Project Overview

The Department of Chemistry and the Student Academic Success Center (SASC) completed the Fall 2014 Inclusive Chemistry Success Project that coordinated pre-assessment, advising, core instruction, supplementary instruction, and post-assessment. The primary goal was to improve first-term outcomes for a freshman cohort of 20-25 underrepresented and underserved students based in SASC who planned to enroll in CHEM 1021 Introduction to Chemistry and CHEM 1113 General Chemistry in order to complete a MAPS requirement or to prepare for a STEM major.

With its genesis in the Equal Opportunity Programs of the 1960-70s, and its emergence from the University Learning Center in 1995, SASC combines an historical commitment to social justice with an inclusive model of academic excellence that has always been, and will always be centered on the student. We define ourselves as a multicultural learning community that serves underrepresented, underserved, first-generation, low-income, and other non-traditional students by our mission to provide equal opportunity for academic, personal, and career success. We deliver instruction, scholarships, advising, services, resources, and community to improve the recruitment, retention, persistence, and graduation rate of students who contribute to the cultural diversity and academic excellence of the CU Boulder campus.

Specifically, SASC hosts two academic support programs, three scholarship programs, two core instructional programs, and four supplementary instructional programs in addition to providing advising, technology support, and work study to its students. Overall, SASC serves 900 actively enrolled students with an overall retention rate of 95%, a persistence rate of 70%, and a graduation rate of 60%. These outcomes match or exceed the campus average for traditional undergraduates, despite its special mandate to recruit and graduate a population of underserved, underprepared, non-traditional, and at-risk students.

We enrolled 22 students in the SASC CHEM 1021 course in the fall of 2014 with funding support from the IMPART grant, the Chancellor's Award for STEM education and IBM funding for STEM education. We compared exam and course grades of students enrolled in CHEM 1021 in Spring 2014 to the exam and course grades of students enrolled in CHEM 1021 in Fall 2014. We have defined "Success rate" as the number of students who receive an A or B in the course. We recognize that our definition of success is an ambitious goal, but we have noted that students who receive lower than a B- grade in their chemistry courses tend to struggle significantly in the next course given the sequential nature of the curriculum. The SASC cohort of Fall 2014 CHEM 1021 was able to perform on the exams to a similar level as the general population whereas the SASC cohort of Spring 2014 CHEM 1021 was 7-8 points below the exam average of the general population. The Success rate improved by 14%, and the percentage of students receiving D's or F's in the course was reduced by 13%.

Given the success of this project, the Department of Ecology and Evolutionary Biology (EBIO) and SASC would like to propose the Inclusive Biology Success Project which would address another STEM course that many SASC students take during their first semester on campus: EBIO 1210, General Biology. The project would be built on the model described above with adjustments designed to address specific student struggles with EBIO 1210. This proposal requests $9,900 in start-up funds for the cost of training and staffing required to develop, implement, and evaluate a pilot stage of the Inclusive Biology Success Project in 2015-2016 academic year. Continuing support of the project will be sought from other sources of competitive grant funding, including the NSF Improving Undergraduate STEM Education.

Background

As a MAPS requirement, biology is a milestone for college readiness; as a subject, it is a gateway to STEM majors; as a degree, it is a pathway to STEM careers in academe, business, government, and industry. Yet the chronic achievement gap between an underserved student population and the general student population in terms of access to STEM courses, persistence in STEM majors, and graduation into STEM careers exposes a sequential failure of our K-16 pipeline to prepare, retain, and graduate an important population of prospective STEM majors who are underrepresented in STEM careers. An institutional commitment to implementing freshman assessment and promoting introductory courses

would improve general student outcomes while also fostering the number of STEM majors among underrepresented students (Mervis, 2010). In 2011, it was reported that only about 20% of minority students with intended STEM majors complete STEM degrees, as compared 33% of white students with intended STEM majors. It is suggested that engaging students in well-designed introductory STEM courses should improve performance and could be particularly helpful in reducing the high rate of attrition for many minorities in STEM subjects (Hrawbowski, 2011).

At CU Boulder, the EBIO department offers a sequence of General Biology courses that students typically take their freshman year: EBIO 1210 and EBIO 1220. SASC has offered a one-unit co-seminar as supplemental instruction for both of these courses. On average, 40% of SASC students since 2006 have achieved a grade of A or B (defined as "Success Rate"). In EBIO 1210, compared to only 58% of the general population of students, as shown in the table below. The DFW rate, which represents the percentage of students receiving D's, F's or W's in the course, is also significantly higher for SASC students as compared to the general population.

EBIO 1210 SASC students with co-seminar				**EBIO 1210 General student population**		
	Number of students	**Success rate**	**DFW rate**	**Number of students**	**Success rate**	**DFW rate**
Fall 2006	29	14%	48%	1180	33%	29%
Fall 2007	24	58%	29%	1279	66%	13%
Fall 2008	27	26%	52%	1393	54%	17%
Fall 2009	25	20%	48%	1377	47%	22%
Fall 2010	37	70%	5%	1374	64%	15%
Fall 2011	27	52%	19%	1327	69%	12%
Fall 2012	29	31%	31%	1226	67%	13%
Fall 2013	22	41%	32%	1298	62%	19%
Average	**28**	**40%**	**32%**	**1307**	**58%**	**18%**

Current research with underrepresented students in general biology has shown that highly structured courses can reduce the achievement gap for these students. A study at University of Washington modified the traditional format of their large general biology course with promising results. This course design was considered highly structured because it required students to prepare for class sessions, actively participate in class sessions use clickers or random-call responses and complete a weekly low-risk assessment in the form of a practice exam. The constructivist focus was not on drilling the concepts, but on active-learning exercises that challenge students to explain their thinking. The study reports that student gains in performance reflected a deeper understanding of the content (Haak, 2011).

We would like to re-engineer a small lecture section of EBIO 1210, incorporating both our strategies that were successful with our Inclusive Chemistry Success Project as well as the strategies outlined in the study described above. We hope to see significant improvement overall, such that students feel powerfully prepared for the next STEM course. We also hope to see positive results that extend beyond the freshman year, ensuring a confidence-building experience of inclusive excellence that will encourage persistence in the subject and the degree.

Study Design and Methods

The primary goal of our project is to improve first year outcomes for a freshman cohort of twenty five (25) underrepresented and underserved students who plan to enroll in EBIO 1210, General Biology in order to complete a MAPS requirement or to prepare for a STEM major.

The EBIO Department has four EBIO 1210 instructors: Dr. Barbara Demmig-Adams, Dr. William Adams, Dr. Dan Medeiros and Dr. Sam Flaxman. Our SASC instructor, Robert Buchwald, met with these

instructors and collaboratively created a plan for the small SASC lecture section of EBIO 1210 that would parallel the large lecture sections in content as outlined below.

Dr. Buchwald will lead 3 1-hour core-credit lecture meetings that will be supplemented by 2 1-hour non-credit POGIL (Process Oriented Guided Inquiry Based Learning) sessions staffed by SASC Instructional Assistants (IAs) for a total of five instructional hours per week. "POGIL originated in college chemistry departments in 1994…as a student-centered strategy; students work in small groups with individual roles to ensure that all students are fully engaged in the learning process. POGIL activities focus on core concepts and encourage a deep understanding of the course material while developing higher-order thinking skills. POGIL develops process skills such as critical thinking, problem solving, and communication through cooperation and reflection, helping students become lifelong learners and preparing them to be more competitive in a global market" ("What is POGIL?")

As a pedagogical method, POGIL has been shown to improve process skills and content knowledge for individual students while fostering the "positive interdependence" that prepares them for participating on team projects in the workplace (Farrell, 1999). Notably, it decreases the DWF rate in comparison to a standard lecture format for STEM courses because it increases student engagement in their learning cycle (Chase, 2013). The SASC instructional team has been trained in using this method of group learning, and we have incorporated activities into all our classrooms this year. Surveys of students in the Inclusive Chemistry Success Project indicate that students find these POGIL sessions helpful in practicing the material and also, given the discovery learning element, a great preparation for lectures.

Dr. Buchwald will work with the Caitlin Kelly, our EBIO 1210 biology co-seminar instructor, to develop these POGIL activities for each week during the semester. Students will review activity answers before leaving each session. Students will be assessed by a combination of IA evaluation of their engagement with the requirements of their role and their own self-assessment of their participation. We will collect qualitative data on POGIL activities by administering the same POGIL survey at the end of the semester that we used for the Inclusive Chemistry Success Project.

Dr. Buchwald will collaborate on exam writing with the four general biology instructors. Approximately ten multiple choice questions will be given on exams for SASC students and the general population for comparative analysis. Dr. Buchwald will also include short answer response questions on his exams, per the advice of the other instructors, to better gage the student learning on difficult topics. We will also track student comprehension with small group discussions, in-class quizzes and in-class presentations (done with partners) during lecture sessions.

We will require students to complete the CLASS (Colorado Learning Attitudes About Science Survey) both pre- and post semester to collect qualitative data on this project. This survey was developed as part of the PhET (Physics Education Technology) project through the CU Physics Department. We hope to compare our results to the general population of EBIO 1210 students. We used this survey as part of the Inclusive Chemistry Success Project, and we were able to measure significant gains in attitudes toward science.

During the project period, we will measure, collect, and evaluate these data points:

1. ACT/SAT and PGPA for all project participants.
2. SASC Student performance on 10 common multiple choice exam questions for each of the four exams in Fall 2015 EBIO 1210 as compared to the general population of Fall 2015 EBIO 1210.
3. Average Fall 2015 project cohort outcomes compared to 5-year historical averages for SASC students in EBIO 1210.
4. Average Fall 2015 project cohort outcomes compared to 5-year historical averages for general student population in EBIO 1210.
5. Average Spring 2016 project cohort outcomes in EBIO 1220, General Biology 2, compared to 5-year historical averages for SASC students in EBIO 1220.
6. Average Spring 2016 project cohort outcomes in EBIO 1220 compared to 5-year historical averages for general student population in EBIO 1220.

7. Qualitative data from CLASS survey pre- and post semester (Fall 2015).

Timeline

We will evaluate the pilot stage of the Inclusive Biology Success Project in Spring 2016 and submit a report by the end of our 12-month project period in Summer 2016.

1. Core Instruction: Enroll 25 freshmen in a SASC section of Fall 2015 EBIO 1210 re-designed for interactive learning. Students will attend three weekly lectures, and two POGIL sessions run by SASC undergraduate instructional assistants (IAs).
2. Supplementary Instruction: Students who are unable to take the small lecture course will be enrolled in a one-credit Fall 2015 EBIO 1210 co-seminar which will implement parallel POGIL activities to the small SASC lecture.
3. Pre and Post-Assessment: Student performance on exams will evaluated in comparison to the general population based on 10 common questions. Student attitudes will be evaluated pre- and post semester using the CLASS survey.

Outcomes and Impacts

This project contributes specifically to excellence and student development at CU Boulder by creating an opportunity for this diverse freshman cohort 1) to enroll in a pilot biology class featuring inclusive and interactive instruction that closes historical achievement gaps in STEM success; 2) to receive a coordinated success plan of assessment, advising, and support that improves individual persistence in STEM courses; 3) to participate in a multicultural learning community that facilitates equal access to STEM majors and provides holistic support to ensure timely graduation and career readiness. This project contributes generally to a campus environment that supports cultural diversity in teaching by 4) training a diverse cohort of STEM majors to serve as Instructional Assistants in both SASC EBIO 1210 and ARSC 1420 Co-seminar Biology 1, thus enriching their undergraduate experience while providing the freshman cohort with underrepresented peer models of student success; and 5) adapting the EBIO 1210 standard curriculum to Process Oriented Guided Inquiry Learning (POGIL), thus providing the campus with a new model of STEM undergraduate instruction that is both inclusive and rigorous.

Our short-term goal is to improve our first gateway science course within the SASC department such that improved outcomes for freshmen are sustained throughout the general biology sequence. Partial funding will be provided by our SASC Supplemental Instruction budget, and we will seek a cost-sharing arrangement and/or competitive funding opportunities in partnership with the EBIO Department. Our long-term goal is to develop the SASC STEM Co-seminar Program beyond its original service as supplementary instruction into a set of introductory POGIL STEM core credit courses, prioritizing the subjects of biology, physics and psychology based on their demand as STEM major requirements (Bayliss, 2008). We will therefore seek collaborative funding opportunities with other STEM departments who share our mission to serve underrepresented students while improving general student outcomes in their introductory and gateway courses.

At this pilot stage, we expect to demonstrate the impact of teaching a re-engineered EBIO 1210 with active learning POGIL activities and frequent low pressure assessment on improved first-term outcomes for a cohort of underrepresented and underserved SASC freshmen who plan to enroll in the General Biology sequence. After the completion of this pilot stage, we will seek continuing support for the Inclusive Biology Success Project from other relevant sources of competitive grant funding, such as the NSF Improving Undergraduate STEM Education.

References

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Budget Justification

We are requesting $10,000 in funding support for this project; see attached spreadsheet for details. We are primarily requesting assistance with instructor salary (paid at 15 hours/week given the higher number of expected contact hours) and IA salary. We would like to hire 3 undergraduates that were successful in EBIO 1210 within the last two years. They will run the POGIL sessions, attend the SASC lecture and staff the SASC Study Hub for extra office hours. We would like to invest in POGIL training materials, such as workbooks. We would also like to invest in materials for the classroom such as manipulatives and tutorials.

Budget

	Budget for Chanellor's award 2014-2015		
	IMPART	**COSTSHARING**	
SALARIES			
EBIO instructor	$7290	$0	
Instructional Assistant salaries	$1400	$1400	
	$8690	**$1400**	
			$10,090
INSTRUCTION			
POGIL workbooks	$700	$300	
Instructional supplies	$600	$600	
	$**1300**	**$900**	
			$2200
BUDGET TOTAL			
	$9,990	**$2300**	
			$12,290