A Collaborative Multidisciplinary Program Using Location-Based Urban Field Work To Enhance STEM Education Outcomes

David R. Turner, Susan Oxley, Rick Sperling, and Nicole Faris
St. Mary’s University
Introduction

• Field-based activities are a high-impact educational practice
  – Field work is important part of a traditional geoscience education
  – Application to other STEM disciplines is not as well-documented
Project Goals

• Interdisciplinary collaboration

• Assess the effects of high-impact, location-based experiential learning on educational outcomes across STEM disciplines

• Provide outdoor field experience to a historically under-represented student demographic
  – Women
  – Minority (Hispanic)
  – Low-income
  – First generation
  – Urban background

• Practical project experience in a complex multidisciplinary setting
Geology Field Experience

• Geology summer field camp
  – Typically 3 to 7 weeks
  – Long-Distance from school
  – Up to $7,700 plus tuition

• Under-represented student groups
  – Urban background
  – Limited exposure to outdoor environment
  – Budget constraints, family obligations limit ability to participate in more traditional long-term and long-distance field work

• A need for place-conscious, location-based learning activities within the curriculum
  – Short-term
  – Local
  – Application to other STEM disciplines
Project Outline

• Develop and Implement a Field-Based Environmental Chemistry course

• Monitor soil and water quality during the development of a public city park

• Environmental Science and Chemistry students work together in a project-based setting

• Assess the impact of the course on student knowledge, skills, and attitudes
Funding

• NSF-IUSE Award # 1504503
• September 1, 2015 – August 31, 2017
  – Year 1 – planning
  – Year 2 – implementation
Personnel

- PI – Susan Oxley, Chemistry
- Co-PI – David Turner, Environmental Science
- Assessment – Rick Sperling, Psychology
- Student Interns
  - Nicole Faris – Chemistry
  - Salma Montes Arredondo – Environmental Science (thru 12/15)
  - Maham Zafar – Environmental Science (2/17 to present)
- Partners
  - San Antonio River Authority
  - San Antonio River Foundation
About St. Mary’s

• Private, Catholic, Marianist University, founded 1852
• 3,625 total student body, 2,305 undergraduates
  – 798 STEM majors
• Located on the West Side of San Antonio, TX
  – Mixed-use, minority, low-income neighborhood
• Primary Service Area: Bexar County, TX
  – 59% Hispanic
  – Up to 22% High Poverty
StMU Student Profile

- Hispanic-Serving Institution
  - 70% undergraduates Hispanic/Latino
  - 86% Minority
- Almost half of our students come from Bexar County and the San Antonio region
  - More than 85% of our students are from Texas
  - Predominantly urban background
- Educational attainment (Bachelor’s or higher)
  - 26% for Texas
  - 26% for Bexar County
  - 14% for Bexar County Hispanics
- For St. Mary’s Students

<table>
<thead>
<tr>
<th></th>
<th>Fall 2015</th>
<th>All</th>
<th>Hispanic</th>
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<tbody>
<tr>
<td>Female/Male</td>
<td>54% / 46%</td>
<td>58% / 42%</td>
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<tr>
<td>First-Generation</td>
<td>39%</td>
<td></td>
<td>47%</td>
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<tr>
<td>High Financial Need</td>
<td>45%</td>
<td></td>
<td>54%</td>
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StMU Students and the Outdoors

• Student surveys for General Geology in 2014-2015
  – 70% reported engaging in <5 hours/week of outdoor activity
  – 77% reported <5 camping trips/visits to parks in previous 3 years

• Opportunity for outdoor activity complicated by general lack of access to park resources in San Antonio and South Texas
  – 2017 Parkscore index developed by the Trust for Public Land
  – Ranks access to parks/open spaces for 100 largest US cities
  – Scale of 0 (least access) to 100 (most access)
  – Texas cities range from #18 (Plano, 66.5) to #87 (Lubbock, 36.5)

• San Antonio:
  – 71 out of 100 major cities
  – A Parkscore of 43.5 out of 100
Our Students Outdoor Experience

How much time do you spend outdoors each week, including weekends? (n = 54)

- > 10 hr/wk: 1 Fall 2014, 4 Spring 2015
- 5 to 10 hr/wk: 3 Fall 2014, 8 Spring 2015
- 1 to 5 hr/wk: 18 Fall 2014, 16 Spring 2015
- 0-1 hr/wk: 2 Fall 2014, 2 Spring 2015

Number of students (n = 54)
Creating a Location-Based, Multidisciplinary Course
The Site – Confluence Park

- San Pedro Creek flows south into the San Antonio River just south of downtown
- Undeveloped 3-acre lot in a mixed-use community
- Rehabilitation by SARA, SARF as hybrid public city park
At the Confluence – The Past

• Near Mission Concepción and historic site of the Battle of Concepción
  – October 28, 1835
  – First major battle of Texas Revolution
  – Jim Bowie, James Fannin commanding
  – First Texian fatality (Richard Andrews)
The San Antonio River

- Channelized in 40s to 60s for flood control
  - Recognized need to improve the river

- Planning began in 1990s
  - Flood control
  - Amenities
  - Ecosystem Restoration
  - Recreation

- San Antonio River Improvement Project (SARIP) began in 2002 – complete 2013
  - Bexar County ($229 million)
  - COSA ($77 million)
  - USACE ($61 million)

- SARA provides project and technical management

- SA River Foundation raises private funds for beautification

http://www.sanantonioriver.org/
Westside Creeks

- Similar to SARIP

- Focused on restoring creeks on the Westside
  - Apache
  - Martinez
  - Alazan
  - San Pedro

- Restoration of about 14 miles of creeks
  - Elmendorf Lake (January 2017)
  - Linear trails
  - Started construction in 2013, most completed in 2016
Confluence Park - Before
Confluence Park – A Work in Progress
Confluence Park – A Work in Progress

January 2017
Confluence Park – A Work in Progress

March 2017

March 2017

August 2016
Course Outline

• Field-Based Environmental Chemistry
  – 2-semester course
  – Cross-listed between Chemistry and Environmental Science

• Semester 1
  – Sampling Plan
  – Lab Analysis Plan
  – Sample collection

• Semester 2
  – Sample collection
  – Sample analysis
  – Quality Assurance
  – Reporting
Course Demographics – Fall 2016

• 15 students
• Major
  – 12 Environmental Science
  – 2 Chemistry
  – 1 Engineering Science with an Environmental Science Concentration
• Gender
  – 4 Men
  – 11 Women
• Ethnicity
  – 7 Hispanic/Latino
  – 6 White
  – 1 Two or more races
  – 1 Foreign national
Group Structure

• Divided students into four groups
  – Soils: Major Cations
  – Soils: Minor/Trace Cations
  – Water: Cations
  – Water: Anions

• Used CATME Teamwork Software (Purdue) to organize teams

• Surveys to match students:
  – Schedules
  – Self-identified approach to project-work
  – Provides framework for anonymous within-group evaluation of team-member performance

• Groups to develop sampling plans and analytical methodologies
Assessment Plan

- Assess both content knowledge and attitude
  - Content quiz – StMU-developed
  - Student Assessment of Learning Gains (SALG)
  - Classroom Undergraduate Research Experience (CURE) Survey
  - Structured Chemistry Examinations (SChemEs)
  - Student assignments
  - Student reflections
  - Student interviews
Planned Laboratory Analysis

• Soil
  – Major
    • Flame Atomic Absorption Spectroscopy – Na, K, Ca, Mg
  – Minor/Trace:
    • Graphite Furnace Atomic Absorption Spectroscopy – Fe, Cu, Zn, Mn, Pb
    • Portable XRF – Transition metals

• Water
  – Anions
    • Ion Chromatography – F⁻, Cl⁻, Br⁻, NO₃⁻, NO₂⁻, SO₄²⁻, PO₄³⁻
  – Cations
    • Flame Atomic Absorption Spectroscopy – Na⁺, K⁺, Ca²⁺, Mg²⁺
Enrichment Activities

• River orientation
• Guest speakers
  – Southwest Research Institute
    • Geochemist
    • Quality Assurance
  – Raba-Kistner Consulting
• Visits with SARA
  – Analytical Lab Tour
  – Field sampling on San Antonio River
Introduction to the River: Kayaking

- Only two students had been kayaking/canoeing previously
- Adjusted trip downstream to Mission Reach for high river flow
SARA Water Testing Laboratory

- Importance of QA/QC in water analysis
SARA Water Sampling Training
Demonstrating Flexibility – Soil Sampling

Planned Sample Grid

Actual Sample Grid
Plan was for an undeveloped, open site
Actual sampling at an active construction site
Opportunities for vertical sampling to >1m
Water Sampling Plan Development - September 2016
• Three locations selected
• San Pedro Creek above confluence
• San Antonio River above/below confluence
Field Analysis

- Soil
  - Portable XRF
- Water Analysis
  - Alkalinity
  - pH
  - Conductivity
  - Total dissolved solids
  - Temperature
  - Flow rate
“Since we did not follow our sampling grid, we had to logically think where we were going to take our samples from. This required that we think about the surroundings, soil type and location of the sampling area. I think this gave me the most real-world sampling experience.”

“This experience made me realize that flexibility and being on your toes is key in field work. I have heard Dr. Turner and guest speakers mentioned this multiple times but actually experiencing it has really made it sink in for me.”
“I did not expect the amount of communication we would need to have within our group to help out with the sample plan.”

“These processes have had an impact on my thinking for my career paths. I am beginning to develop an opinion against fieldwork in conditions that are not ideal. Conditions such as 100-degree weather and 75 percent humidity are not kind to those trying to take samples.”

“After my first field sampling, I am positive that I don’t want to collect soil samples for the rest of my life.”

“This first day of sampling has greatly impacted my thinking on my future career plans because I do see myself doing this for a living because I really enjoyed it.”
Where Are We Now?

• Third sample campaign February 2017
  – Partial exchange between Soil/Water groups
  – Joint soil prep

• Students are finalizing Standard Operating Procedures
  – Sample Prep
  – Analysis methodology (using modified EPA)
  – QA/QC

• Student-led Data interpretation, Write-Up through May 2017

• Summarize course outcomes Summer 2017
Acknowledgments

• This project is funded by the National Science Foundation-Improving Undergraduate STEM Education: Education and Human Resources (IUSE: EHR) Program (Award ID 1504503 to S. Oxley – Principal Investigator)

• The authors are grateful for the support of the San Antonio River Authority and the San Antonio River Foundation for allowing access to the site