Environmental research to engage community college students

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Introduction

Community colleges (CCs) provide a unique opportunity for non-traditional students to pursue higher education. Non-traditional students are typically older and often have family obligations that restrict their time. CCs allow students to study close to home at lower tuition rates, attracting many non-traditional students. However, to pursue engineering or scientific study, it is important that these students transfer and complete B.S. degrees[1]. CCs are also the home to more women than men[1]. This makes CCs an ideal place to recruit a diverse mindset of students into STEM (science, technology, engineering, and math) fields. However, the students are often not exposed to a variety of career opportunities and this limits their career options beyond a 2-year degree[2].

Most CC students view a 2-year college as an avenue for technical training. This is reflected in conversations with CC faculty. The science faculty say that the biology students are mainly training to be nurses and the chemistry students are mainly training to be pharmacy technicians. While this is appropriate for many students, there are students who are curious and intrigued by the idea of having a 4-year degree. However, they are often intimidated and unknowledgeable of what steps to take and what would be required of them to pursue further education. They are also often held down by financial and family obligations that can distract them from their educational goals[3]. This project has a two-fold purpose, to give CC students a new perspective on possible careers involving the sciences and to expose them to research as a method for them to explore their inner curiosity about the world. While giving presentations on different career options is a simple method to provide career guidance, the research component is

a clear method to providing meaningful educational experiences that may change a student's trajectory in their education by wetting their appetite for exploration.

The research aspect of the WATER (Water Analysis for Training in Environmental Research) project offers a unique opportunity to introduce the application of science to currently underrepresented and non-traditional student populations in a way that makes an explicit connection between "studying science and engineering" and "doing something meaningful"[4]. Students express a need to do something meaningful, especially as it relates to large societal needs, and even more specifically, to health and the environment[4]. Connecting research to application often requires a leap of understanding that students are unlikely to make without specific guidance[5]. The students complete the WATER program with a clear understanding of how research can be used to better public health and the environment. The goal is to provide more meaningful opportunities for students to experience science and to use their curiosity, along with training in the scientific method. These experiences and enhanced STEM career guidance is expected to lead to students exploring more 4-year degrees and to pursuing STEM careers. By working through a CC for recruitment, a more diverse population of students will be exposed to STEM career guidance and be able to experience research while maintaining their current obligations in their home community.

Methods

For the past 5 years, the WATER summer research program has commenced at the CC. Two faculty were selected to lead the group of about 10 research students each summer. One faculty was from biology and one was from chemistry. The students would collect weekly

samples from a local river and spend the remainder of the week analyzing the samples and creating posters for result dissemination. Once per summer, the university faculty mentor would visit the group to talk about career options and mentor the students to pursue further degrees. All survey data was gathered through Institutional Review Board approved surveys and future educational accomplishments were gathered through the National Student Clearinghouse, with permission. The Clearinghouse has data for 98% of all students enrolled in public and private U.S. institutions[6].

Results and Discussion

The WATER project has provided an open-ended research experience for 86 students over the past 5 years. The first year the project was provided for a full class and was a 1 day project in water filtration. The second year was a one day class in testing water samples from different local rivers. After that, students were invited to join the group for a full summer experience. Control students were surveyed that were in an equivalent chemistry or biology class, therefore demonstrating their interest in STEM, but being a comparison to the WATER group to see if the research project played an important role in their future education.

Figure 1: Students and CC faculty gathering water samples, summer 2014.

The summer WATER project involved students gathering water samples (as shown in Fig. 1) from assigned areas in a local river. The GPS coordinates of the samples were recorded, as well as the water temperature. The students collected water about 6 inches below the surface in sterile jars and the samples were kept cold

until tested. The biology students plated the samples onto five different types of nutrient agar plates that support the growth of different microorganisms[7]. The chemistry students tested the pH and the presence of different chemicals, with a focus on metals. Most of the tests were conducted with test strip tests to reduce the cost of testing.

The students were surveyed at the beginning of the project to discern their background and future expectations. The demographics of the control and WATER groups were similar, with 61% female in the control group and 69% female in the WATER group. The control group was 46% African-American and 37% white and the WATER group was 64% African-American and 25% white. This demonstrates that the focus on CCs could add much needed diversity to STEM fields.

The WATER project students were more optimistic about their future educational goals than was the control group. The WATER students expressed an interest in research, but had lower educational expectations of 4-year degree attainment. Than the control group. Both groups had the same average GPA, even though the WATER project students had a wider grade point average (GPA) distribution, as shown in Fig. 2. The WATER project students were slightly older than the control, had about the same number of semester completed at the CC level, but the WATER project students had completed more CC credits. This demonstrated that they were non-traditional students coming back to college after a hiatus, but were taking more credits per semester than the control group. When asked about fields they would like to work, the WATER project students had a large variety of answers, whereas the control group focused on the medical

field and engineering. The largest barrier to education was working full time and lack of money for the control group, which amounted to 75% of the answers, whereas the WATER project group was evenly split between working full time, caring for family members (children or parents), and lack of money (25% answered for each). What is a likely scenario is that the WATER project students were extremely motivated to pursue an education, but were more distracted by environmental issues (financial or family obligations). These issues are likely the cause of the greater GPA spread than the control students.

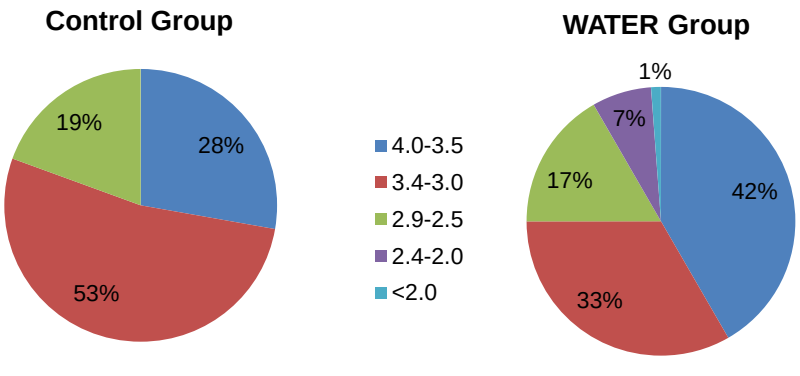

Figure 2: Comparison of GPA of the students conducting the WATER project and the control group. The overall GPA was higher for the control group.

The most exciting part of the project was the increase in graduation rates from 4-year and 2-year institutions by the students in the WATER project as compared to the control group (see Fig. 3). This was the hope of the project, and we have now been conducting it long enough to start to see results. The percentage of students from the WATER project that graduated from a 4-year university and that are currently enrolled in a 4-year university is doubled that of the control group. Also, 28% of the WATER group graduated from a 2-year institution, as compared to 20% of the control group. While this data does not show causation, there may be role to play in providing open-ended research projects to CC students, along with additional career guidance,

that motivates them to complete degrees at a 2-year or 4-year institution as compared to the control group.

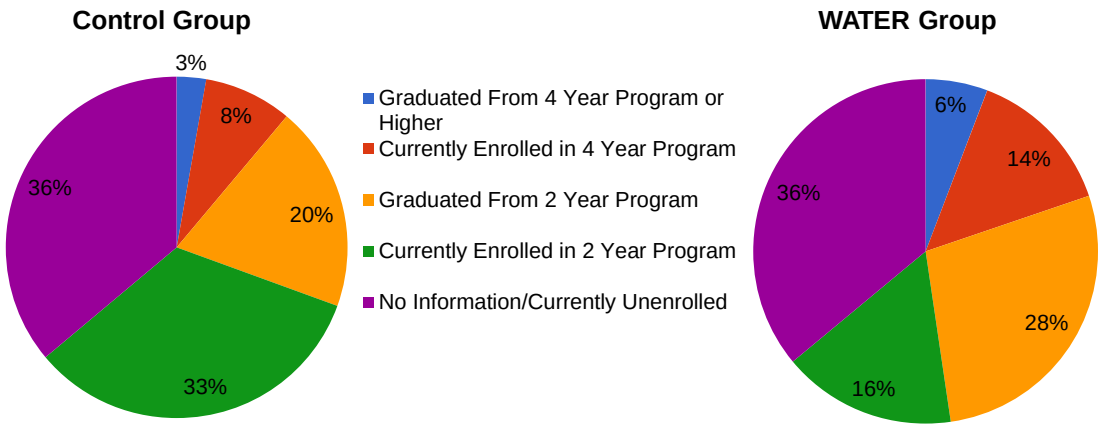

Figure 3: Comparison of educational achievement, as of Dec 2017, of WATER project students and control students.

Conclusions and Future Work

An open-ended research project has been conducted at a community college to test the hypothesis that open-ended research, as compared to well-developed, labs that are usually given at the beginning levels of scientific education, may be a fruitful avenue to inspire CC students to pursue 4-year degrees and beyond. This project is an ongoing work in progress on how to use the resources at the CC level to provide an open-ended research project that more commonly occurs at a 4-year research university. The goal is to inspire more diverse students to purse STEM related 4-year degrees. Environmental monitoring was chosen as a way to show the social importance that science can play in a person's life and to use this as inspiration for further STEM studies.

The next steps for this project are to institutionalize the program for future student cohorts. Also, more formal career counseling is needed so that it can be done locally at the CC and not rely on the university partner to conduct this part of the project. Finally, environmental engineers and/or scientists are needed to more fully analyze the data collected and to guide future analysis projects so that the results can benefit not only the CC student's education, but also the field of environmental engineering.

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