ACS final report form

- Complete this form in no more than five pages.
- Attach your final financial report in a separate document.
- Note that portions or the entirety of your final report may be reprinted on the ACS grants webpage.

Name of project lead: Shanina Sanders Johnson
Campus: Spelman College
Project title: Increasing Diversity in the STEM Pipeline through the Incorporation of Culturally and Socially Responsive Pedagogy in the Organic Chemistry Laboratory
Today's date: 12-19-2018

I. Project summary

Briefly describe the purpose, intended goals, and major activities of your project.

Organic chemistry has a reputation as a challenging course due to its abstract nature. The laboratory component of this course is often seen as a way to demonstrate organic concepts in a concrete manner. However, the labs often suffer from a prescriptive format that does not allow students to engage with the science, particularly students from underrepresented groups, as course materials are often constructed from a majority narrative. As we seek to increase diversity and inclusion in the nation's future science, technology, engineering, and math (STEM) workforce, a transition to curriculums that incorporate diverse perspectives and are relevant to a range of individuals is desirable. This project provides a strategy to allow students from different backgrounds to connect with science on a personal level. This will allow students to feel included in science and aid in their development as scientists. Thus, this model presents instructional strategies for technical training that will be useful in STEM-based disciplines and is relevant for all academic institutions who desire to acknowledge and encourage the role underrepresented groups play in our nation's future STEM sustainability. In this regard, the major goals for this project were to:

1. Build the capacity of Associated Colleges of the South (ACS) institutions to develop STEM curriculum that is culturally relevant and socially responsible.
2. Create and pilot organic lab experiments that include culturally and socially relevant themes and reflect active learning strategies.
3. Establish a virtual presence for ongoing collaboration and for the peer review and dissemination of novel lab activities.
4. Create assessment criteria for current and future lab experiments and activities.

Goal 1: Build the capacity of ACS institutions to develop STEM curriculum that is culturally relevant and socially responsible through a workshop.
The major activity for goal 1 was a summer workshop for organic faculty from ACS institutions. This workshop was planned as the catalytic activity for establishing a community of practice (CoP) among the institutions and envisioning a new organic lab curriculum that would speak to our goals. The CoP would serve as a platform for professional development and collaboration by providing a space for continued support as the group shares best practices, innovative pedagogies, and expertise in teaching and learning. It is envisioned that the proposed collaborative effort will allow faculty to reflect upon their current teaching styles and find areas where culture and social responsibility can be introduced into courses to benefit a diverse student body. Further, the training would allow participants to become advocates of culturally and socially relevant teaching at their home institutions.

Goal 2: Create and pilot organic lab experiments that include culturally and socially relevant themes and pedagogy and reflect active learning strategies.
Teams of faculty at Centre College, Spelman College, and Southwestern University committed to modifying and implementing a current lab experiment with culturally relevant teaching and instruction during the fall of 2018. Those lab activities were discussed and analyzed at the workshop during and after the training sessions by the CoP.

Goal 3: Establish a virtual presence for ongoing collaboration and for the peer review and dissemination of novel lab activities.
Products of the project would be reviewed for inclusion in the OrganicERs and STEM Central websites upon completion. Organic faculty from ACS institutions and beyond can join these groups and access the materials as well as interact with other faculty in conversations related to course innovation and reform. The sites also provide an ideal platform for identifying collaborations. Such resources will be beneficial to those at ACS institutions engaging in activities related to teaching and learning. These varied interactions will extend our community of scholars by providing an additional layer of support, assessment, and opportunities for dissemination.

Goal 4: Create assessment criteria for current and future lab experiments and activities.
A common assessment rubric will be developed by the end of the workshop to assess the quality of culturally relevant teaching materials. This rubric will also serve as a template to develop new activities that meet the criteria established by the group.

II. Attainment of goals

Explain the steps you took to achieve and evaluate the success of *each* project goal. Provide details regarding the tools and methods used to measure each goal and the extent to which, based on those measurements, each goal was met.

Goal 1: Build the capacity of ACS institutions to develop STEM curriculum that is culturally and socially responsive through a workshop and webinars.
Invites were extended to organic faculty at all ACS institutions for the proposed summer workshop. The workshop was held on June 19–22, 2018 at Spelman College and brought organic chemistry faculty from seven of the ACS institutions together. Highlights from the workshop included an opening dinner keynote from Dr. Kimberly Jackson about culturally relevant activities in her biochemistry courses. This session was designed to allow the attendees to think outside the box in terms of the design of an organic lecture or lab. Day 2 began with an introduction and dive into culturally relevant teaching by Dr. Charlease Kelly-Jackson, which was followed by a discussion on assessment and evaluation from Dr. Mary Atwater. The social

responsibility aspect was woven into the discussion on day 3 of the workshop as Dr. Aditi Pai introduced case studies as a tool to engage students in STEM courses. The workshop served as a great tool to develop relationships between the faculty and discuss the challenges and resources needed to create atypical organic laboratories. The sessions provided valuable information that was used to guide the group in analyzing the three pilot labs and suggesting ways that cultural and social elements could be used to guide the instructional materials and components of the experiments to engage students.

Goal 2: Create and pilot organic lab experiments that include culturally and socially relevant themes and pedagogy and reflect active learning strategies.

The ideas and experimental plans from the workshop were revised for implementation at the three lead institutions. The CoP identified several elements of culture that could be included in the organic lab curriculum including, gender, language, ethnicity, place, ability, sexual identity, religion, and social class. A synopsis of the revised experiments is below.

Spelman College- Two modules were developed and implemented at Spelman to accompany the synthesis of aspirin experiment and a thin layer chromatography (TLC) of over the counter pain relievers experiment. Both of these experiments involved inquiry and reflected active learning in the laboratory so the cultural and social aspects were the primary focus in assignments we called, Beyond the Experiment. The 1st assignment asked students to interview a friend or family member who uses alternative pain relievers and determine their rationale for selecting the remedy. The student then researched the medicinal properties (i.e., source and mode of action) of the alternative medicine. The assignment allowed the instructor and the students to learn about each other and create community in the classroom while also validating the student's frame of reference regarding alternative medicine. Holistic medicine is a vital part of African American communities that offers a gateway into the practice of medicine and the components of drugs, which is key to organic chemists. The 2nd Beyond the Experiment assignment delved into history. It allowed students to search the literature and evaluate the person who discovered aspirin. Contrary to what is given in their textbook, Felix Hoffmann is not believed to be the inventor of aspirin. This module allowed students to evaluate the role of religion and politics in chemistry in terms of how scientific accomplishments and contributions are recognized. The students then read an article about female researchers that did not get credit for their scientific contributions and reflected on this topic in current times. The cultural elements of ethnicity, gender, place, religion, and social class were reflected in these assignments as well as social issues.

Southwestern- Two modules were also developed at Southwestern in the organic chemistry I lab. One experiment, called "The Sweeter Side of Organic Chemistry," was revised to include cultural and social aspects of the history and production of sugars. Students were asked to reflect on a reading assignment from the book *Napoleon's Buttons: How 17 Molecules Changed History*. Students were then required to give a presentation on a cultural issue related to sugar of their choice and discuss the role that sugar played in a historical context or a modern day problem. Topics included "Stevia and the Rights of Indigenous Peoples," "The Disparate Risk of Diabetes on Racial Minorities," and "The Sugary Drinks Portion Cap Rule." In the second experiment, "A Tale of Two Metabolites," students were asked to devise a method of separating urea and cholesterol. The inquiry-based activity is supported by assignments that delve into the history of urea and cholesterol that include political, social, and cultural aspects.

Centre- The selected experiment at Centre College is from the organic II laboratory. It is a multi-week synthesis of chalcones. In the revised lab, students will read an assigned newspaper article describing how Tu Youyou's, a Nobel-prize winning female chemist, research was developed from an ancient Chinese folk remedy. They will also read "Chalcone: A Privileged Structure in Medicinal Chemistry," a 2017 article from *Chemical Reviews* that provides a wealth of information about chalcones, their natural sources, and their medicinal effects. Students will search the literature about herbs from different folk medicine traditions, integrating the

information from their individual literature searches with the *Chemical Reviews* article and using it to compose the introductory sections for the papers they write about the chalcone synthesis they have carried out. It is expected that the students will explore elements of religion, ethnicity, place, gender, and social class in this module. This course was not taught during the fall of 2018 and will be implemented this year. The goal was met in terms of development of culturally and socially relevant curriculum at each institution in an active learning environment. The created materials were also piloted at Spelman and Southwestern during the fall of 2018.

Goal 3: Establish a virtual presence for ongoing collaboration and for the peer review and dissemination of novel lab activities.

An online learning management system site, Moodle, was created and provided to all participants of the workshop. This space currently houses materials from the workshop, organic course syllabi, and the developed modules. This collaborative space will allow for review and adoption of the materials by the CoP. After revision and critiques, we plan to disseminate on platforms such as OrganicERs and STEM Central. OrganicERs was introduced to the group attending the workshop and many organic faculty from ACS institutions are members. We had initially planned to record portions of the workshop for dissemination. We did record some of the sessions but did not have the time to sufficiently edit the sessions for distribution.

Goal 4: Create assessment criteria for current and future lab experiments and activities.

The workshop session on assessment and evaluation led us to rethink our plans for creating a rubric to assess the quality of our developed curriculum. The validity of such tool would be challenging to measure. Instead, we were introduced to James Banks' model of multicultural curriculum reform as a guide to construct culturally relevant activities. Banks presents a four-tiered approach to teaching that includes contributions, ethnic additives, transformation, and decision making and social action. This is a well-known model that will allow us to revise our curriculum in a meaningful way as it speaks to moving past superficial changes to more impactful strategies. We would then use known assessment tools to measure students' engagement, sense of belonging in science, and motivation to study chemistry. Instruments such as the Relevance of Science Education (ROSE) survey, the Scientist Centrality Scale, and the Chemistry Motivation Questionnaire II will be used for this purpose in the revised laboratories.

III. Impact of project

Explain the impact your project had on relevant constituencies (e.g., students), structures, (e.g., a major program), processes (e.g., community engagement), and/or relationships (e.g., consortial partnerships).

The project provided a space for organic chemistry faculty from ACS institutions to meet and collaborate. Faculty from seven ACS institutions attended the workshop and developed a rapport and camaraderie that will aid in future partnerships and further collaboration. Designing activities that included culturally and socially relevant elements allowed us to talk about our interactions with students and how we can collectively improve the student experience in organic chemistry. Implementing these activities allowed students to construct knowledge from a cultural perspective about chemistry concepts. Students seemed enthusiastic about the activities and this was confirmed in their positive feedback. It is hoped that this model will enhance the learning environment of each institution and provide culturally relevant scientific investigations that are shaped by a variety of cultural backgrounds and lived experiences while promoting the engagement and academic performance of women and minorities in the organic chemistry laboratory course. This platform will also demonstrate the influence and applicability of chemistry in addressing national issues.

IV. Consortial (ACS-wide) value of the project

Describe how your project results can or will strengthen ACS, e.g., via the dissemination of a final report, the future training of campus leaders, or the building of an inclusive community of practice.

The results from this project will offer ACS institutions a pedagogical model to make STEM lab courses more inclusive and engaging for students and serve as a resource for shared teaching materials that can be used in organic lab courses. The CoP formed by this project has a shared goal of

V. Lessons Learned

Describe the surprises, challenges, and lessons learned during the project, e.g., is there something you are very glad you did or would do differently? Did you face obstacles that called for creative problem solving? What would have made the project even more successful?

We were very pleased with the rapport established in the workshop among the faculty. As a group, our awareness about individual and cultural differences was raised and we agreed that those differences can be nurtured to bring about impactful and innovative changes in STEM. As we shared stories and experiences, we found many similarities in our students, our expectations for them, and our desire for them to succeed. We were all challenged with making organic chemistry culturally relevant and were able to collectively imagine ways that this could happen in the classroom. We had initially hoped to have a group of 30 participants but ended up with half that size. However, the small size of our group allowed for more open conversation and transparency. Some colleagues shared struggles of relating to students and connecting the course material to their interest. We brainstormed ideas to help each other and to help our students grow and learn in environments that may not currently engage and inspire them. As with many teaching innovations, more time is necessary to fully implement this philosophy. However, the pilot phase has allowed us to test some of our strategies and see how they can be revised for future use and dissemination.

VI. Next Steps

Explain what you intend to do with/how to you intend to use or build on the results of your project.

At Spelman, we plan to move this project further by revising the curriculum for the organic I laboratory to include culturally relevant instructional materials in all of the experiments. We have submitted an NSF grant to obtain funding to support this project. This would include modified or new experiments, a new lab manual, and modules for every experiment that encourage students to relate their learning to their lives. At Southwestern, we will continue to refine both the metabolites and sugars labs. With the addition of the culturally relevant aspects to the sugar lab, we are hoping to publish this experience in the *Journal of Chemical Education* in the coming years. Additionally, we are planning on incorporating culturally relevant materials in additional laboratories for both semesters of organic chemistry and in the lecture class. The lead faculty from Centre, Southwestern and Spelman have also expressed interest in adopting the experiments and or the developed modules from the other ACS institutions.

VII. Feedback/suggestions for the ACS grant program (optional)