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The Impact of Summer Research Experiences on Community College Students' Pursuit of a Graduate Degree in Science and Engineering

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The Impact of Summer Research Experiences on Community College Students' Pursuit of an Advanced Degree in Science and Engineering

The Transfer-to-Excellence Research Experience for Undergraduates program (TTE REU) is a summer undergraduate research program offering multi-disciplinary research projects to community college students in the state of California. TTE REU is hosted by three NSF-funded centers at University of California, Berkeley: the Center for Energy Efficient Electronics Science, the Center of Integrated Nanomechanical Systems, and the Synthetic Biology Engineering Research Center. The overall goal of the TTE REU program is to increase the number of students who will go on to graduate school in STEM. The TTE REU program has supported 44 community college students to date with engagement being spurred on by research. Each TTE participant is paired with two mentors-a faculty advisor and a graduate student mentor-who oversee and guide the student during their nine-week internship in an independent research project. In addition to their research projects, TTE participants are trained in laboratory safety, research protocol, and professional ethics; they partake in academic and professional development seminars to prepare for a baccalaureate degrees and careers in science and engineering. Approximately 94% of the past TTE students eligible to transfer to a 4-year institution were admitted to and are now enrolled various universities across the nation and majoring in science or engineering in comparison to a 39% statewide average[1]. This paper will focus on the impact of the program on the interest in pursuing an advanced degree in STEM after participating in the TTE REU program.

TTE REU Overview

The TTE REU program began in 2011, at the Center for Energy Efficient Electronics Science and consisted of 2 students. In 2012, NSF funded a REU Site to expand the existing TTE REU Program at the University of California, Berkeley. This award allowed community college students from across the state of California to conduct research for 9 weeks at the University of California, Berkeley. The objectives of the TTE REU Program are to provide a research experience on cutting-edge research projects, advise students on how to prepare to transfer to 4 year colleges and universities, and to expose the students to professional career opportunities available in STEM disciplines. Community colleges typically host very diverse student bodies in terms of gender, ethnicity, race, and socio-economic status. The TTE REU program hopes to tap this student body to increase the diversity of students pursuing a four year degree in a STEM field.

Since the addition of the NSF Site funds, the TTE REU now hosts approximately 15 students per summer. Each student is paid a $3,600 stipend for the summer, as well as a travel allowance of up to $350. All students are also provided with room and meals throughout the summer.

Each participant is matched with a faculty member whose research focus is similar to the participant's academic interests. Participants have two research mentors, the faculty advisor and a graduate student or post-doc mentor, who oversee the student's research project. Graduate student mentors are offered a $1,000 stipend at the end of the summer. Mentoring occurs through

research group meetings and one-on-one discussions. Each student has their own hands-on independent research project that is intended to further develop the student's interest and knowledge in science and engineering careers.

The TTE REU program consists of a 9 week summer long research internship. During the first week, students take part in a laboratory "boot camp" that introduces basic laboratory and research skills in order to acclimate the students to the university and labs. Students also participate in an orientation that covers strategies for reading research journals, maintaining research notes, ethics, safety training, data analysis, and basic software introduction (Office, Matlab, Adobe, etc). The remaining 8 weeks see the students working on their research projects for approximately 40 hours per week. They also have regularly scheduled seminars and workshops that have a wide variety of topics including: information about their majors, writing personal statements, financial aid, professional skills, science communication, and transfer preparation. At the end of the summer, all students complete a personal statement, write a 2 page research paper, a research poster, and a 15 minute research presentation. After the summer is over, all students are automatically enrolled in the University's Transfer Alliance Project (TAP) which will provide continued support and advice on putting together a competitive transfer application for the university of their choice. The students are also offered a stipend of $1000 in travel funds in order to present their research project at a national conference. The TTE REU program is described in greater detail by Artis[2,3].

Data Collection Methods

The evaluation of the TTE program examines the overall success of the REU Site. Formative evaluation for each cohort of participants is conducted to ensure that the program is progressing as planned. The formative evaluation measures include a survey conducted midway, examination of weekly research journal entries, and one-on-one progress meetings. The summative evaluation, also includes a number of measure and is conducted at the end of the research experience as well as during some follow-up communications. The items that make up the summative evaluation include pre- and post-surveys (pre-surveys were administered at the start of the program), exit interviews, and data tracking as the students leave the program and return to their home institutions. The summative evaluation is completed for each TTE REU class to determine the impact of the program and the extent to which it has achieved programmatic and participant goals. The evaluation uses a mixed-methods approach that includes qualitative as well as quantitative data collection. Quantitative measures include responses to survey questions and evaluation rubrics that were developed with Likert scales. Qualitative measures consist of analysis of one-on-one and focus group interviews as well as observations made through the examination of students' weekly research journals.

An additional component of the overall evaluation plan includes feedback from all program stakeholders. In addition to the feedback from the community college students, faculty and graduate student mentors, and program staff also provide evaluation information regarding the impact of the program. The community college student evaluations include:

- Quality of mentoring guidance received by the student during the research experience
- Level of interest in the topic of the research project
- Self-reported level of personal growth and confidence in research skills and scientific or engineering knowledge
- Any personal challenges faced during participation in the program
- Awareness of the application process for a 4-year college/university as well as graduate school
- Understanding of additional disciplines within STEM
- Understanding of other career options within STEM
- Perception of experiences in interacting with program staff
- Whether or not they are interested in extending their research efforts after completion of the summer program
- Involvement in the development of a scientific publication
- Self-reporting of future plans, especially as they relate to transferring to a university or to graduate school
- Overall level of satisfaction with the summer research program
- Any suggestions that they have for improvement

Evaluation Results

One of the goals of the REU program is to increase the diversity of the students who are pursuing degrees in STEM, especially advanced degrees in STEM. Table 1 includes the demographic data from the program across the three years of operation under the REU Site funding.

Table 1. Demographics of Student Participants

	2012	2013	2014
Male	11	12	8
Female	3	4	6
Hispanic	1	6	4
Non-Hispanic	11	10	9
Do not wish to provide	0	0	1
American Indian	1	0	1
Asian	4	4	5
Black or African American	4	0	0
Native Hawaiian or other Pacific Islander	0	0	0
White	4	8	4
Do not wish to provide	1	4	4

As it can be seen from the data presented in Table 1, the student participants represent a fairly diverse group of learners.

Students were also asked what the highest degree level they expected to earn. This question was asked both pre-summer experience and post-summer experience. The data from this analysis is presented in Table 2.

Table 2. Degree Aspirations for Research Participants

	2012		2013		2014	
	Pre-	Post-	Pre-	Post-	Pre-	Post-
Associate's	0	0	0	1	0	0
Bachelor's	0	0	2	2	2	0
Master's	3	0	6	3	3	7
MD	2	2	1	0	1	2
PhD	8	8	5	8	6	6
Undecided	1	4	2	1	3	2

The data in Table 2 represents a slight shift upwards in the number of students who expect to earn advanced degrees. In the 2013 cohort, an addition 3 (20% of the total) plan to earn a PhD as their highest degree. In 2014, there is a similar shift upwards of the number of students who intend to pursue a Master's degree. In the first year of the program (2012) there was a shift in the number of people who went from desiring a Master's degree to the "undecided" category. Hopefully, these students are undecided between a Master's and a Phd; however, it is impossible to know for sure if this is the case since the data is not available in paired format. Of the students who are currently eligible to transfer (all but the 2014 cohort), 94% of the students have transferred to a 4 year school to pursue a Bachelor's degree. Of the students who have transferred, 97% are pursuing a degree in STEM.

Students were also asked a number of questions with a 5-point Likert scale about their career intentions pre- and post-experience. Table 3 includes the data from this portion of the survey.

Table 3. Student intentions for further study or careers.

How likely are you to…..		Very Unlikely	Somewhat Unlikely	Neutral	Somewhat Likely	Very Likely	Avg.
Attend a 4-year institution	Pre-				1	43	4.98
	Post-	1			2	40	4.86
Pursue a Bachelor's degree in the field of science or engineering	Pre-				1	43	4.98
	Post-	1				42	4.91
Attend graduate school	Pre-			3	22	18	4.35
	Post-	1	1	6	13	19	4.20
	Pre-		5	8	17	14	3.91

Pursue a graduate degree in one of the fields represented by the REU	Post-	4	3	9	12	12	2.53
Pursue a graduate degree in science or engineering	Pre-		1	5	15	22	4.35
	Post-	1	1	5	14	21	4.26
Pursue a career in science or engineering*	Pre-				4	24	4.86
	Post-	1				26	4.85
Pursue a career in one of the fields represented by the REU	Pre-		4	5	20	14	4.02
	Post-	4	2	6	17	11	3.73

*Not asked in 2013

As it can be seen from the data presented in Table 3, student enthusiasm for many of the things we hoped to improve, actually decreased by a slight amount. This could be due to the fact that students had unrealistic expectations of what research would actually entail. In this case, the REU served a valuable role in helping them to form informed opinions of what graduate school and careers in the field entailed. Another explanation for the data could be that the program was not meeting the needs of the students and should be revamped. We are exploring this data further to determine a course of action going forward.

Conclusion

The TTE REU program provides community college students with the opportunity to conduct rigorous research for a summer at University California, Berkeley and learn more about transferring to 4-year universities. Students who have participated in this program have seen a significant improvement in transfer rates into a 4 year school to 94% when compared to a 39% statewide average[1], and of this, 97% of those who transferred are now working towards an undergraduate degree in a STEM major. Participants also leave at the end of the summer stating a higher career aspiration while also feeling like they are less likely to attend graduate school.

[1] Community Colleges Chancellor's Office- Management Information Systems Data Mart http://datamart.cccco.edu/Default.aspx

[2] Artis, S., et al, *Transfer-to-Excellence: Research Experiences for Undergraduates at California Community Colleges,* Presented at ASEE 2014

[3] Artis, S., et al, *Development of a Multidisciplinary Summer Research Program for Community College Students in Science and Engineering,* Presented at ASEE 2013