Improving Civic and Scientific Literacy in Biology Through SENCERized Classroom Research Experiences

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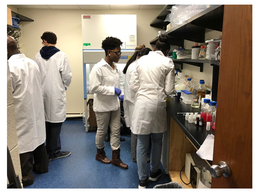
Background to the problem

Mercy College is a federally designated Hispanic Serving Institution, serving 6,272 undergraduate students, 59% of whom are underrepresented ethnic minorities (UMs). Biology enrolls approximately 224 students and attracts a higher percentage of UMs - 40% Hispanic, 25% Black, 18% White, and 17% other.

A survey has revealed that Biology students are:



- 33% are transfer students
- 20% are of nontraditional age
- 63% receive federal Pell grants
- 23% hail from high-needs high schools
- 20% are first- generation college students
- ~ 20% care for a dependent
- 75% are employed

National data trends show that Mercy's Biology program has higher attrition rates than colleges with similar admission standards: 65% national STEM attrition versus 89% for Mercy's Biology majors. The graduation rate for STEM majors is approximately 10% for both first-time full-time freshmen and transfers.

Why are they leaving? In a recent survey of Biology students, they had concerns about job opportunities, their GPAs and the workload and rigor of coursework. In addition:

- 53% of students who transferred out of the Biology major felt that their high school science courses did not prepare them for the rigors of college science coursework.
- 71% of survey respondents transferred from the Biology major into the Health Sciences major, a field of study perceived as a less arduous path leading to greater job opportunities.

To engage our students we focusing on **High Impact Practices** (High-Impact Educational Practices: What They Are Who Has Access to Them and Why They Matter by George D. Kuh (AAC&U 2008)

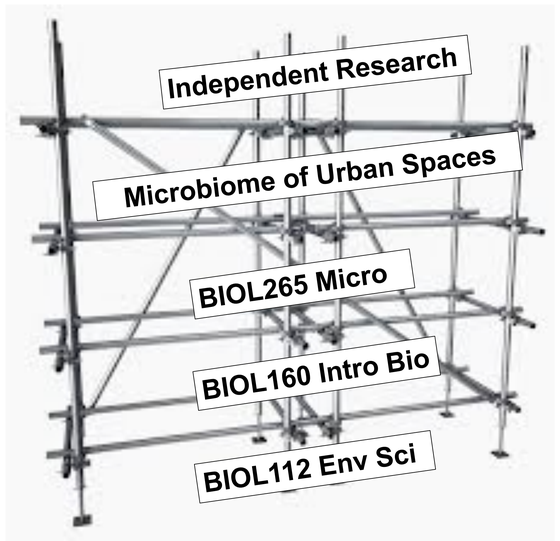
1. Undergraduate Research
2. Collaborative assignments and projects

Program Outcome (PO) Code	Program Outcomes (POs)	Program Goal (PG) Alignment
PO1	Synthesize core concepts to demonstrate a broad and in-depth knowledge of the biological sciences	PG1
PO2	Access and critically evaluate and interpret the scientific literature	PG1, PG2, PG3
PO3	Effectively communicate scientific concepts through oral and written modes	PG3
PO4	Apply the scientific method to formulate hypotheses, design and conduct experiments, and interpret experimental results	PG1, PG2
PO5	Exhibit proficiency in laboratory techniques in the biological sciences, troubleshoot experiments, and demonstrate safe laboratory practices	PG1, PG2
PO6	Critically evaluate experimental findings and scientific information using statistical and quantitative analyses	PG1, PG2
PO7	Exhibit ethical behavior in science and evaluate the implications of unethical scientific conduct	PG2
PO8	Critically examine basic, applied and societal problems in the biological sciences and, through the lens of life science professionals, propose problem solving strategies to address these problems	PG1, PG3
PO9	Work as effective team members on collaborative projects	PG4

SENCER
SCIENCE EDUCATION FOR NEW CIVIC ENGAGEMENTS AND RESPONSIBILITIES

Civic engagement means working to make a difference in the civic life of our communities and developing the combination of knowledge, skills, values and motivation to make that difference. It means promoting the quality of life in a community, through both political and non-political processes.

What is Civic Scientific Literacy? It is the form of literacy that deals with the level of understanding of basic scientific constructs that an individual would need to access and make sense of information about public policy issues involving science and technology.

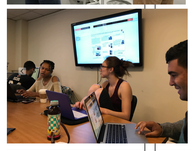


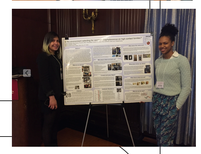
The Microbiome of Urban Spaces

Since Spring 2016, I have been developing a novel elective course "**Microbiome of Urban Spaces**", such that it incorporates both student inquiry and an authentic student driven research experience that addresses my personal research questions in the area of antibiotic resistant bacteria.

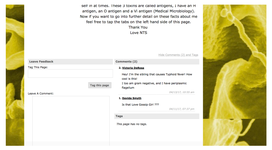
Each semester, a team of 8 students sampled sites around the campus. In Spring 2016, they sampled the new residence hall, in Fall 2016 they sampled water sites such as the Hudson and East River, and in Spring 2017 they sampled the new occupational therapy unit in the Health Professions wing at Mercy, looking for antibiotic resistant Staphylococci. In Fall 2017, students investigated antimicrobial paints.

Along with classical microbiology, students have used metagenetic sequencing of the 16S rRNA gene and deep sequencing. Bacterial colonies were identified using DNA sequencing. Hundreds of resistant bacteria were isolated on sites around the campus and many resistant bacteria were isolated from the water samples. Along with genotyping, the students identified the resistance patterns of the bacteria using the Kirby Bauer methods as well as characterized the SCC*mec* types of the bacteria using PCR. Students also learned how to maintain lab books, keep citations, communicate effectively and to generate posters and abstracts.





BIOL 265 Micro



Getting Friendly with Bacteria - ePortfolio

- My cell wall structure/Gram stain reaction
- My type of respiration
- My type of metabolism
- Where do I normally live/do I sometimes go on holidays (from a lake into someone's intestine?
- Am I a pathogen? If not, am I useful for something?
- Do I have virulence factors?
- Who are my family members (My Genus) – Make friends with them on digication
- Who are my friends (In my classification tree) – Make friends with them on digication
- Do I have any pretty pictures of me/diagrams/movies
- Am I famous/in the news/notorious?

In Micro students generate ePortfolios on resistant organisms and team projects that serve to educate the public about issues in microbiology.

BIOL 160 Intro Bio

- The classroom experiences include think-pair-share moments, active learning assignments, brainstorming, quizzes and plenty of teamwork and collaboration.
- Students choose their teams and engage in student chosen and student driven research into topics of civic importance relevant to the biology course and important issues (and each student!).
- They gain experience with the generation of posters, use of citations and generation of bibliographies.
- Librarians help us print and present the posters in the library.

Through these literature-based projects, students took their first steps towards understanding and immersing themselves in the scientific method using authentic student-driven discovery.

BIOL 112 Env Sci

- This course is a Gen Ed course and serves students from all majors. The classroom experiences include think-pair-share moments, case studies, active learning assignments, brainstorming, quizzes and plenty of teamwork and collaboration.
- Students write weekly summaries of popular science articles in areas relevant to Env Sci and generate ePortfolios.
- Students self assign into teams and engage in student chosen and student driven projects aimed at solving environmental problems visible to the Mercy Community.
- At the end of the semester, they present a proposal to solve the problem. In Fall 2016, they generated a proposal to reduce plastic use in the Mercy cafeteria which was been given to the administration at Mercy to promote plastic use reduction.

These pilots have shown the feasibility of intervening in the lecture to enhance civic engagement and scientific literacy while exposing all students to research and the scientific method in Gen Ed courses

Impact and Successes

Impact on students

More than 40 students mentored in research	More than 27 posters at local, national and international conferences	Students have received honorary mentions, research fellowships and travel awards from CSTEP, SACNAS, ASM and ABRCMS. They have been accepted to internship programs and to graduate school.

Impact on Prof. Smyth

Published a paper on CUREs	Paper accepted on ePortfolios at the International Journal of ePortfolios	11 oral and poster presentations at Mercy and local universities as well as 13 oral and poster presentations at local, national and international conferences

Case Study 1
- Took BIOL 160 with me – did poster
- Took Microbiology of Urban Spaces Spring 2016 – presented at WURC 2016
- Summer lab – Presented at ABCRMS 2016
- Changed her major – HS to BIO
- CSTEP – Poster accepted to CSTEP
- Has been accepted to Albert Einstein SURP, Rutgers/Princeton Summer MD/PhD program.

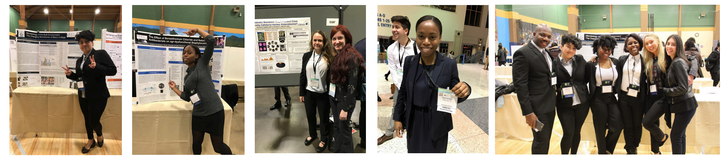
⇒ Wanted to be a PA, now wants to do MD PhD

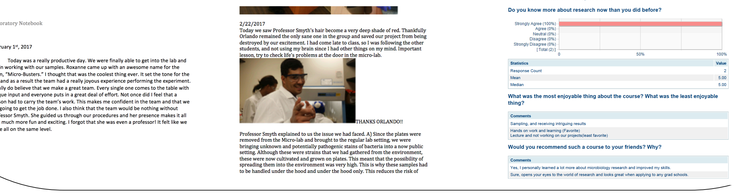
Case Study 2
- Took BIOL 265 with me – did posters in lecture class
- Took Microbiology of Urban Spaces Spring 2016
- Summer lab – Gave a talk at ABCRMS 2016!
- CSTEP – Poster accepted to CSTEP
- Was awarded an ASM Capstone award to attend and present at ASM
- Has given two oral presentations at local and national conferences

⇒ Wanted to be a Vet Tech, now wants to do PhD in Microbiology!

Case Study 3
- Took Microbiology of Urban Spaces Spring 2016
- Summer lab – Accepted to ABCRMS 2016 and given travel award
- CSTEP – Poster accepted to CSTEP
- Got an honorary mention at CSTEP

⇒ Is now working as a CLS, and wants to do PhD in Pathology





Acknowledgments

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