



The Impact of Summer Research Experiences on Community College Students' Self-Efficacy

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The Transfer-to-Excellence Research Experience for Undergraduates program (TTE REU) offers multi-disciplinary research projects to community college students in California, hosted by the University of California, Berkeley. The overall goal of the TTE REU program is to increase the number of students transferring to a 4 year school to major in science and engineering by enhancing self-efficacy. To date, the TTE REU program has supported 55 community college students. Each TTE participant is hosted and advised by a faculty member and mentored by a graduate student mentor, who provides day to day support to the student during their nine-week internship in an independent research project. This paper will focus on the impact this program has on the students self-reporting of their self-efficacy through an analysis of the program participants and the students who applied but were not accepted into the program. All TTE REU participants were surveyed before and after the research experience and asked 4 self-efficacy questions. Most of the students' reports of self-efficacy increased after the completion of the summer research program. In addition to the pre-post survey comparison among TTE participants, we administered a survey to a group of community college students that applied to but did not participate in the TTE program. The non-participant group received the same survey as the TTE participants during the post-participation period. Having a group of participants and non-participants allowed us to compare whether the TTE group reported higher self-efficacy than their peers who would not have had the opportunity to participate in a similar experience.

Introduction

In the next decades, the United States is facing a severe shortage of scientists and engineers. Traditionally, students in these majors are male and come from non-Hispanic white or Asian populations. With the shifts in the U.S. population demographics, the need for attracting and retaining students coming from non-traditional backgrounds has intensified. Nationwide, of the students enrolled in science and engineering bachelor programs in 2012, approximately 20% were women, 5% were African American/Black, and 10% were Hispanic.² Currently the US population is 17% Hispanic and 14% African American/Black, but projections show that by 2060, the US population will be 29% Hispanic and 18% African American/Black.³ In order to meet the nation's future engineering and technology needs, a more diverse pool of students must be attracted to major in science and engineering.

To address this problem, a push has been made to recruit students from community colleges to transfer into a bachelor program, majoring in STEM. Community colleges have a diverse population to pull from, 57% are women, 14% are African American/Black and 16- 20% are Hispanic.^{2,4} The national transfer rate in 4-6 years for students enrolling in community college with the intention to transfer to a bachelor program is between 25-39% and efforts are needed to increase this transfer rate.⁴

Past studies on increasing the diversity of engineering have focused on social cognitive career theory.¹ Within this framework, researchers have examined the role of self-efficacy and its correlation to academic achievement in science and engineering. Self-efficacy is a person's belief that s/he has the ability to achieve their goals, such as a career in science or engineering. Self-efficacy is more than self-confidence, as it is situational dependent. Studies have shown that increased self-efficacy reporting leads to students being more successful in science and engineering. High self-efficacy can positively influence academic persistence and perseverance in attaining career related goals.^{6,7}

There are four predominant factors that lead to the development of self-efficacy in an individual. *Mastery experiences* are the most significant factor in developing self-efficacy and occur when a person masters a task that s/he believes to be difficult. Mastery experiences will often translate from one domain to another, i.e., if a person masters a difficult topic in a calculus course, s/he might believe that they can master difficult topics in physics courses. *Vicarious experiences* occur when a person observes someone they perceive to be a peer have the same difficulties with topics and then observing that peer accomplish the task at hand—"if she can do it, so can I." Faculty, parents, and mentors can provide *social persuasion* as one of the factors in the development of self-efficacy. A faculty member who expresses confidence that the student can master a topic and encourages the student to keep trying, can provide a vital source of increasing self-efficacy. Finally, if a person exhibits a physical reaction (e.g., sweaty palms, racing heartrate) to a task, these *physiological states* can lead to positive or negative changes in self-efficacy. We believe that a summer research experience can contribute positively to the development of each of these four factors and thus to improved self-efficacy for engineering among participants.

With all of this in mind, the TTE REU Program was created with the goals of increasing student self-efficacy and transfer rates of community college students into STEM. The program was designed as an intervention for students so that they would have the opportunity to build their confidence in science and engineering with the goal that this intervention would lead to increased transfer rates to a bachelor program. As detailed by S. Artis⁵, TTE REU brings community college students from around the state of California to the University of California, Berkeley to complete a 9 week summer research internship. The first week of the internship has the students going through a "laboratory bootcamp" whereby the students learn lab safety, tour labs around campus, speak with graduate students and postdocs from different science and engineering disciplines, and learn different laboratory sampling techniques. For the remaining 8 weeks, the students are given a research project under the supervision of a graduate student or postdoc mentor within a faculty lab. Throughout the summer, the students are engaged in weekly seminars about transferring, science communication, or research. They also have the opportunity to speak with people from different engineering and science disciplines so that they can have a better idea of what different majors have to offer in terms of jobs and careers. At the end of the summer, students present their research in a presentation, poster, and research paper.⁵

Methods

Students participating in the TTE REU were given a pre survey before their arrival on campus. This survey asked the students to rate their competency in various areas related to their research, as well as questions pertaining to their self-efficacy. The ratings were on a scale of 1-5, with 1 being strongly disagree and 5 being strongly agree. In regards to self-efficacy, four questions were asked:

1. I have had experiences that made me confident in my ability to perform tasks that will allow me to succeed as a student in science and engineering. (mastery experiences)
2. I have had the opportunity to watch and work with others and have seen them perform tasks that I will need to perform in order to succeed as a student in science and engineering. (vicarious experiences)
3. I have received positive feedback about tasks I expect that I will need to perform in the future to succeed as a student in science and engineering. (social persuasions)
4. I have experienced a lot of anxiety or nervousness about tasks that are related to success as a student in science and engineering. (physiological states)

Students were again surveyed at the completion of the 9-week internship asking the same questions, in order to see if the internship influenced their answers. Data was also collected through longitudinal surveys given to the students on an annual basis, and these surveys were used to determine transfer status of the past interns.

In order to assess the program's effectiveness, students who applied to the program, but were not accepted were also surveyed. The TTE program has a limited number of spaces available, and the students who were not accepted were not necessarily unqualified or even less qualified for the internship, but rather were not accepted due to lack of laboratory space. The students who applied in 2012, 2013, 2014, and 2015 were surveyed in 2015 and 2016. This was done to see if the students were able to have experiences outside of TTE REU that would have led to changes in their reported self-efficacy and to also ensure that it was the TTE REU program causing changes in the survey results. These students were also surveyed in order to see what the transfer rate was among students who did not participate in TTE REU. The control groups were only surveyed once. Surveys were administered to each cohort of the control group approximately 18 months after they were turned down for participation in the TTE program. This timeline was chosen because both participants and non-participants would have had equal time to apply to and matriculate to a four year institution.

Results and Analysis

Students from the 2012, 2013, 2014, and 2015 TTE REU cohorts reported increased self-efficacy for three of the four questions asked. Results for each question and the pre, post, and control group are shown in Figure 1. In total, 55 TTE students participated in the program and 55 responded to both pre and post surveys. Among the comparison group, 176 received the survey, and 42 responded. The demographics for each group can be found in Table 1. The increases were shown in Questions 1, 2, and 3, with the average response being between "strongly agree"

and “agree”. These increases were not shown in the control group, and the control group had very similar ratings in self-efficacy to the TTE REU students, prior to the research experience.

Of the four questions asked, Question 4, pertaining to the students’ reported anxiety is of concern, as it is not significantly impacted by the summer research program. Several things have been tried each year in order to reduce the students’ anxiety. These include addressing anxiety during the student orientation, increased interactions with TTE REU program staff, increased social interactions amongst the students, and addressing this during mentor orientation for the TTE REU mentors. The anxiety rates have not changed as a result of any of these interventions, and each year has presented similar results, regardless of the interventions done to reduce this nervousness. Continued work in addressing this issue is ongoing. However, some researchers have found that it is the individual’s *perception* of their physiological state that is more important than the physiological state itself. In other words, some may perceive a racing heartbeat as an adrenaline rush and perceive this to be a good thing rather than a bad one. Our findings for question 4 could also be influenced by the wording of the question itself. We will be investigating this further in the coming years.

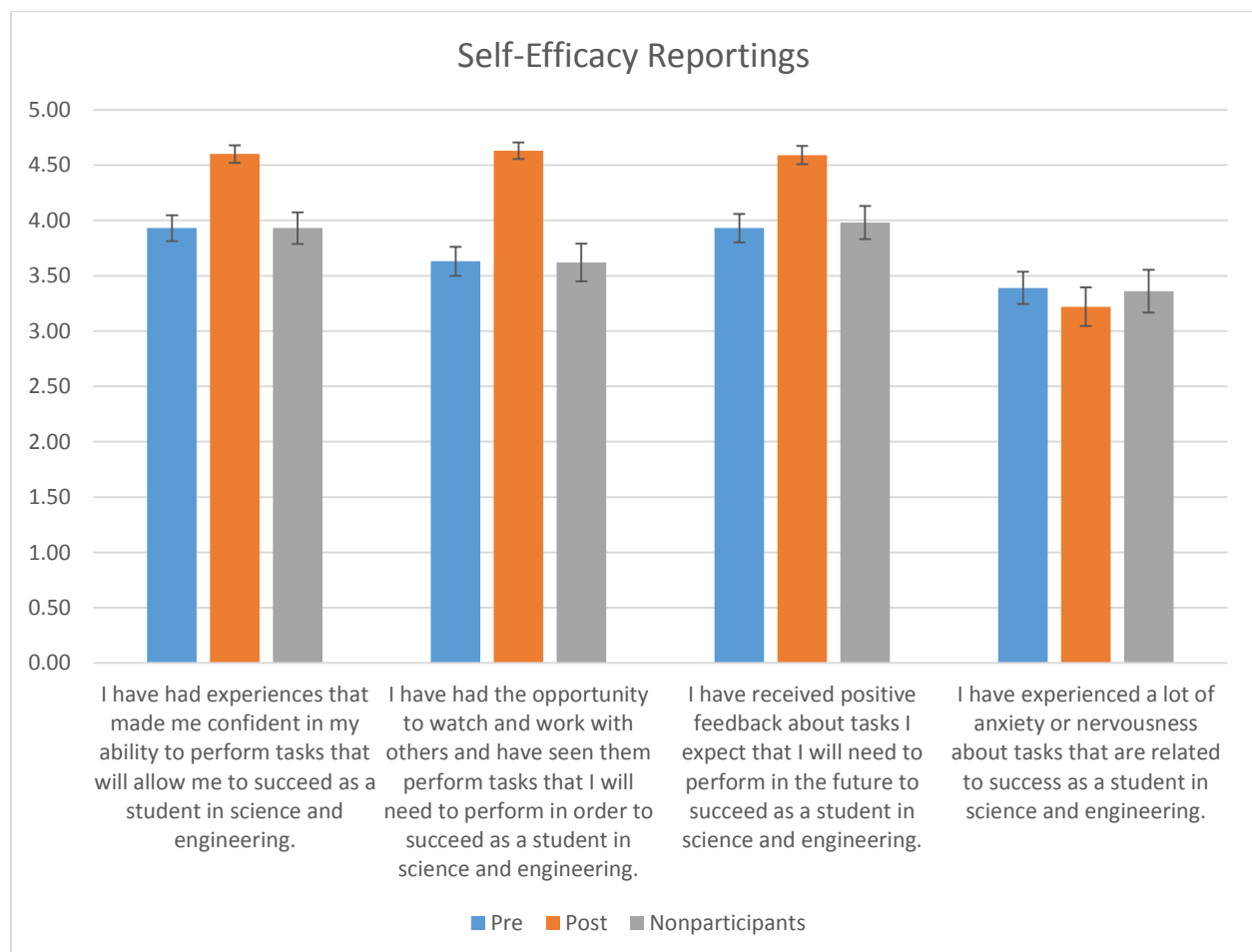


Figure 1: Results from Self-Efficacy Reporting

	Gender	Racial Breakdown	First Generation
TTE Cohort	36% Women	40% Underrepresented Minority	67% First Gen
Control	25% Women	24% Underrepresented Minority	49% First Gen

Table 1: Demographic Information of Surveyed Groups

Students from both groups were also asked various questions in regards to applying to transfer and transfer enrollment in a four-year school majoring in STEM. TTE participants indicate a higher understanding of the admissions process after participating in the TTE program. One interesting finding is that the non-participants indicate higher levels of understanding when asked about the admissions process than participants. While non-participants rated themselves higher in this area, data on admission rates would suggest otherwise.

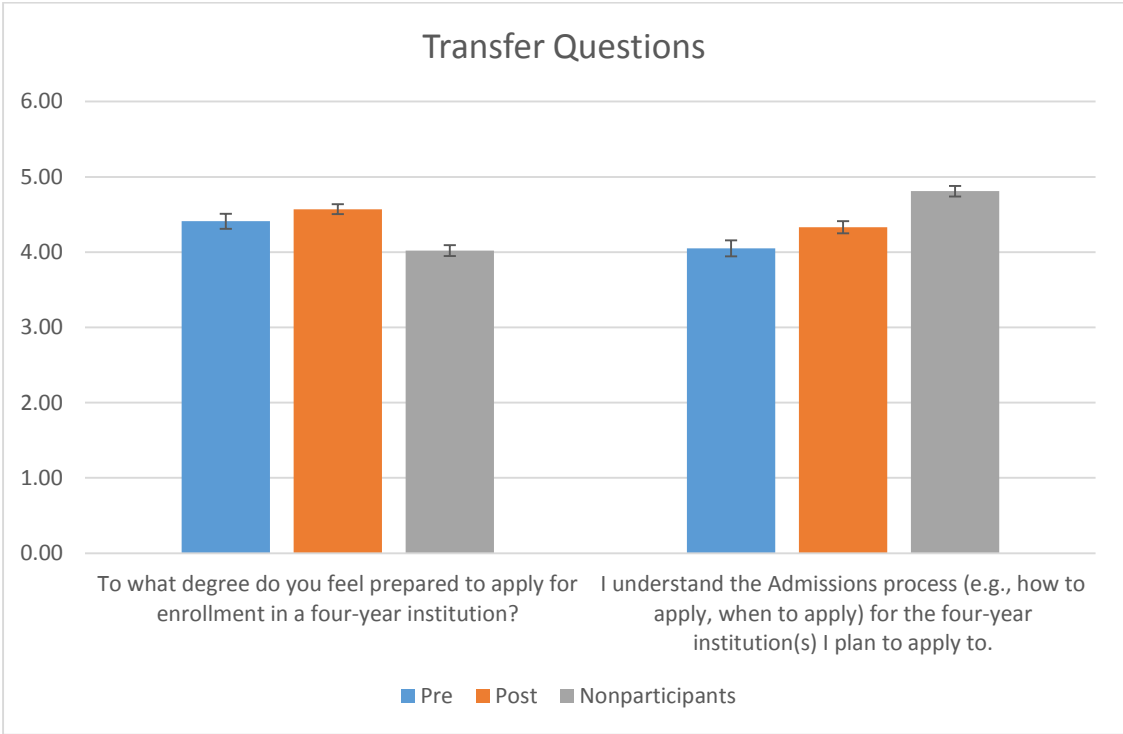


Table 2: Transfer Admissions Reporting

As a result of this intervention, TTE students are successfully transferring out of community college at a much higher rate when compared to the nationwide average. From the 2012, 2013, and 2014 cohorts (At the time of publishing, the 2015 cohort has applied, and will not know admission decisions until after publication.), 86% of the students who participated in our program have gone on to transfer to a bachelors program in science or engineering. In comparison, the control group has a 21% transfer rate, which is similar to the nationwide average.

The demographics of the students who participated in TTE REU in years 2012, 2013, 2014, and 2015 are higher than the national averages for underrepresented students. Thirty-six percent of the TTE REU cohorts were women, 67% were first-generation students, and 40% were underrepresented minorities. Of those who have transferred to a STEM discipline, 83% are from

an underrepresented group. By increasing the transfer rate amongst students from diverse backgrounds, the TTE REU program is increasing diversity within the engineering fields.

Findings from this study provide an initial frame of reference to consider how summer research experiences can improve the self-efficacy of community college students. However, there are several limitations. Among the control group of non-participants the respondents self-selected to submit responses. This could have biased the survey results by only capturing the status of those that took the time to respond. Survey responses among the control group did not solicit information about academic experiences or specific programs they participated in related to four year transfer while enrolled at a community college. Future studies could investigate this further to determine how community college experiences are building students' research self-efficacy and knowledge about transfer to a four year institution. This type of information could further delineate whether the TTE program is helping participants become more informed about four year transfer and building their research self-efficacy or whether other factors such as experiences and programs at the community college level are also playing a role in facilitating these gains.

Another limitation is that it was not possible to provide the non-participants with a pre-survey that would have allowed the comparison of whether these students were starting from the same baseline as the TTE participants. Finally, this study had a delay in providing the survey to the non-participants at the exact same time as the participants were exiting. This delay may have caused only a select group of non-participants to respond to the survey.

Future Work

Future work could look at other REU programs that are designed to facilitate transfer among community college programs to four year universities. It would be interesting to see if other programs see similar rates of success with transfer. Given the success in the number of TTE participants that successfully matriculate to an elite four year university in comparison to other community college students who do not participate in such programs it would also be interesting to compare the rate of transfer for other REU program participants in the context of admissions policies and traditional rates of transfer to their universities among community college students.

Conclusions

Students showed an increase in self-efficacy reporting after the TTE REU Program that was not shown in students who did not participate in TTE REU which suggests that the research experience had a very positive impact on the students. An increase in the transfer rate was also noted in the students who participated, while the students who did not participate had transfer rates similar to the rest of the nation. Similar programs for community colleges should be considered nationwide in order to increase transfer rates from community colleges as well as to add diversity within science and engineering.

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