Research Experiences in Classroom and Their Impacts on Biology Freshmen at an HBCU

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Abstract

Introduction. The Historically Black Colleges and Universities Undergraduate Program (HBCU-UP), through Targeted Infusion Projects (TIPs), provides support to achieve short-term, well-defined goals to improve undergraduate STEM education. In the current TIP at Xavier University of Louisiana (XULA), two freshman lab courses have been redesigned as Course-based Undergraduate Research Experiences (CUREs). Merits of early research experiences are well documented (Dolan, 2016), yet fewer than 10% of XULA Biology freshmen have research opportunities in their first year. The XULA TIP aims at bridging this gap by infusing two authentic research projects in two foundational labs in Biology. The first, the ‘Yeast ORFan’ project, in collaboration with Juanita College, PA, aims at studying yeast ‘ORFans’ (genes of unknown function). The second, in collaboration with the USDA SRRC, LA, is centered on the phenotypic and genotypic characterization of an Aspergillus (fungal mold) species known to damage food crops. Although CUREs are gaining attention for their ability to offer research opportunities in a classroom setting (Dolan, 2016), few undergraduate minority-serving institutions have established CUREs as part of their curricula. There is, therefore, a great need to study CUREs and their impacts on underrepresented minority (URMs) students’ attitudes towards Biology, learning, retention, and their desire to pursue careers in STEM in general. The XULA CURE infusion project is the first of its kind at an HBCU (XULA) and the results of this intervention/newer way of teaching will enhance our knowledge in the area of science education.

Methods. Two established courses (Biol 1210L and Biol 1220L), meeting once/week for 1 credit hour and required for all Biology majors, were redesigned as CUREs. The student population consisted of ~ 240 students per semester; ~ 85% were URMs and ~ 70% were female. The overarching goal was to introduce students to scientific competencies using interdisciplinary concepts and ‘do-able’, real-life research projects with the above-mentioned yeast and mold as model systems. Data were collected by instructors in the form of student feedback, class participation, assignments, in-class computer work and the application of knowledge in lab experiments and on quizzes. Data were also collected by the external evaluator using assessments such as the Biological Experimental Design Concept Inventory (BEDCI, Deane et al., 2014) and the ‘Science Motivation Questionnaire’ (Glynn et al., 2011).
**Results.** In year one (Fall 2019-Spring 2020), only the Fall 2019 semester was 100% in person since these were ‘normal’, pre-COVID-19 pandemic conditions and students gained research experience with the yeast ORFan project. Instructors noted early on that, although students enjoyed the flexible format of hands-on lab work combined with data analysis, etc., the weekly two-hour session did not provide enough time to teach lab skills and research-related scientific content, allow students to practice, learn troubleshooting, reflect on experimental design, conduct experiments, record results and understand their significance. Nevertheless, the combined hard work of both the CURE faculty and students demonstrated a pattern of improved academic performance on the four common (identical) quizzes. For example, in four sections taught by the same instructor, students in one section consistently underperformed at the start of the semester (on Quizzes 1 and 2), but their scores improved steadily until, by Quiz 4, their scores were indistinguishable from those of the students in other sections (unpublished data). Students also were evaluated on lab skills, experimental work, and group presentations. Lastly, based on the external evaluator’s analysis, students showed gains in four of the five assessed areas of biology motivation (intrinsic motivation, self-efficacy, self-determination, and career motivation, unpublished data). In mid-March, 2020, the threat of COVID-19 caused the University to shut down overnight. Students were forced to leave, and some had no place to live. Many students and faculty lost their loved ones or became infected with the virus. The remaining weeks of the Spring 2020 semester were taught exclusively online; instructors conducted Zoom class meetings while developing a completely new style of teaching and communicating. Fortunately, since the courses were designed to focus on many lab skills early on, the online transition, while not optimal, still allowed for about 75-80% of the projects to be covered. Both year two semesters (Fall 2020-Spring 2021) were taught as ‘hybrid’ courses (at least 50% in person) with extremely strict COVID-19 guidelines. The XULA team developed novel strategies, including preparing in-house videos for the group that was on ‘Zoom’ to study, while the other group was in the lab. At the time that this abstract was submitted (May 2021), year two had just ended. All of our strategies, results, and outcomes will be discussed during the conference workshop or poster session.

**Conclusions and Discussion.** Preliminary analysis of year two suggests that while students appreciated the efforts of the CURE team during the COVID-19 pandemic, their morale overall was down. Our students were used to seeing their instructors and advisors in person. While the hybrid model is better than being all online, most students prefer in person learning. Some have confessed that they tend to get lazy and not pay attention since Zoom recordings can be made available. However, things are looking up and XULA plans to move back to all in person instruction. Year one results have demonstrated positive trends in most evaluative areas and year three (Fall 2021-Spring 2022) should provide even more insights. In conclusion, our working hypothesis remains that providing meaningful research experiences early on to all URM Biology majors can positively impact their self-confidence and desire to stay in STEM. Findings from our study will also advance the understanding of this type of intervention and provide a roadmap for other minority-serving institutions who might want to implement it.

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