Using an Extracurricular Interdepartmental Collaborative Water Analysis Project to Promote Student Engagement at a Commuter Community College

Yasmin Edwards, Bronx Community College, yasmin.edwards@bcc.cuny.edu
Diane Banks, Bronx Community College, Diane.Price@bcc.cuny.edu
Dicken St Hilaire, Bronx Community College, Dickens.St_hilaire@bcc.cuny.edu
Aneska Tejada, Bronx Community College, Aneska.Tejada.stu@bcc.cuny.edu
Grissel Dejesus, Bronx Community College, gdejesu001@ccny.cuny.edu

Summary

A culture of student participation at community colleges has been shown to improve retention and graduation rates. At urban commuter community colleges most students work (part-time or full-time), in addition to the rigors of a full-time course load. Therefore, convincing these students to allocate time for extracurricular activities is an ongoing challenge for faculty. This study utilized interdisciplinary research between three Science, Technology, Engineering, and Math (STEM) programs at Bronx Community College to foster extracurricular engagement between participating students majoring in Liberal Arts - Biology option, Chemistry and the Medical Laboratory Technician (MLT) programs. During the fall 2018 semester, students were invited to work closely with three faculty members representing each discipline to conduct an extracurricular water analysis project. This project was not funded; therefore, students were invited to participate based on their desire to work closely with faculty in a laboratory setting and the faculty members volunteered to work with students.

Description of project

Student participation in extracurricular activities at community colleges has been challenging compared to senior residential institutions (Astin, 1999 & Derby, 2006). Bronx Community College is one hundred percent commuter based. Students often leave the campus immediately following their classes. Socioeconomics contributes to the disparity in extracurricular participation because many students work (part-time or full-time), diminishing the time available to participate in extracurricular activities.

Lower participation rates in extracurricular activities exacerbate inequities of academic outcome (Meier, Hartmann, & Larson, 2018), while participation in extracurricular activities has been associated with an increased positive connection to school, particularly among students who previously considered the importance of college to be marginal (Mahoney, Joseph L., Cairns, Beverly D., & Farmer, Thomas W., 2003).

The meaning of the term extracurricular can vary widely. The definition which best applies to the current study is that proposed by Bartkus et. al. (2012, p. 698), which states that:

Extracurricular activities are defined as academic or non-academic activities that are conducted under the auspices of the school but occur outside of normal classroom time and are not part of the curriculum. Additionally, extracurricular activities do not involve a grade or academic credit and participation is optional on the part of the student.

The study focused on student engagement in extracurricular research activities across three academic disciplines. The aims of this study were to (1) reestablish the biology club (2) increase student-faculty research collaborations, and (3) increase extracurricular student-faculty interactions.

This study applied the student involvement theory with interdisciplinary research to increase participation in STEM related extracurricular activities. The student involvement theory, as first designed and defined by Astin (1984, p. 528) is

> *the quantity and quality of the physical and psychological energy that students invest in the college experience. Such involvement takes many forms, such as absorption in academic work, participation in extracurricular activities, and interaction with faculty and other institutional personnel.*

The theory postulates that greater student investment in education results in greater personal and academic success, instead of primarily focusing on techniques and subjects, as previous pedagogical models had. Its emphasis is the motivation and behavior of the student, and the student's personal investment in their studies and extracurricular activities as an institutional resource. Four students volunteered to meet with faculty during club hours (two hours once per week) to complete a water analysis project. The work was completed by a heterogeneous group of students (sophomores and seniors) who completed (or were taking) at least one course with one of the three faculty advisors. In accordance with the student involvement theory, the project was designed to heighten student involvement at each step of the project to encourage personal investment and self-motivation. Instructor involvement was limited to the demonstration of techniques, guidance and encouragement of students. This design sought to foster student ownership and a sense of being invested in the project's outcome. Student participation was motivated by personal interest and the students' belief that they would derive both personal and educational benefit from working collaboratively with each other and faculty in an informal setting.

The project also modeled collaborative interdisciplinary work. As defined by Aboelela et. al., (2007, p. 339),

> *interdisciplinary research is a study or group of studies undertaken by scholars from two or more distinct scientific disciplines. The research is based upon a conceptual model that links or integrates the frameworks from those disciplines, using a study design and methodology that is not limited to any one field, and requiring the use of perspectives and skills of the involved disciplines throughout multiple phases of the research process.*

In lieu of a research project, an interdisciplinary water analysis project was selected by faculty based on relative ease of completion and to capitalize on student interest in the quality of municipal water supply following the ongoing Flint, Michigan water contamination crisis of 2015 and the serendipitous find of a pH anomaly with water from a hand wash station in the science building on campus. Student awareness of the crisis and the pH anomaly on campus created a focal point of interest in water quality and its analysis. Faculty worked with students to demonstrate how aspects of their discipline's contributed to the project. For instance, the biology professor demonstrated and explained the importance of collecting sterile water samples to avoid microbial contamination which might confound the later microbial analyses. Anion analyses were completed with the guidance of the chemistry professor who explained the utilization of instrumentation in professional chemistry laboratories. The physicochemical (turbidity and pH) analyses were overseen by both the biology and chemistry professors and the relevance of these measures to both disciplines was explained. The samples were given to the MLT students for microbial analysis. The MLT students were taught how to perform serial dilutions of the water samples by the biology and MLT professors in preparation for plating and in advance of the microbial analyses they completed with the guidance of the MLT instructor. The two club hours per week allocated for extracurricular activities by the college proved insufficient for the completion of the microbial analyses. Therefore, the MLT students met additionally with the MLT faculty during mutually agreed times. The interdisciplinary collaborations between faculty and students informed all aspects of the project.

It is often outside of the classroom that students make interpersonal connections, practice appropriate emotional management, and build their adult identity (Mahoney, Joseph L. et al., 2003). Extracurricular activities complement the formal curriculum by enhancing knowledge and technical expertise (Freeman et al., 2014). This interdisciplinary, extracurricular water analysis project supported the complex activity of learning beyond the classroom, increasing student engagement with fellow students and faculty advisors.

Table 1: Student Skills Enhanced by Project
Technical
1) Use of sterile water sample collection methods
2) Use of varied water analysis methods
3) Practice accurate data recording
4) Practice data presentation
5) Use of instrumentation in Chemistry
Personal Development
1) Improve communication skills
2) Develop collaboration skills
3) Develop personal motivation
4) Develop positive interaction with faculty
5) Increase peer interaction and cooperation

Evidence of effectiveness and impacts

Students were introduced to the interdisciplinary and collaborative nature of STEM related disciplines. The student groups worked independently (with faculty guidance), collecting and labeling samples, performing physicochemical and microbial analyses. The student-centered design - in alignment with student involvement theory – increased student behaviors that promote improved academic performance by fostering greater personal investment by each student in their educational experience. Students reported that the extracurricular experience helped them to build connections with other students and faculty as well as a greater appreciation for STEM related activities and reinforced and deepened their understanding of course content.

Aim 1: Reestablishing the Biology Club

The biology club was re-chartered in fall 2018 under the leadership of the biology faculty club advisor and is now a vibrant student led, faculty mentored extracurricular group. An additional biology faculty member was also recruited to assist with the mentorship of students. While only one student who was a declared biology major participated in this research, many biology and chemistry majors joined the club the following semester. In the summer of 2019, biology club members conducted a water analyses project related to the impact of water quality on *Hydra* morphology.

Aim 2: Increase student faculty research collaborations

The water analysis project led to further student faculty research collaborations. The chemistry major worked with both the biology and chemistry faculty members to present the data collected during the project at an on-campus science fair. In addition, the Biology faculty member used the project as the basis for an independent research project by a biology major interested in research. The student attempted to develop a polymerase chain reaction (PCR) based water testing protocol for microbial contamination and completed a poster presentation of their findings. The MLT faculty and student researchers completed the microbiological analysis of the water and prepared a paper for journal publication. The MLT research students were both active members of the MLT club and became paid tutors for the MLT program. One student continued to conduct research with faculty in the chemistry department at the college post-graduation.

Aim 3: Increase student/faculty extracurricular interactions

The MLT student researchers were encouraged to collaborate with the biology faculty researcher to enhance their Polymerase Chain Reaction (PCR skills). During their didactic coursework, MLT students were introduced to and practiced PCR techniques as it relates to diagnosing and treating clinical diseases. Research across disciplines helped to reinforce the interdisciplinary collaboration and enhanced MLT knowledge beyond the clinical setting. Current biology club members have worked with the chemistry professor

to gain experience working with the instrumentation used to determine the anion content of the water samples.

Outcomes of participating students

Table 2

Participating Students by Major	**Project Activities**	**Student Outcome**
MLT (n=2) Sophomore & Senior	(1) Sample Collection (2) Gram Stain Analysis (3) Microbial Culture (4) Colony Forming Units (CFU) Calculation	(1) Written paper for publication (2) One student graduated fall 2018 and continues to conduct research while working full time in a Clinical Microbiology laboratory (3) 2nd student became a MLT tutor
Biology (n=1) Sophomore	(1) pH Measurement (2) Turbidity Measurement (3) Chemical Analysis Instrumentation	(1) Did not enroll after the summer of 2019 (2) Stopped responding to faculty emails.
Chemistry (n=1) Senior	(1) pH Measurement (2) Turbidity Measurement (3) Chemical Analysis Instrumentation	(1) Poster Presentation, Summer 2018 (2) Graduated, June 2019

Reflections on the project

MLT Student reflection

"During this collaboration, I was able to use several laboratory techniques that I've learned in the MLT program such as; dilutions, testing for cations and anions, cultures, and gram stains, along with skills that I've learned from previous employment at a lab… Legionella testing and using Analytical Profile Index (API). My favorite part was being able to share the process of how the samples were prepared and analyzed for Legionella to the… faculty members because it was something they were not familiar with. This research opportunity gave me the ability to improve my laboratory skills not only in class, but also in the science field. I was able to gain the analytical and laboratory skills I could use in any career in a laboratory. This was a great opportunity to test the skills I have learned in the MLT program and learn new skills along the way."

Chemistry Student reflection

"Being able to interact with other students that were in my major and doing research in my field was incredible. I enjoyed being able to discuss theories about topics within the experiment, or class lessons related to the experiment but to also practice those theories, and terminologies as we proceed with our experiment. I realized that's when it all combines together, theories and practice. After the collection of data another group of students made the examination of the samples. I wished I had been part of that process as well so that I'd learned more about the instruments used and how everything was determined. I was able to present our work in the science fair at our college (Bronx Community College). For me, it was a door opening experience because I was not only able to perform the experiment and be part of the different stages of it but also to present our project and explain how it all was worked out… and even more incredible being something done on our campus."

Faculty reflections

Coordinating student and faculty schedules was a significant limitation. The designated club hours on Thursdays from 12 PM – 2 PM proved insufficient. This was a particular challenge for the MLT students performing the microbial analyses. Faculty teaching and service requirements were also limiting. Consequently, the objective of the original research project was modified from a research project to a project focused on student engagement.

The MLT students experienced limited availability of the culture plates needed to analyze samples due to lack of funding. This limited the access to differential and selective media needed to isolate and identify more microorganisms.

At BCC, students typically graduate in 2-3 years making consistent student participation challenging. Sustaining consistency among student researchers for long term studies (beyond one year) poses a challenge. The MLT faculty experienced challenges continuing the research post fall 2018. Novice student researchers required basic training which required faculty time and oversight. Research memory was lost as more experienced student researchers graduated within a year of starting the project. To remedy student retention for MLT projects so that the training of novice students is not time limiting for faculty, students with varied skill levels will be recruited to join future study's. This process will afford novice research students the opportunity to learn techniques and acquire research memory from advanced outgoing research students.

This project could have been improved by giving the students with strong interest who were willing to make the time commitment the option to take part in all aspects of the project instead of limiting them to specific a discipline as suggested by a student participant.

Follow-up and Future Plans

The original project led to reactivation and participation in the biology club by both biology and chemistry majors. In the summer of 2019 students worked with faculty members from

the biology and chemistry department to evaluate the impact of water quality on the morphology of *Hydra*. The reactivation of the biology club arose out of word of mouth communications between students. To expand the number of student participants further, outreach efforts will include setting up tables on “Club Day” to display the work of STEM clubs on campus and invite students to join. In the Spring and Fall of 2019, MLT students finalized the microbiological analysis of the water samples while simultaneously working on a new project to identify an unknown species of fungi. Future plans include continued design of complete research projects beginning with the generation of a research question, collection of data and hypothesis testing. The goal being to engage students in the full cycle of a research project, ending with documentation and presentation of their work. This would require planning for a lengthier time commitment for both student and faculty which would be best supported if funds are garnered to support the work. This funding would include stipends for students and acquisition of resources. Finally, future projects will be designed to continue to cultivate interdisciplinary collaborations. Faculty from the department of mathematics will be invited to join the faculty participants to enhance the data analysis component of the project.

Related Publications

Aboelela, S. W., Larson, E., Bakken, S., Carrasquillo, O., Formicola, A., Glied, S. A., & Gebbie, K. M. (2007). Defining interdisciplinary research: Conclusions from a critical review of the literature. *Health services research,* 42(1p1), 329-346.

Astin, A. W. (1984). Student involvement: A developmental theory for higher education. *Journal of college student personnel*, 25(4), 297-308.

Bartkus, K., Namelka, B., Nemelka, M., Garner, P. (2012). Clarifying the meaning of extracurricular activity: a literature review of definitions. *American Journal of Business Education,* 5 (6), 693 – 703.

Bronx Community College. (2020). Facts & Figures. Retrieved from https://www.bcc.cuny.edu/about-bcc/facts-figures/

Derby, D. C. (2006). Student involvement in clubs and organizations: An exploratory study at a community college. *Journal of Applied Research in the Community College*, *14*(1), 39-45.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, *111*(23), 8410–8415. https://doi.org/10.1073/pnas.1319030111

Mahoney, Joseph L. (2000). School Extracurricular Activity Participation as a Moderator in the Development of Antisocial Patterns. *Child Development*, *71*(2), 501–516. https://doi.org/10.1111/1467-8624.00160

Mahoney, Joseph L., Cairns, Beverly D., & Farmer, Thomas W. (2003). Promoting interpersonal competence and educational success through extracurricular activity participation. *Journal of Educational Psychology*, *95*(2), 409–418. https://doi.org/10.1037/0022-0663.95.2.409

Meier, A., Hartmann, B. S., & Larson, R. (2018). A Quarter Century of Participation in School-Based Extracurricular Activities: Inequalities by Race, Class, Gender and Age? *Journal of Youth and Adolescence*, *47*(6), 1299–1316. https://doi.org/10.1007/s10964-018-0838-1