AC 2012-3041: SUMMER PROGRAM FOR TRANSITIONING STEM MINORITY STUDENTS FROM TWO-YEAR TO FOUR-YEAR COLLEGE DEGREES

Dr. Aurenice Menezes Oliveira, Michigan Technological University

Aurenice Oliveira is an Assistant Professor in the Electrical Engineering Technology program at Michigan Technological University. She received the Ph.D. degree in electrical engineering from the University of Maryland, Baltimore County, USA, in 2005. Her current research interests include communication systems, digital signal processing, optical fiber systems, and engineering education. Oliveira is the Michigan Tech Project Director of the U.S.-Brazil Engineering Education Consortium funded by FIPSE - U.S. Department of Education. Oliveira has also been contributing to STEM K-12 outreach initiatives, minority and diversity programs, and to the NSF-ADVANCE initiative at Michigan Tech. D Oliveira is a member of the IEEE Photonics Society, the IEEE Women in Engineering Society, and the American Society of Engineering Education (ASEE).
Abstract:

In this paper we describe a summer program designed to support institution-wide improvements in community college students’ transfer and attainment of a baccalaureate degree. The program helps community college students transfer to a four-year institution by addressing the opportunities and challenges for students who want to pursue a baccalaureate degree. It encourages academically and economically disadvantaged students as well as minority students, Hispanic-American, Native American, and African-American, to continue their education beyond community college. The program includes academic tutoring and comprehensive advising, 3-credit university-level course, competitive stipend, and room/meals. Students live on the University campus while completing an undergraduate research internship with a faculty member and graduate students. The program has achieved a success transfer rate of over 70% in the past years, and has received several awards including the ABET 2010 Claire L. Felbinger Award for Diversity, for the extraordinary success in achieving or facilitating diversity and inclusiveness in the technological segments of our society.

1. Introduction:

There is broad consensus that U.S. competitiveness in an increasingly global economic environment relies on getting more Americans interested in and sufficiently prepared for STEM-related jobs. The STEM workforce accounts for more than 50% of the nation’s sustained economic growth [1]. Reports by NIH, NSF, the Department of Education, and the U.S. Department of Labor corroborate that our nation needs to increase the supply and quality of future STEM workers by improving the pipeline into the STEM fields for low-income and/or minority, first-generation-to-consider-college, and rural students [2]. As of 2007, 52% of the current STEM workforce had reached at least 50 years of age. The Bureau of Labor Statistics projects job growth of 22% for STEM occupations between 2004 and 2014 [1]. Nearly all the major STEM groups are expected to have about the same rate of growth as the national average of 13%. Most of the highest-growth occupations require a postsecondary education. Increasing the STEM workforce will be of particular importance within the next decade as the U.S. is dealing with large infrastructure and maintenance needs. The US Bureau of Labor Statistics has stated that, over the course of an average career, an individual with a bachelor's degree will earn $376,000 more than someone with an associate's degree.

However, while job opportunities are increasing, the number of students studying in STEM fields has decreased [3]. For instance, unflattering stereotypes about what an engineer does, and the type of people who become engineers has long plagued engineering and taken a toll on the next generation of engineering technologists [4]. Misunderstandings include: engineering is too hard, technologists spend all their time alone in front of the computer, jobs are manufacturing-based and devoid of creative innovation, and neither engineers nor
technologists do work that makes a difference in the world [5],[6]. The program that we describe here is designed to bridge STEM community college students transfer to a four-year institution, and to dispel the myths about STEM areas and engineering technology.

Research suggests that the main barriers to STEM education among students like those we work with include lack of: 1) family understanding/engagement to support STEM study, 2) low academic confidence and college preparedness, 3) confidence to pursue STEM study at a 4-degree institution, 4) understanding of financial aid options, and 5) awareness of the availability of high-paying careers with a bachelor degree [7], [8]. Therefore, our overall goal is to provide a comprehensive and sustained program to address these barriers within the selected population. This will result in increased STEM degree attainment among students who are currently underrepresented in the STEM workforce.

The seven-week summer program that we describe in this paper is part of the Michigan College and University Partnership (MICUP). The Michigan Tech’s MICUP program helps community college students transfer to a four-year institution by addressing the opportunities and challenges for students who want to pursue a bachelor's degree. The program encourages academically and economically disadvantaged students as well as minority students, Hispanic-American, Native American, and African-American, to continue their education beyond community college. The program includes academic tutoring and comprehensive advising, 3-credit university-level course, competitive stipend, and room/meals. Students live on the University campus while completing an undergraduate internship with a faculty member and graduate students. This experience strengthens students’ academic background in their major. Students are more likely to graduate from higher-education institutions when they are in settings committed to their success, providing clear expectations for their learning, providing academic and social support, providing frequent feedback about their performance, and require them to be actively involved in learning with other students and faculty [9], [10], [11], [12]. Our program is designed to create these Educational Learning Communities. The program is sponsored by the State of Michigan Department of Energy Labor & Economic Growth and its King-Chavez-Parks (KCP) Initiative, and the NSF Louis Stokes Alliances for Minority Participation (LSAMP) program. The goal of the KCP Initiative is “to increase the number of Michigan’s most educationally disadvantaged citizens who have the opportunity to complete college degrees and experience career success as active participants in a knowledge based global society and economy” [13]. Our program has achieved a success transfer rate of over 70% in the past years, and has received several awards including the ABET 2010 Claire L. Felbinger Award for Diversity, for the extraordinary success in achieving or facilitating diversity and inclusiveness in the technological segments of our society.

2. Program Participation and Student Requirements:

The attractive reason for College students to participate in our program, include:
- Students receive a competitive stipend ($2,500);
- A scholarship for a three credit summer course at Michigan Tech;
Students live on our campus for seven weeks with room, board, and meals from Michigan Tech’s Housing and Residential life;
Students participate in an undergraduate research internship in their desired area of study, and develop a professional research poster with a faculty mentor;
Group activities;
Specific assistance related to non-traditional students needs. (Community Colleges are proven training grounds for future community leaders and we know that there are many non-traditional students among them. These students can require specific assistance related to their needs).

2.1. Students’ Requirements:

Students must be pursuing a Community College degree in one of these fields:
- Computer Science
- Mathematics
- Science
- Engineering
- Technology (mechanical or electrical engineering)

In addition, students must also:
- Have a minimum GPA of 2.80 on a 4.00 scale;
- Have completed your freshman year at a partner community college;
- Plan to continue your education at a four-year institution (not necessary our institution).

2.2. Students’ Selection:

The selection of students for the program is based on the evaluation of application material such as:
- Complete application form, which include personal and academic information, in addition to applicant’s desired area of undergraduate research;
- Statement of intent (with 250 words or more) describing why the applicant would like to participate in the program, what the participant would gain from this experience, and how the program will help the participant career goals;
- Updated transcript;
- Faculty recommendation.

2.3. Faculty’s Selection:

The selection of faculty is based on faculty interest in mentoring low-income, first-generation and/or underrepresented community college students, and on promoting and encouraging successful transition to four-year institutions throughout the state. Faculty mentors are not financially compensated for participation in this program. The faculty-student match is based on the faculty’s research area and student research interest. Faculty mentors must fill up a mentor interest form provided by the Michigan Tech’s MICUP program in order to volunteer for the program.
3. **Summer Undergraduate Research Internship Experience:**

Students participating in the summer undergraduate research internship experience will gain, among others:

- Undergraduate research internship experience with faculty mentor;
- Professional development seminars (one per week);
- Professional poster presentation training;
- 7-week on campus living experience;
- Participant progress reports.

3.1. **Summer Undergraduate Research Internship Learning Outcomes**

- Learn basic principles of scientific research in Academia;
- Become familiar with the university academic environment;
- Learn how to research the technical literature online and use the university library resources;
- Learn how to write a technical report and a how to create a technical poster;
- Develop presentation skills;
- Understand the difference between requirements for 4-year degree courses and 2-year degree courses;
- Learn basic computer and software skills such as: use of Excel®, MS Word®, Power Point®, etc.
- Become familiar with the use of discipline specific software and simulation tools such as: Multisim®, LabView, CAD, etc.
- Learn about the discipline specific topic of research such as: electronics communications systems, power electrics, motors, mechanic systems, etc.

3.2. Summer Undergraduate Research Internship Learning Objectives

- Student participation in this program will generate a positive recognition of the various facets of STEM;
- Recognition will result in increased interest among prospective STEM students;
- Open the college “door” to underrepresented students, especially in STEM areas;
- Increasing students interest, hence a greater enrollment in STEM disciplines at the bachelor level;
- Retaining post-graduate interest in STEM area disciplines;
- Contributions of the program to the STEM-learning knowledge base.

3.3. Undergraduate Research Projects Examples

Project 1:
In this section, we present the first example of undergraduate research in Electrical Engineering Technology conducted by a Michigan Tech’s MICUP Summer Program student in a few weeks of summer 2010. In this case, the student took a 3 credit course in data communications, and the goals for the undergraduate research were closely aligned with the topics that the student was learning in that class. The project focused on Fourier analysis of periodic signals and its applications to data communications. This particular project was tailored to fit the short time window of the program, which was total of seven weeks with research posters due by the end of the 5th week. The project and the 3-credit course provided the student with the opportunity to:

- Apply knowledge of mathematics to solve engineering problems;
- Design and conduct experiments in the laboratory;
- Use laboratory equipment to solve engineering problems;
- Use programming to solve engineering problems;
- Develop and improve computer skills.

The project consisted of using a function generator to create specific signal waveforms to be analyzed in both time domain and frequency domain, using measuring devices such as oscilloscope and spectrum analyzer. The student also learned how to use Electronic Workbench Multisim® to simulate the experiments prior to the hand-on lab experiment.
The simulations provided a link between the theory learned in the classroom and student’s research and the actual lab experiment. This project reinforced several key concepts in data communications such as periodic signals, Fourier series, harmonics, bit rate, and channel bandwidth.

Some of the challenges the student indicated during the course of the project were:

- Existence of a gap between class material covered at Community College and what is covered at the Michigan Technological University in a similar class;
- Not adequately prepared for laboratory environment;
- Not proficient in using basic computer software (Word, PowerPoint, Excel) needed for the class and project;
- Deficiency in pre-requisites for Michigan Technological University classes.

At the end of the 5th week, the student made a poster with the project results to be presented in the overall Summer Program poster section along with the project posters of other students and mentors.

The Summer program student provided the following feedback at the end of the 7-week program:

“The MICUP internship was an excellent experience. Once the direction was laid out, my primary focus was to succeed in the class and working in the project with my mentor.”

“I increased my laboratory and computer skills.”

Fig. 3: Summer Program student Darlene and her lab partner.
Project 2
In this section, we present the second example of undergraduate research conducted by a Michigan Tech’s MICUP program student in a few weeks of summer 2011. The project focused on the investigation of key technological and social aspects of digital inclusion in the United States. The assigned goals were:

- Understand the technological and social impacts of digital inclusion (or exclusion);
- Become familiar with basic computer software applications, and with technical writing;
- Become familiar with the university academic environment.

In this case the student didn’t have the hands-on lab component as in the first example, instead, the research was conducted based on literature review. The students experience was based on learning how to research the technical literature online and using the university library resources such as books, journal articles, magazine, and periodicals in general. The particular topics investigated by the student were:

- What is digital inclusion?
- Economical impact of digital exclusion;
- Social impact of digital inclusion;
- Teaching methodologies for digital inclusion;
- Important services for those with access to the digital world;
- Main access technologies used for digital inclusion;
- Statistics on digital inclusion in the United States.

The conclusion of this research project revealed that the digital divide is an ongoing problem not only in the United States but all over the World. Showing people the benefits of digital inclusion and how it can improve their lives both socially, economically, and culturally is essential in bridging the digital divide gap.

Similarly to the first project, at the end of the 5th week, the student made a poster with the project results to be presented in the Michigan Tech’s MICUP Summer Program poster section along with the project posters of other students and mentors. Both first and second projects listed here as examples were advised by a faculty member with a doctoral degree in Electrical Engineering. The faculty member conducted weekly meetings with the students and almost daily email exchange to follow student’s progress, needs, and any issue related to campus life. The faculty member was also involved with student’s lab needs in all the steps of the project. Small projects like these ones can be investigated in a variety of STEM areas. The main goal is to provide students with an undergraduate research experience as one of the key components to create educational learning communities.

Based on students’ feedback, and success rate in their classes and projects, the learning outcomes were met for both projects used here as examples. Providing undergraduate research with a faculty mentor, 3-credit classes, and out-of-classroom academic and social support creates an excellent learning community, and encourage minority students continue their education beyond community college.
4. Program Statistics and Recognition:

The program has achieved a success transfer rate of over 70% in the past years, and has received several awards including the ABET 2010 Claire L. Felbinger Award for Diversity, for the extraordinary success in achieving or facilitating diversity and inclusiveness in the technological segments of our society. In Table 1, we show the program achievements summary with data from years 2001 to 2010, and in Fig. 5, we show number of program participants. The number of participants has steadily increased in the past years thanks to the Michigan Technological University Center for Diversity and Inclusion efforts to bring a more diverse population to our campus, which has a predominantly Caucasian male population. Table 1 also includes 21% non-STEM students, from Business. However, the majority of the students’ participants in this program are from Engineering (33%) and Sciences (46%). A new 100% STEM disciplines program is currently being developed at our institution. The data presented here was collected by the Michigan Technological University Center for Diversity and Inclusion [14].

Program National Recognition

- ABET selected the program to receive the 2010 Claire L. Felbinger Award for Diversity, for the extraordinary success in achieving or facilitating diversity and inclusiveness in the technological segments of our society.
- The Michigan Tech’s MICUP Program received the Innovative Program Award from the National Association of Student Personnel Administrators, Region IV, 2006.

| Program students served during our summer undergraduate research internship experience. First generation, low income and underrepresented students attending Community Colleges. | 129 |
| Retention rate of transferred students summer internship participants (data from 2001 to 2010). | 70% |
| Program students transferred to Michigan Technological University | 39 |
| Program students currently making progress toward bachelor degree graduation at Michigan Technological University. | 12 |
| Program students that have already received their bachelor’s degree from Michigan Technological University. | 15 |

Table 1: Program achievements summary [14].
5. Conclusions
The Michigan Tech’s MICUP program is designed to help community college students transfer to a four-year institution by addressing the opportunities and challenges for students who want to pursue a baccalaureate degree. The combination of an undergraduate research internship mentored by a faculty member, a 3-credit class, and out-of-class activities focusing on professional development and career goals all contributed to the positive experience the students reported. The program participation and national recognition indicate that the program has been a successful college transitioning experience to make the idea of STEM more appealing to a wider, diverse group of students.

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References: