

Pedagogy of Service Learning as Informal Science Education: Community
Engagement, Engineering, and Underrepresented Youth

Brett Tempest
College of Engineering
Department of Civil and Environmental Engineering

Lisa R. Merriweather
College of Education
Department of Educational Leadership

Abstract

Informal Science Education (ISE) holds great promise for not only teaching secondary students about science but also for motivating students, particularly underrepresented students, to consider a STEM related college major. Service learning, as a teaching innovation and a potential form of ISE, has been underexplored as a pedagogical strategy that can be used by both formal classroom teachers and other agents of science education in community-based organizations. This project will build on a pilot project - Bridge to Engineering - conducted in Fall, 2013. That program focused on exposing high school students to STEM careers through community service, but had very little emphasis on understanding or developing a pedagogy of ISE through service learning. Using participatory action research, this work will assess the viability of service learning as an ISE pedagogical strategy by exploring the perceptions of educators and students during the project. This critical component is the center of this SoTL project and will inform science education methods instructors and science educators on best practices for integrating service learning into science education. Increasing diversity throughout the Lee College of Engineering and the College of Education is an espoused priority for each. The College of Education further has a commitment to preparing educators for the 21st century which includes serving a diverse constituency. This project contributes to those priorities by focusing on underrepresented youth and pedagogical strategies that can better assist them in being prepared and motivated to enter post-secondary programs in engineering and other STEM related fields.

Budget Request and Narrative

**Budget Request for SOTL Grant
Year 2014-2015**

Joint Proposal?		Yes	
Title of Project			Pedagogy of Service Learning as Informal Science Education: Community Engagement, Engineering, and Underrepresented Youth
Duration of Project			12 Months
Primary Investigator(s)			Brett Tempest and Lisa Merriweather
Email Address(es)			brett.tempest@uncc.edu , lmerriwe@uncc.edu
UNC Charlotte SOTL Grants Previously Received (please names of project, PIs, and dates)			Lisa Merriweather 2011-2012 Othermothering: A Culturally Responsive Model of Doctoral Mentoring
Allocate operating budget to Department of			Civil and Environmental Engineering

		Year One
Account #	Award	January to June
Faculty Stipend	Transferred directly from Academic Affairs to Grantee on May 15	\$ -
911250	Graduate Student Salaries	
911300	Special Pay (Faculty on UNCC payroll other than Grantee)	
915000	Student Temporary Wages	
915900	Non-student Temporary Wages	
920000	Honorarium (Individual(s) not with UNCC)	

921150	Participant Stipends	
925000	Travel - Domestic	
926000	Travel - Foreign	
928000	Communication and/or Printing	
930000	Supplies	600
942000	Computing Equipment	
944000	Educational Equipment	
951000	Other Current Services	
GRAND TOTAL	\$ -	600

		Year Two
Account #	Award	July to June
Faculty Stipend	Transferred directly from Academic Affairs to Grantee on May 15	\$ -
911250	Graduate Student Salaries	4,000
911300	Special Pay (Faculty on UNCC payroll other than Grantee)	
915000	Student Temporary Wages	
915900	Non-student Temporary Wages	
920000	Honorarium (Individual(s) not with UNCC)	
921150	Participant Stipends	400
925000	Travel - Domestic	
926000	Travel - Foreign	
928000	Communication and/or Printing	200
930000	Supplies	200
942000	Computing Equipment	
944000	Educational Equipment	
951000	Other Current Services	
GRAND TOTAL	\$ -	4,800

Attachments:

1. Attach/provide a narrative that explains how the funds requested will be used.
2. Has funding for the project been requested from other sources? Yes No.
If yes, list sources.

The Levine Scholars will provide funding of \$1,000 towards construction materials for the project. A letter outlining this commitment is provided in Section III of this proposal.

Budget Justification Narrative

A total of \$5400 is requested. Graduate student stipend amounting to \$4,000 will support one student from the College of Education for 250 hours during the 2014-2015 academic year. The student will report to the project team and will coordinate the work of the science education graduate students, assist with the development of the science teacher questionnaire and interview protocols, and transcription and analysis of data. This student will also compile, format and publish the final Bridge to Engineering activity modules and lesson modules in an online format. Participant stipends in the form of \$20 gift cards will be used to encourage twenty high school and college Bridge to Engineering participants to attend the focus groups that will evaluate program success. \$200 for communications and printing is required to disseminate and archive the Bridge to Engineering materials. \$800 is budgeted for classroom supplies, including flip charts, markers, props and materials to build demonstration equipment.

Letters of Support



Charlotte Mecklenburg Police Activities League
1330 Spring Street
Charlotte, NC 28206

October 30, 2013

The University of North Carolina at Charlotte
9201 University City Boulevard
Charlotte, NC 28223

Scholarship of Teaching and Learning Grant Committee,

The Police Activities League (PAL) is impressed with the ongoing efforts of UNC Charlotte to promote diversity, access, and inclusion throughout the campus and local community. We are pleased to have the opportunity to partner with the University to help enrich the minds of our youth members through education, mentorship, and hands-on experience. Part of PAL's objective is to engage our high school age, underrepresented minorities in STEM activities and build their familiarity with post-secondary education opportunities. The 2013 Bridge to Engineering program was a great experience for PAL Youth who sought to complete community service with a connection to science and engineering.

The Police Activities League is a 501(c) 3 nonprofit organization that provides educational, programmatic, and structured support to nearly one thousand underrepresented minorities in the Charlotte-Mecklenburg communities between the ages of six (6) and seventeen (17). We strive in helping them improve their decision-making skills and preparing them for a successful future. Many of our enrichment programs focus on enhancing the quality of life for our children and allowing them to make a positive contribution to society. Our mission is to "provide opportunities for the youth of our community that fosters their leadership and citizenship skills through academics and athletics."

We look forward to partnering with UNC Charlotte again in 2014 and will support the program by recruiting program participants from our membership. We understand that UNC Charlotte will conduct an action research design that will be used to evaluate the project activity. We consent to students being surveyed and participating in a focus group at the beginning and end of the project to ascertain their perceptions and understanding of engineering as a career choice.

Implementing this project will not only increase students' knowledge of engineering design and building, but it will also introduce them to UNC Charlotte's culture and academic programs. PAL strongly encourages its students to explore universities of interest, and we believe that a project of this caliber would give our youth members a good sense of what UNC Charlotte has to offer them as undergraduate and graduate students in the future. We are excited about working with UNC Charlotte students and faculty to help raise diversity awareness and provide a beneficial learning experience for our local youth groups.

Sincerely,

Derrick D. Long

Derrick Long

Director Of Programs & Services



UNC CHARLOTTE
College of Education

Office of the Dean
9201 University City Blvd., Charlotte, NC 28223-0001
(704) 687-8722, www.uncc.edu

November 6, 2013

Dr. Lisa Merriweather
Department of Educational Leadership
College of Education
UNC Charlotte

Dear Dr. Merriweather,

I am pleased to write a letter of strong support for your proposed grant project connecting science, engineering, and children and parents. The need for more authentic experiences with STEM concepts for high school students is great, and there is great promise through informal science education methods. Your project promises to provide insight on these needed areas of STEM education.

Your project, which builds on a previous collaborative project with the College of Engineering through a Chancellor's Diversity grant fund, will focus on how to teach science (engineering) informally through service learning. I am delighted that you will work with the North Carolina Mathematics and Science Education Network and Police Activity League students, the Levine Scholars, as well as the science educators in the College of Education.

I am also impressed with your goals to assess science educators' perceptions of service learning as a viable informal science education method and the perception of underrepresented youth of engineering as a helping profession career choice.

Dr. Merriweather, I support this work and will help in any way I can.

Sincerely,



Ellen McIntyre
Dean
College of education





The University of North Carolina at Charlotte
9201 University City Boulevard
Charlotte, NC 28223-0001

Department of Educational Leadership
704/687-8730
FAX 704/687-3493

November 5, 2013

The University of North Carolina at Charlotte
9201 University City Boulevard
Charlotte, NC 28223

SOTL Grant Committee:

The purpose of this letter is to support Dr. Lisa Merriweather's Scholarship of Teaching and Learning grant proposal. African Americans and Latino/as are extremely underrepresented in engineering. Early exposure to the profession in ways that are meaningful and engaging may help to increase students' desire to enter this profession. Innovative programs with strong research assessment components are needed to further our understanding of how to better reach out to this population of youth. The collaboration of Drs. Merriweather and Tempest represents such an effort. The active engagement through service learning to help broaden students' understanding of engineering through hands on activities to cement their learning of related concepts to be headed by Dr. Tempest coupled with the rigorous assessment of the impact on the students led by Dr. Merriweather offer a refreshing approach to address the issue of underrepresentation.

Dr. Merriweather is uniquely qualified to develop and conduct research on a program geared toward reaching back into the community. She has a strong commitment to redressing inequities in the African American community and her service to the community has consistently involved working in such environs. Additionally she was the lead qualitative researcher for the assessment of two initiatives: Summer Diversity Institute completed in 2012 and the Quality Enhancement Plan in the College of Education completed in 2013. Her consistent invitations to serve as the qualitative methodologist for doctoral students from various departments in the College of Education also demonstrates her ability to develop and conduct research inquiry projects. She has the demonstrated passion and skill needed for this project to make a great contribution to the teaching and learning of science in secondary school.

Both Dr. Tempest and Dr. Merriweather have a sincere interest in adding to scholarship of teaching and learning that helps to bridge underrepresented students into STEM fields. Students need to be exposed to science in engaging ways and teacher educators need to be exposed to new ways of engaging students. This project promises to do both. It has my complete support and I fully endorse it.

James J. Bird

James J. Bird, PhD.
Interim Chair
Department of Educational Leadership

November 4, 2013

To whom it may concern,



Upon approval from the University of North Carolina at Charlotte's Facilities Management department, we will be building a produce garden on campus lead and created by a student organization. Our vision for this project is much more than a productive garden. The emphasis will be on community and sustainable education. Students and faculty will be attracted to the space because it is a cool, outdoor, place to hang out on campus, as the garden will have many public hammocks and picnic tables. Student engineers, architects, artists, and many others will use this space to display green projects that visitors can learn about while enjoying the peace of a garden environment.

We have spoken to Brett Tempest and his group, Engineers Without Borders, about recreating his solar powered irrigation system project (recently established at Garinger High School) at our garden once the garden is approved and established. Funding of up to \$1000 will be provided to Engineers Without Borders to create this project within the new UNCC produce garden/sustainability space. We look forward to working with Engineers Without Borders and creating a space in which sustainability projects such as this solar powered irrigation system can be put on display for the campus community.

Sincerely,

A handwritten signature in black ink that reads "Kevin Rodengen". The signature is fluid and cursive, with a long horizontal stroke at the end.

Kevin Rodengen
UNCC Garden Project Creator
Levine Scholar
Krodenge@uncc.edu



UNC CHARLOTTE

The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

9201 University City Boulevard

3252 EPIC

Charlotte, NC 28223-0001

Department of Civil and
Environmental Engineering

TEL: 704/687-1219

FAX: 704/687-0957

November 7, 2013

Dear Scholarship of Teaching and Learning Grant Committee:

I am pleased to learn that Dr. Brett Tempest, of my department, and Dr. Lisa Merriweather, of the College of Education, have teamed to prepare a proposal to the Scholarship of Teaching and Learning grant program. The pilot project, Bridge to Engineering, which was developed during 2013 with support from the Chancellor's Diversity Challenge Fund, was remarkably successful at exposing high school students to engineering practices and increasing their commitment to STEM study via a month-long service project. The positive impacts were not limited to the high school students who participated. The UNC Charlotte students also described gains to their own professional development and also a great sense of fulfillment for having participated. Dr. Tempest and Dr. Merriweather have determined that significant improvements can be made to the delivery of the program by applying the efforts they describe in their SoTL proposal.

Because of the project's intent to encourage interest in STEM fields, it will help in the College of Engineering's continuing objective to recruit capable students that are representative of the ethnic and economic diversity found in our region. It will also benefit the College of Engineering by providing new ways to engage our students in service learning, which had demonstrated academic advantages. Students will grow in their leadership abilities through the challenge of guiding the youth through the solution of engineering problems. By further developing the Bridge to Engineering curriculum with funds from SoTL, I believe that the program will become a prominent example of community engagement for the University will continue to help build the pool of strong applicants to attend engineering school at UNC Charlotte.

Thank you for considering this funding proposal and please do not hesitate to contact me if I can provide any additional information.

Sincerely,

A handwritten signature in blue ink, appearing to read "John L. Daniels".

Dr. John L. Daniels, P.E.
Interim Chair, Department of Civil and Environmental Engineering

Project Narrative

Overall Purpose

The purpose of this project is to advance understanding of how best to use the principles of informal science education through service learning in the teaching of science to increase the interest, knowledge and ability of underrepresented youth in STEM related fields, with a particular emphasis in engineering.

Specific Objectives

There are five key objectives of the research outlined in this proposal :

(1) To review the curriculum and develop improvements for the Bridge to Engineering program -

This proposed SoTL project is designed to improve the Bridge to Engineering (as described as “Pilot Work” on page 9) program by engaging graduate students majoring in science education who possess the pedagogical knowledge necessary to develop rich instruction. Specifically, these students would develop and revise the lesson plans used in the Bridge to Engineering program so that they are appropriate and engaging for high school students, formulate a design process that allows for greater creativity amongst the students and develop activities that can be co-facilitated with engineering students;

(2) To “beta test” developed modules for the Bridge to Engineering program - The science educators will “beta test” the modules by observing the engineering students as they deliver and/or co-facilitate the updated program with the engineering students during Fall 2014;

(3) To assess science educators’ perceptions of service learning as a viable informal science education method - The science educator graduate students will engage in reflective journaling

and participate in a focus group or an individual interview - This data will allow them to make any necessary adjustments to the program and provide data for evaluating the project;

(4) To assess the perception of underrepresented youth of engineering as a helping profession career choice - Youth will participate in a focus group interview;

(5) To disseminate the research findings - The completed modules, activities, notes and plans will be published online for future use by science educators as well as other enrichment programs with similar goals of engaging high school students in STEM service learning.

Specific Research Questions

(1) What are the primary elements of an informal science education program that uses service learning?

(2) How can science educators use service learning projects as a vehicle for informal science education to enrich learning in typical classrooms or in community-based science education programs (eg. Discovery Place)?

(3) What are the key considerations for encouraging teachers to adopt service learning as informal science education pedagogy?

(4) How do informal science education principles through service learning help to bridge underrepresented youth into engineering?

Rationale

Identification of Problem:

Underrepresented students need to be better motivated and better prepared to enter STEM-related majors in collegiate settings.

Relationship to Unit's Mission, Objectives and Priorities:

The William States Lee College of Engineering has a strong commitment to diversity and recognizes the value of outreach into the local community to develop talent of all people regardless of race, ethnicity, class, and gender. Recruiting talented individuals into engineering, especially from underrepresented groups, is a key priority. The College of Education shares this vision of reaching underrepresented populations and additionally seeks to prepare educators who understand the importance of developing such talent in schools and communities. The College of Education appreciates that innovative research around issues of pedagogy and practice better prepare educators to improve the outcomes of learners and develop individuals' talent, knowledge and potential. This proposed SoTL project connects directly to the priorities of both Colleges by focusing on underrepresented populations and improving praxis in high need subjects such as science.

Pilot Work:

During Fall 2013 the proposers of this project used funds from the Chancellor's Diversity Challenge to carry out a program that exposed high school students with aptitude in math and science to the career of engineering via a community service project. The title of the program was "Service Learning: A Bridge to Engineering for Underrepresented Minorities." Over the course of four weekends, the high school students designed and constructed a system that collects and stores rainwater from a roof and distributes it to a community garden using a solar powered pump. Students were taught about solar energy, rainwater collection and treatment, and pumping. This knowledge allowed them to engineer elements of the overall system in groups guided by UNCC engineering students. The project

had a strong and visible benefit to the community because the garden produces food for Charlotte's Meals on Wheels kitchen.

The design and construction activity was planned and facilitated by members of UNCC's Engineers Without Borders student organization. At the end of the project the students came to UNCC with their parents to present and celebrate their accomplishments. The celebration was followed by a tour of College of Engineering classrooms and laboratory facilities. The program was a great success and achieved the goals of the Diversity Challenge. Though the program was successful, it was clear that before repeating the Bridge to Engineering program, the curricular aspects of the program should be improved with input from experts in science education methods.

Impact of the Study on Undergraduate or Graduate Teaching and Learning:

The proposed study has impacts in three primary areas. The findings will make a scholarly contribution to the understanding of informal science education and the potential to use service as a structure for engaging learners. This provides a new tool for science education and may change how teachers approach teaching science. Secondly, UNCC science education students and engineering students benefit from the service learning experience. Service Learning has documented benefits to cementing fundamental disciplinary knowledge in students. Therefore, it will contribute to student learning and success for students on this campus. Finally, the enrichment and exposure that the program provides to high school students is a critical component of their progression to STEM programs in college. The experiences provided by Bridge to Engineering build self efficacy, provide knowledge of various disciplines and offer opportunities for mentoring from current

engineering students. This creates the longer-range benefit of increased diversity in the incoming student pool.

Extramural Funding

The proposers are developing a body of research that is related to how service learning can cast STEM majors as socially engaged for students who would value this quality in a career. Data from this program will help us seek additional external funding. The National Science Foundation's "Advancing Informal STEM Learning" (AISL) program is our preferred destination for a proposal in this field. The November 14, 2014 for full proposals will allow us time to incorporate some results from this study into a proposal.

Literature Review

Conceptual Framework:

Social cognitive career theory posits that one's measure of self-efficacy, expectation of outcomes and representation of goals are factors which guide career selection (Lent et al. 1994). A student planning a career has outcome expectations that are established through a variety of personal observations as well as social interactions with peers, parents, teachers, guidance counselors, and others (Alika 2012, Schmidt et al. 2012). Therefore, students' knowledge and mental schema of engineering constitute critical information towards their decision to study it. Many students develop strong preconceived notions and biases towards engineering professions with little accurate input. For instance, Knight and Cunningham's study (2004) of 3rd-12th graders found a strong tendency to conceive engineers as male, and to describe only the technical aspects of the profession.

Knowledge of Issue:

Increasing the appeal of STEM related vocations to chronically underrepresented groups - females, African Americans, and Hispanics - is a major priority for those involved in STEM education. STEM majors and careers are sharply differentiated across gender and racial boundaries. Further, many students, especially female students, who begin high school with aspirations to enter a STEM field, abandon the idea by graduation time (Sadler et al. 2012). Given that most future scientists develop their interest in their future profession while in high school (Olson 2009), exposing students who are underrepresented in STEM fields to those vocations is a critical component to boosting their representation with those academic areas. Several researchers discovered that community engagement during college and post-college is a strong priority expressed by many underrepresented student groups (Espinosa 2011, Dika and Lim 2012). The Higher Education Research Institute publishes an annual snapshot of entering freshman classes, which together provide a 40 year history of demographics and student attitudes. Interestingly, amongst all student groups there has been a resurgence of altruistic values (Pryor et al. 2006, Pryor et al. 2011). However, the same literature shows an even stronger affinity by students attending historically black colleges and universities. This suggests that underrepresented minorities may opt to choose career options with perceived high community engagement. Because engineering is perceived as a vocation with low community engagement, it may be selected less often.

Novelty of Proposed Project:

Informal science education (ISE) is a means by which people learn about science in settings that are structured and planned, but are outside of a formal classroom environment. Zoos and museums are two well-known spaces that encourage ISE by stimulating curiosity and

providing information to visitors. ISE was shown by Fadigan and Hammrich (2004) to have had a significant impact on career choice in 152 women who had been involved in an ISE enrichment program. Informal activities also allow students to build self-efficacy in science and math by building confidence in their ability to understand science, and allowing them to more comfortably step into the role of explainers (Gottfried 1980, Dorsen et al 2006).

Linking engineering with community engagement through service may result in underrepresented students being more motivated to enter engineering as a career. Although, enriching the pre-college experience of students with science and engineering activities has been shown to promote interest and awareness in STEM majors (Lawrence and Mancuso 2012) and service learning has been used in high schools with similar goals for exposing students to science (Wyss et al. 2012), little research has considered the application of service learning to introduce the service-oriented dimension possible in engineering careers. ISE experiences based in service learning have not been thoroughly explored using systematic inquiry. Further exploration of service learning within this context represents not only a novel method to activate the interests of students who have aptitude for math and science and a desire to enter professions which have a stronger perceived connection to societal amelioration but also represents an innovative research inquiry project. Understanding how science educators across various environs such as schooling and community-based science education settings can engage service learning as a strategy to boost interest and understanding in STEM related fields, particularly among underrepresented populations can be an integral component to stemming the tide of the loss of talent from engineering to other fields of practice.

Methods

This research follows a participatory action research (PAR) methodology. Brydon-Miller, Kral, Maguire, Noffke, and Sabhlok (2013) describe PAR as reflection on action followed by revision. This project recognizes the power of action and reflection in the development of community based initiatives and that all involved in research have expert knowledge which can be harnessed for further knowledge development.

The “action” part of the project involves conducting a community-based service learning project aimed at underrepresented youth. Science educator graduate students and engineering students will work collaboratively to develop a series of lesson modules that can be used to teach engineering concepts to the youth to aid in the construction of a community garden. The engineering students will bring the content knowledge and the science educator students will bring the pedagogical knowledge and strategies that will increase the probability of the knowledge transfer to the youth participating in the program. Together they will facilitate the service learning activities and based on reflective practice will make modifications as needed to the learning modules.

The systematic inquiry will involve the science educator students writing reflective journals throughout the experience, and participating in either a focus group or individual interview at the conclusion of the service learning activity. The interviews will seek to capture perceptions of service learning as pedagogy, the benefits and drawbacks of service learning as a tool in formal science education courses, and the potential for luring underrepresented youth into STEM related fields through community engaged science/engineering related projects. The youth who participate in the service learning project will also be invited to take part in a focus group to share their perceptions of engineering and the value of the program to

them. To gather baseline data a questionnaire will be distributed to science educators to find out how they teach science, and why they teach science in the way that they do. These reflections along with interviews at the close of the service learning project, and a focus group interview with the youth will inform the findings. Findings will be developed using a coding approach to develop relevant themes.

Evaluation

Participatory Action Research will also serve as the conduit for evaluating the program. The reflective journal will inform the formative portion of the evaluation and will occur throughout the planning and implementation portions of the service learning project. The reflections will provide information that may be used to make modifications to the service learning project while the project is ongoing. The interviews with both the science educator participants and the youth participants will serve as the summative evaluation of the project.

Through these formative and summative evaluations, we will be able to determine if the outcomes met our intended objectives of the project and provide a qualitative descriptive analysis of how. The reflections will help to guide the review and implementation of the modified curriculum materials. The analysis process will provide a mechanism for assessing the perceptions of the science educators and the youth. The reflections and analysis of the interviews will contribute to the development of the website. The data collection efforts will provide the necessary data needed to inform our overall goal of how best to use service learning as a type of informal science education. Additionally through these methods we will be able to assess the saliency of using service learning as a pedagogical strategy to increase interest in STEM subjects within underrepresented populations.

Knowledge Dissemination

Products originating from this work include practical educational materials as well as scholarly research. The practical materials, including program description, lesson plans, activity designs and guidance for replicating the Bridge to Engineering project, will be posted online for educators and community organizations to use. The scholarly output and research results will be shared across a number of venues including the forum provided the Center for Teaching and Learning, conferences and educator's forums. Additionally publication opportunities in journals and books will be sought. The Journal of Engineering Education, and the International Journal of Science Education are two potential, peer reviewed outlets for publishing work.

Human Subjects

Human subjects are involved in the data collection activities. Upon successful completion of the SOTL grant funding process, an IRB protocol will be developed and submitted. After approval, the data collection phase of the project will begin.

Timeline

The project will begin in June 2014 (month 1) and proceed until May 2015 (month 12).

Task	1	2	3	4	5	6	7	8	9	10	11	12
Submit IRB Protocol	x											
Recruit science educator students to select this project as their clinical experience			x									
Begin collaborations with representatives from MSEN, College of Education Science Education Instructors, PAL, and Levine Scholars program		x										
Review materials produced during Bridge to Engineering 2013	x	x	x									
Revamp 2013 materials and develop new activities				x	x	x						
Observe delivery of new activity modules					x	x						
Revise activities based on observations					x	x	x					
Collect data for formative and summary evaluations and analyze data			x	x	x	x	x	x	x	x		
Publish project description and activity modules online								x	x	x	x	x
Prepare scholarly publications related to project findings										x	x	x

References

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