher Education, 22, 187-202.

Balazs, C.L. and Morello-Frosch, R. 2013. The Three R's: How Community Based Participatory Research Strengthens the Rigor, Relevance and Reach of Science, Environmental Justice 6, 1-13.

Bandura, A. 1986. Social Foundations of Thought and Action: A Social Cognitive Theory, Prentice Hall, 617p.

Batchelder, T. H., & Root, S., 1994. Effects of an undergraduate program to integrate academic learning and service: Cognitive, prosocial cognitive, and identity outcomes. Journal of Adolescence, 17, 341-355.

Bloom, B.S Engelhart, M. D.; Furst, E. J.; Hill, W. H.; Krathwohl, D. R., 1956. Taxonomy of educational objectives: The classification of educational goals. Handbook I: Cognitive domain. New York: David McKay Company.

Bocci, M., 2015. Service-Learning and White Normativity: Racial Representation in Service-Learning's Historical Narrative, Michigan J of Community Service Learning, 22, 1-13.

Callahan, C.N., Libarkin, J.C., McCallum., C.M., and Atchison, C.L. 2015. Using the lens of social capital to understand diversity in the earth system sciences workforce. Journal of Geoscience Education, 63, 98–104.

Celio, C. I., Durlak, J., Dymnicki, A., 2011. A Meta-Analysis of the Impact of Service-Learning on Students, Journal of Experiential Education, 34, 164-181. doi: 10.1177/105382591103400205

Flanagan, C. 1954. The critical incident technique. Psychological Bulletin, 51, 327-358.

Hansen, S. S. and Fortner, S., 2016. Geoscience Service-Learning Literature Themes, Report for National Academy of Sciences (NAS) Service-Learning in Undergraduate Geosciences Workshop, April 20-21, 2016

Hoisch, T.D. and Bowie, J. I., 2010. Assessing Factors that Influence the Recruitment of Majors from Introductory Geology Classes at Northern Arizona University, Journal of Geoscience Education 58, http://dx.doi.org/10.5408/1.3544297

Holmes, M.A. and OConnell, S., 2005. Holmes, M.A., and O'Connell, S., 2005, Where are the Women Geoscience Professors?: NSF-AWG Workshop: http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1085&context=geosciencefacpub.

Holsapple, 2012. Service-Learning and Student Diversity Outcomes: Existing Evidence and Directions for Future Research, Michigan J of Community Service Learning, 18, 5-18.

Houlton, H. 2010. Academic provenance: Investigation of pathways that lead students into the geosciences, unpublished M.S. thesis, Purdue U. 166 p.

Huntoon, J.E., and Lane, M.J. 2007. Diversity in the geosciences and successful strategies for increasing diversity. Journal of Geoscience Education, 55, 447–457.

Jones, S. R. and Hill, K., 2001. Crossing High Street: Understanding Diversity through Community Service-Learning. Journal of College Student Development, 42, 204-216.

Levine, R.E., Gonzalez, R., Cole, S., Fuhrman, M., and Le Floch, K.C. 2007. The geoscience pipeline: A conceptual framework. Journal of Geoscience Education, 55, 458–468.

Lockeman, K.S. and Pelco, L.E., 2013. The Relationship between Service-Learning and Degree Completion, Michigan J.of Community Service Learning, 19, 18-30.

Matthews, P. H., Dorfman, J. H., Xuedong Wu, X., 2015. The Impacts of Undergraduate Service-Learning on Post-Graduation Employment Outcomes, The International J. of Research on Service Learning and Community Engagement. 3, n.1 http://journals.sfu.ca/iarslce/index.php/journal/article/view/109/71.

Mitchell, T.D., Donahue, D.M., Young-Law, C., 2012. Service Learning as a Pedagogy of Whiteness, Equity & Excellence in Education, 45, 612-629.

National Academy Press, 2011, Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads, 270 p. http://www.nap.edu/read/12984/chapter/1#xi

NSF 2015. Women, Minorities, and Persons with Disabilities in Science and Engineering, http://www.nsf.gov/statistics/2015/nsf15311/start.cfm.

Prendeville, J., and Elton, D., 2001, Report of the Geosciences Diversity Workshop, Aug. 2000: NSF 01-53: http://www.nsf.gov/geo/diversity/geo_diversity_workshop_final_report_august_00.jsp (last accessed 25 Mar. 2016).

Stokes, P.J., Levine, R. and Flessa. K.W., 2015. Choosing the Geoscience Major: Important Factors, Race/Ethnicity, and Gender. Journal of Geoscience Education, 63, 250-263.

Swail, W. S., Redd, K. E., & Perna, L. W., 2003. Retaining minority students in higher education: A framework for success. ASHE-ERIC Higher Education Report, 30, No. 2.

Tedesco, L.P. and Salazar, K.A., 2006. Using Environmental Service Learning in an Urban Environment to Address Water Quality Issues, Journal of Geoscience Education, 54, 123-132.

Ting, S.R., 2003. A longitudinal study of non-cognitive variables in predicting academic success of first-generation college students. College and University, 78, 27-31.

Whitney, D., Behl, R., Ambos, E., Francis, D., Holk, G., Larson, D., Lee, C., Rodrique, C., and Wechsler, S. 2005. Ethnic differences in geoscience attitudes of college students. EOS, 86, 277–279.

Velasco, A.A., and Velasco, E.J. 2010. Striving to diversify the geosciences workforce. EOS, 91, 289–296.

Vogelgesang, L. J., & Astin, A. W., 2000. Comparing the effects of service-learning and community service. Michigan J. of Community Service Learning, 7, 25-34.

Yeh, Theresa Ling, 2010. Service-Learning and Persistence of Low-Income, First-Generation College Students: An Exploratory Study, Michigan J. of Community Service Learning, 17, 50-65.