

Broader Impacts 101: Evaluating the Impact of a
Graduate-level Course in Science Communication and Outreach

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and

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Abstract

Graduate coursework in the sciences offers little formal training in communication and outreach. While funding agencies, including the National Science Foundation (NSF), require grant proposals to address the broader impacts of research, novice scientists have few opportunities to create and engage in activities that convey research findings to the public. Many scientists employ a deficit model when communicating with the public, an approach that fails to effectively engage the citizens in critical dialogue regarding 21st century challenges including climate change and health disparities. We seek funding to develop, teach and assess a course that will explicitly address a gap in graduate student training at the University of North Carolina at Charlotte. The proposed research utilizes a mixed methods approach to evaluate the effects of a graduate level course, Broader Impacts 101: Engaging the Public through Communication and Outreach, on science communication and outreach self-efficacy. The proposed course will provide context, information, and experiences that will challenge students to develop ideas for Broader Impacts initiatives and communicate their research to non-science audiences. Attitudes of participants toward the role of research scientists in the development of public science literacy will be evaluated. Positive impacts, including a paradigm shift regarding effective communication methods and increased engagement of student researchers from underrepresented groups, are predicted which will result in both short and long term benefits for novice scientists, the university and the public.

Budget Request for SOTL Grant Year 2017-2018

Joint Proposal? Yes x No

Title of Project Broader Impacts 101: Evaluating the Impact of a
Graduate-level Course in Science Communication and Outreach

Duration of Project May 15, 2017 – June 14, 2018

Primary Investigator(s) Dr. Adam Reitzel; Lenora Crabtree

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UNC Charlotte SOTL
Grants Previously
Received (please names
of project, PIs, and dates) None

Allocate operating budget to Department of Biological Sciences

Account #	Award	Year One January to June
Faculty Stipend	Transferred directly from Academic Affairs to Grantee on May 15	\$ -
911250	Graduate Student Salaries	\$1200.00
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	
942000	Computing Equipment	
944000	Educational Equipment	
951000	Other Current Services	
GRAND TOTAL		\$ 1200.00

Account #	Award	Year Two July to June
Faculty Stipend	Transferred directly from Academic Affairs to Grantee on May 15	\$3850.00
911250	Graduate Student Salaries	\$3600.00
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)	\$600.00
921150	Participant Stipends	\$606.60
925000	Travel - Domestic	\$1516.00
926000	Travel - Foreign	
928000	Communication and/or Printing	
930000	Supplies	
942000	Computing Equipment	
944000	Educational Equipment	
951000	Other Current Services	
GRAND TOTAL		\$10,172.60

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.

Budget Narrative

Graduate Student Salary (\$4,800)

Lenora Crabtree will develop and co-lead the design, execution, and assessment of this project. Ms. Crabtree completed a Masters degree in Biology at UNCC in May of 2016. Her capstone project, "Changing the Lens: Broadening Participation in Life Science Education and Research Through Culturally Responsive Pedagogy," explored diversifying the STEM workforce by improving engagement and retention of students from groups traditionally underrepresented in STEM. She is continuing that research in the College of Education Department of Curriculum and Instruction as she pursues a PhD with an Urban Education focus. Ms. Crabtree earned a bachelor's degree in Molecular Biology at Vanderbilt University. Her interest in STEM education along the K20 spectrum reflects sixteen years as a high school science educator as well as experiences in graduate education and STEM research. As a graduate assistant (GA), Ms. Crabtree will work with Dr. Reitzel for all of Summer 2017 (Budget Year 1: May 15 – June 15, 2017; Budget Year 2: June 16 – August 15, 2017) that will include 20 hours/week for 12 weeks at a pay of \$15/hour. Most of this time will be invested in the development of curriculum, design of assessments, and pre-course preparation. We additionally request 4 weeks of pay at the same rate for May 15 – June 14, 2018 in Budget Year 2 to complete assessments and reporting. Together, we request \$4800 for approximately 320 hours of GA support. Any remaining hours per week during the course of this project will be used to prepare manuscripts and conference presentations.

Faculty Stipend (\$3,850)

Dr. Reitzel will be in the Instructor of Record and will co-lead the design, execution, and assessment of this project. Dr. Reitzel requests a faculty stipend for the Second Summer Session of 2017. During this time, Dr. Reitzel and Ms. Crabtree will focus on final preparations for the course and completion of all materials for the offering of the course in Fall 2017.

Participant Costs (\$606.60)

Funds are requested for up to 18 course participants and UNC Charlotte faculty and staff to participate in a focus group discussion related to their experiences in this course. Participation will be incentivized by the provision of a meal (per diem dinner at \$18.70) and a \$15.00 gift card.

Travel (\$1,516)

Funds are requested to support the travel of Ms. Crabtree and Dr. Reitzel to the annual meeting of the National Alliance for Broader Impacts in 2018. This three-day conference is the premier professional conference for educators, researchers, and students to discuss approaches and share insights from activities aimed to broaden the impact of STEM disciplines in the development of effective, engaging curriculum and community engagement. Attending this conference will serve as the principal off-campus component for Phase IV of this project, Dissemination of Findings. Funds requested include airfare (\$400 each; \$800 total), per diem food (6 days total at \$39.81 per day; total \$239), and lodging (6 nights at per diem rate of \$79.50; total \$477).

Honorariums for invited speakers (\$600)

Funds are requested for 3 honorariums (\$200 each) for outside experts to present material and lead discussions for classes in teaching and communicating science. We will prioritize invited speakers in three areas: Master teacher in science at the high school level, media relations and broadcasting, and web site presentation and strategies for conveying science on the internet. These speakers will complement our use of teachers and staff on campus.



Office of the Associate Provost
For Graduate Programs and Dean of the Graduate School

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October 29, 2016

Scholarship of Teaching and Learning
Grant Review Committee
UNC Charlotte

Dear Review Committee,

This letter is in support of a proposal submitted by Dr. Adam Reitzel and Ms. Lenora Crabtree entitled *Broader Impacts 101: Evaluating the impact of a Graduate-level Course in Science Communication and Outreach*. As the Dean of the Graduate School I have a keen interest in providing professional development opportunities for our graduate students. While the University's first priority is to provide sound academic programs and the intellectual framework in which they will be meaningful, it is also our responsibility to provide opportunities to develop a diverse and cohesive graduate community. As outlined in the Graduate School's strategic plan we believe that the most effective graduate training for the future will prepare students to collaborate effectively across disciplines, adapt quickly to changing conditions, work well in teams, communicate effectively at all levels, and work effectively with people whose language and culture are different from their own.

I believe the course proposed by Dr. Reitzel and Ms. Crabtree when developed will help achieve University graduate education goals including attracting and retaining outstanding graduate students, promoting our mission as North Carolina's Public Research University to the community outside the University, and supporting the continued development of graduate programs of the highest quality.

In order to allow graduate students to take full advantage of opportunities to use their expertise to make a meaningful and lasting difference in their discipline, the community, and the world, the University must expand opportunities for graduate student professional development. This proposed course will help support curricula to teach graduate students communication skills required as professionals and to broaden the impact of the research conducted at UNC Charlotte. It has my full and unconditional support.

Sincerely,

Tom Reynolds, PhD
Dean

Broader Impacts 101: Evaluating the Impact of a
Graduate-level Course in Science Communication and Outreach

Specific Aims

The purpose of this proposal is to develop and assess a graduate-level course that will integrate training in communication and outreach for graduate students in the sciences at the University of North Carolina at Charlotte.

Objectives:

1. Develop a course for STEM graduate students using an active learning approach to improve science communication and outreach skills.
2. The course will:
 - a. Introduce graduate students to the history, necessity and at times controversial role of “Broader Impacts” initiatives aligned with science research.
 - b. Explore the various methods scientists use to communicate research findings to the broader public and utilize diverse tools to share current student research.
 - c. Examine the intersection between science and social issues including the underrepresentation of specific groups in STEM fields.
 - d. Engage in collaborative outreach with science educators in order to develop a deeper understanding of the connections between university-based scientific research and the K12 education continuum.
3. Assess projected course outcomes including graduate student self-efficacy in the areas of communication, collaboration and outreach.

4. Conduct pre- and post-course assessments to gauge the degree to which the course impacts self-efficacy among participants and influences attitudes toward the role research scientists play in improving public science literacy and education.

Research Questions:

1. Does a semester course focused on Broader Impacts result in an improvement in graduate students' self-perceptions as effective communicators of scientific information?
2. Does developing and participating in educational outreach activities increase the perception by graduate students that their research is important to society?
3. Does participation in a course related to the Broader Impacts of research increase the probability that a student researcher will apply for and receive extramural funding?
4. Does engaging with the community through a course related to the Broader Impacts of science increase a graduate student's interest in improving public science literacy?
5. Does participation in a course related to the Broader Impacts of Science have an impact on student engagement and interest in research for persons who are members of groups traditionally underrepresented in science?

Project Rationale

Multiple funding agencies, including the National Science Foundation, require research proposals to describe specific Broader Impacts aims. These activities are evaluated with equal weight to the proposed research and are expected to be innovative and transformative. Thus a successful proposal requires an engaging broader impacts plan that includes specific plans to communicate research findings to the public in order to increase funding success. Over the past

two years, Dr. Reitzel has required students in his graduate level courses to write a mock NSF grant proposal. Graduate students identify the Broader Impacts section as the most difficult portion of the assignment for a variety of reasons. Statements including "My research does not have any broader impacts," "I don't know what I can do," and "I have no training or experience related to these types of activities" are frequently heard as students discuss the assignment. Because Broader Impacts are essential to a successful grant proposal, students inexperienced in writing these components are not likely to be competitive when applying for funding. These comments also underlie a deeper issue. Graduate students in the STEM disciplines often demonstrate a lack of ability to communicate their research with persons outside of their specific area of focus which is typically quite narrow. Effective communication with the broader public is critical in a democracy in which the electorate plays a critical role regarding how challenges intricately connected to research are addressed by society. We seek funding to develop, teach and assess a course that will explicitly address this gap in graduate student training at the University of North Carolina at Charlotte. The proposed course will provide context, information, and experiences that will challenge students to develop ideas for Broader Impacts initiatives and communicate their research to non-science audiences. The class size for this pilot course will be limited to 15-18 students in order to facilitate meaningful interaction among students in diverse STEM related fields. Outreach conducted by participants will engage over 450 K12 students and 15 teachers in activities directly related to ongoing science research at UNCC.

Literature Review

Critical Gaps in Graduate Level Science Education

While science graduate students receive extensive training in laboratory research, limited opportunities to conduct outreach and speak to non-scientist audiences leaves them underprepared to share their research findings with the public (Heath et al. 2014, Kuehne et al. 2014). Addressing twenty first century challenges including climate change, public health and sustainability of resources necessitates adequate scientific research funding support and an educated and scientifically literate society (Komoroske et al. 2015). Funding for research from federal agencies including the National Science Foundation (NSF) and National Institutes of Health (NIH) will only be sustained with the support of an electorate that values science inquiry (Heath et al. 2014).

Deficit Model Thinking Dominates Science Communication

Science communication experts theorize that a significant impediment to effective interaction between scientists and the public is deficit-model thinking. A deficit approach is based on the perception that the public is composed of similar, uninformed and uninterested persons whose blank slate of knowledge simply requires filling by an all-knowing scientist (Varner, 2014). Utilization of a deficit model creates multiple obstacles to effective communication between academic research scientists and others in the community (Webb et al. 2012). Providing training to graduate students encourages scientists-in-training to identify potential misconceptions and evaluate their attitudes and abilities in the areas of communication and outreach.

Educating Future Scientists in Effective Outreach and Communication

Following a quantitative analysis of the abstracts of 360 funded NSF proposals, Kamenetsky (2013) proposed that one way to address the lack of knowledge regarding communicating science is to provide training to graduate students regarding outreach. A small

number of institutions have developed courses for graduate students and published the results of these endeavors. A cross-disciplinary team of life scientists at the University of Illinois created a graduate course on the broader impacts of science research, “Amplify the Signal”, and utilized quantitative methods to analyze the impact of the course. Survey results indicated that engagement in authentic outreach improved student ability in writing for the non-science public and implementing creative informal science outreach (Heath et al. 2014). Brian MacFadden (2009), a paleontologist at the University of Florida, created and taught a course for graduate students in the life sciences entitled “Broader Impacts of Natural Sciences on Society.” Analysis of post-course quantitative and qualitative data revealed that scientists-in-training were more likely to perceive the benefits to society of broader impact initiatives and the practical benefit of increased funding (MacFadden 2009).

Broadening Participation in STEM through an Emphasis on Broader Impacts

The persistent lack of diversity in the science, technology, engineering and math (STEM) workforce is a significant societal issue. Recent studies suggest that students from underrepresented groups are highly motivated by altruistic values and more likely to leave science if they do not see the work as benefitting their communities. Thoman et al. (2015) studied participants in an undergraduate research program and concluded that “students from cultural backgrounds that traditionally place high value on helping others through work can be retained in science when their research experience embraces this cultural strength (Thoman et al. 2015).” Using a national data set including information from over 5,000 undergraduate students, researchers found that “underrepresented minority students often leave the sciences due to the perceived lack of social value or relevance to improving conditions for their communities” (Hurtado et al. 2010). Current research indicates that students from groups traditionally

underrepresented in science may be more motivated when mentoring emphasizes the societal impact of science. Researchers from Brown, Tufts and Harvard conducted focus groups with graduate students from diverse backgrounds. Following a two-day retreat, the trainees developed eight action points including, “Adapt STEM training to include or make room for a social justice component” (Campbell et al. 2014). Emphasizing the broader impacts of scientific research through a course involving students in education and outreach may engage and retain young researchers from groups underrepresented in science and ultimately increase diversity in the STEM workforce.

Methodology and Expected Findings

This project will be co-led by Dr. Adam Reitzel, an Assistant Professor in the Department of Biological Sciences and Lenora Crabtree, a PhD student in the College of Education. The co-PIs for this project developed a shared interest in bridging graduate training and Broader Impacts through Ms. Crabtree’s graduate studies, participation in an NSF-funded Research Experience for Teachers and discussions with graduate students in the Department of Biological Sciences and other STEM programs. To address the need for training of STEM graduate students in communication and outreach, we will develop and evaluate the effectiveness of a course for graduate students in the sciences. Students will explore relevant topics through class discussions, primary literature, interactions with guest speakers, presentations, and service learning. A mixed methods approach will be used to evaluate the effectiveness of the proposed course in achieving stated objectives. Quantitative data will be obtained from student and mentor surveys while post-course focus group discussions and instructor notes will provide qualitative data. The study will consist of four phases.

Phase I - Student Enrollment and Pre-course Survey

In order to publicize the course to graduate students, information will be sent to coordinators for graduate programs in STEM as well graduate student discipline specific groups. Electronic bulletin boards will announce the course. In addition, short promotional talks regarding the course will be given in required classes for graduate students.

Ten days before the initiation of the course, enrolled students will receive a survey via email. Answers to survey questions will be maintained in an anonymous database. The survey will consist of Likert-type items assessing student self-efficacy related to communication and outreach. Questions will also address student attitudes regarding the role of scientists in community outreach and education.

Phase II – The Course

The course will take place over a sixteen-week semester and will be divided into three units. Students will explore topics through class discussions, reading primary literature and interactions with guest speakers. The focus of the first unit will be Science and the Public. Guest Speakers will include an NSF review panel member and Science Communication consultant. The second unit of the course will address the opportunities scientists have to communicate research and new discoveries to the public via broadcast media, mainstream publications and the Internet. Speakers will include a local radio personality and a web design specialist. During this portion of the course, students will design their own TED Talk-style presentations and prepare an article for a non-discipline specific publication. Opportunities for research scientists to work alongside K12 educators will be the focus of the final unit of the course. A guest speaker from the Urban Education Collaborative will address the challenge of urban science education. Discussion topics will include the importance of inquiry based learning in today's classroom and the challenge of

diversifying the STEM workforce. Students will research science standards for a specific grade level, observe an experienced teacher, and conduct activities related to their research in a K12 classroom.

Phase III – Follow Up Surveys and Focus Group Discussions

Phase III, which begins at the end of the course, will involve a second administration of the student survey, a survey of faculty mentors, and focus group discussions. Faculty mentors will receive surveys to assess their perception of the course and its impact on their mentees' attitudes toward broader impact activities. Course participants will be invited to a focus group discussion incentivized by the provision of a meal and a \$15.00 gift card. Open-ended questions regarding the impact of the course on student attitudes toward interacting with the public will allow students to share information that might not have been gleaned from the online surveys.

Phase IV – Analysis of Data and Dissemination of Results

Qualitative data gleaned from mentor surveys and focus group discussions will be compared with student survey results, allowing for a triangulation of data. The course instructors will maintain notes regarding student discussions and presentations throughout the course that will provide additional qualitative data for analysis.

The proposed course is anticipated to have a positive impact on student attitudes toward the role of research scientists in improving science literacy and education. In addition to a paradigm shift related to the importance of communicating science to the broader public, we anticipate additional long-term benefits regarding improved preparation of graduate students for academic careers. Institutions of higher education require scientists to assume teaching duties and participate in service and community engagement in addition to conducting research. Broader Impacts 101: Engaging the Public through Communication and Outreach will

complement an existing course, Teaching at the University Level (GRAD 6001/8001). By providing students with specific training related to the broader impacts of science, we seek to facilitate the development of scientists and educators who are committed to the university's role as an urban research institution serving the greater Charlotte community.

Knowledge Dissemination

Results from this SoTL-funded graduate course will be disseminated through three primary avenues. First, the co-PIs will present this research at two conferences: at the UNC Charlotte's Teaching Week as well as at the annual conference for the National Alliance of Broader Impacts (NABI) as an oral presentation. NABI is the premier organization for the development and implementation of Broader Impacts initiatives in public and private institutions, with a focus on colleges and universities. Second, the co-PIs will publish the design of the course and the results from the assessments as a peer-reviewed publication in an education-focused journal, such as *Bioscience* or NSTA's *The Science Teacher*. Third, results of this project will be disseminated by the students participating the course. We anticipate that students that complete this course will return to their respective departments and share the information and strategies among their peers. Our goal would be that the material and strategies will then be adopted by other students via this peer-to-peer exchange.

IRB Approval

Prior to the study, Institutional Review Board approval will be obtained. When IRB approval is given, enrolled students will receive a cover letter establishing informed consent. Student privacy, confidentiality and anonymity will be protected throughout the study

and student participation in surveys and the focus group will not be used for grading or course evaluation purposes.

Timeline

Date	Project Tasks
First Summer Session 2017	<ul style="list-style-type: none"> ● Prior to First Summer Session, PIs develop short informational sessions and deliver materials electronically describing course targeting graduate students in STEM disciplines ● PIs develop detailed syllabus and prepare course materials ● PIs communicate with guest speakers and community partners
Second Summer Session 2017	<ul style="list-style-type: none"> ● PIs research, develop, complete and administer pre-course survey to enrolled students ● PIs complete course materials
Fall Semester 2017	<ul style="list-style-type: none"> ● Course offered throughout semester ● PIs maintain notes describing student comments, presentations and informal feedback during course
End Fall 2017 - Spring 2018	<ul style="list-style-type: none"> ● PIs distribute and collect post-course survey for students and faculty mentors ● PIs conduct focus groups and post-course interviews ● PIs begin analysis of surveys and interviews ● PIs attend and present findings at annual National Alliance of Broader Impacts National Conference (April)
Spring 2018 – First Summer Session 2018	<ul style="list-style-type: none"> ● Completion of data analysis and dissemination of results through publication(s) ● PIs assess course and offer amended course Fall 2018

Word Count: 2362

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