



Evaluating a Multi-Campus Undergraduate Research Program to Improve Retention of 2+2 Engineering Students

Dr. Cynthia Howard-Reed, Pennsylvania State University

Cynthia Howard Reed is the Assistant Director for Student Research and Graduate Equity and an Assistant Teaching Professor in the College of Engineering at Penn State. She has a MS in Environmental Health Engineering and PhD in Civil Engineering from The University of Texas at Austin and received her BS in Civil Engineering from North Carolina State University. Prior to her position at Penn State, Dr. Reed conducted research in the field of indoor air quality at the Environmental Protection Agency and National Institute of Standards and Technology.

Dr. Jennifer X Wu, Pennsylvania State University

Jennifer Wu is the Director of Engineering Institutional Research and Associate Research Professor in the College of Engineering at Penn State. She has a PhD in Educational Administration from the University of Minnesota, Twin Cities. Prior to her current position at Penn State College of Engineering, she has had diverse experiences in academic advising, global programs, multi-cultural training and communications, and cocurricular event management, all in land-grant university settings.

Mrs. Erin A Hostetler, Pennsylvania State University

Erin Hostetler is the Director for Student Research and Graduate Equity. Erin specializes in administering Research Experience for Undergraduates (REU) programs, with a focus on increasing access to research and ensuring a standard and equitable experience for REU participants. Erin holds a B.S. in Elementary Education and an M.Ed. in College Student Affairs. An alumna of Penn State, Erin has been with the College of Engineering for five years, and a staff member at Penn State for 16 years.

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Abstract

An increasingly common pathway for students to obtain an engineering degree is through a 2 + 2 model. At Penn State, this model has been implemented through students spending their first two years at a Penn State regional campus and then transitioning to the main campus at University Park or another regional campus to finish their degrees. Although there are several programs in place to help with this transition, recent data show a significantly higher attrition rate for change of campus students compared to their counterparts who started at the University Park campus. In 2015, the University Administration and College of Engineering established the Multi-Campus Research Experiences for Undergraduates (MC REU) program to provide a high-impact engagement opportunity for regional campus students and improve their retention. This program is an 8-week research experience for regional campus STEM students that includes working with a faculty for 6 weeks at their home campus and spending 2 weeks with a faculty at University Park. In addition, students engage in professional development and team building activities. To date, about 270 regional campus students have participated in the MC REU program during its five-year tenure. Additional goals of the program include broadening education for regional campus students, increasing the number of regional campus students entering graduate studies, and promoting mutual awareness and collaboration among faculty across the Commonwealth. Anecdotal evidence has indicated a positive effect on the retention of MC REU participants who transfer to finish their degrees or finish at their original campus. To confirm this positive correlation, a longitudinal statistical study was conducted to examine the retention rate of the students who participated in the MC REU program with that of other regional campus students. Results from this study have the potential to confirm a multi-campus undergraduate research experience as a viable strategy to improve retention of students participating in the 2 + 2 pathway to an engineering degree.

Introduction

The significant attrition rate (~ 50 %) for engineering students is well documented [1, 2]. Others have found the attrition rate to be similar or even higher for students who transfer universities to finish their degrees [3, 4, 5]. Some attribute the lower retention rate of transfer students to Hill's [6] term "transfer shock" which is characterized by a dip in a student's grade point average (GPA) during his or her initial semesters at a new school. Although GPAs tend to rebound in subsequent semesters, not all students persevere in engineering to see this happen. To combat these alarming trends, researchers and educators have been searching for ways to help students find success and stay in engineering, no matter their college enrollment path.

A recommended approach to increasing student retention is through more academic and social engagement [7, 8, 9]. A key factor for success is increased student-faculty interactions. In fact, Astin [7] claims "students who interact frequently with faculty members are more likely than other students to express satisfaction with all aspects of their institutional experience." Positive impacts resulting from high quality student-faculty interaction include increased confidence,

more engagement in the classroom, and increased satisfaction with college environment [10, 11]. In a recent study, Lopez and Jones [12] surveyed 280 STEM students (80 engineering) and found the experience of student-faculty interactions at the community college and four-year university level to predict their success in their field of study. Faculty interpersonal validation through increased interactions is especially important for non-traditional students. For example, Rendon [13] found that “students who came to college expecting to fail” were transformed by positive faculty interactions resulting in better integration of students at their college and academic success.

A proven method to increase student/faculty interactions is through undergraduate research projects [14]. As a result of increased student-faculty interactions, undergraduate research enhances interest in STEM careers and graduate school [15, 16] and has been shown to increase retention rates in science and engineering programs [17]. The Council on Undergraduate Research [18] reports the benefits of undergraduate research to include the development of mentoring relationships with faculty, increases in retention and graduation, better understanding and appreciation of the research process, and communication, problem-solving, and critical thinking skills. Furthermore, Zydney et al. [15] reported that the student-faculty interaction played an important role in helping students determine their career choice after college.

This paper presents an application of the undergraduate research experience for students with limited access to research opportunities at their home campus. The application is more unique by incorporating a research project design that includes students working with a faculty at their home institution as well as collaborating with a second faculty at another university campus. This two-campus design allows the student high-impact interactions with multiple faculty and graduate students, as well as promotes new faculty collaborations. Follow up enrollment and graduation data for program participants indicate positive outcomes on retention.

Research Program Model

To provide access and opportunity to students across the state, Penn State consists of several regional campuses and a larger main campus at University Park. This network of campuses provides students the opportunity to begin their degree on one campus and then either complete their degree at the same campus or do so at University Park or another regional campus. In Fall 2019, just over 7,000 students enrolled as first-time freshmen at all the regional campuses compared to just over 8,000 students starting at the University Park campus. Although the campuses operate as “one university, geographically distributed,” co-curricular opportunities for students vary between sites. In particular, there are fewer research faculty at the regional campuses limiting regional campus student research opportunities.

In 2015, the Provost, Vice President for Commonwealth Campuses and the College of Engineering established an undergraduate program for regional campus students to experience research. In addition to facilitating co-curricular engagement, program objectives included providing resources to aid student transitions to other campuses, promoting graduate school opportunities, and supporting research collaborations between faculty across different campuses.

To accomplish these goals, the program was designed as an 8 to 10 week research experience for regional campus STEM students that included working with a faculty for at least 6 weeks at their home campus and spending 2 weeks with a second faculty on the University Park campus.

In addition to research, the two weeks at University Park were designed to expose students to opportunities and available resources through programmed activity. The first week at University Park included an arrival weekend orientation with a program information session, group ice breakers, campus scavenger hunt and a half day leadership challenge workshop at a nearby university recreational facility. During the weekdays, the participants met daily for 1.5 hours with research program staff for professional development workshops (e.g., safety training, research ethics, communication skills, etc.) and laboratory tours. The remainder of their time is spent working with their University Park faculty on their projects with opportunities to use specialized laboratory equipment, meet graduate students, create with makerspace resources, etc. The first week concludes with an ice cream social and debrief for the participants. The second week at University Park occurs toward the end of the research program and also includes professional development workshops geared toward the program's final deliverables (e.g., creating a poster, presenting a poster, writing a research paper, etc.). During this second week at University Park, there is also one workshop session devoted to all things graduate school, including a panel of current graduate students (some of whom were alumni of the research program). Finally, the students return to University Park at the end of the program to present their research at a formal poster symposium. The symposium includes several guest speakers and awards.

Students are selected for the program through a competitive process. They must connect with a faculty on their home campus and submit a short (1 – 2 page) proposal describing the importance of the research, what the student is responsible for, and an associated timeline. Selected participants receive a scholarship, room and board during University Park visits, and a small amount of research funding for their faculty on each campus.

To date, over 260 students from 14 regional campuses have participated in the undergraduate research program during its five-year tenure. Using the University's enrollment data, we were able to follow the academic progress of regional students who participated in the summer research program. To measure the success of the program, a participant-control group design was used to determine whether retention rates were significantly different between regional campus students who participated in the program, and those who did not. In addition, the subset of regional campus student participants who transitioned to University Park to finish their degrees were compared to those who transitioned at the same time but did not complete the research program.

Research Program Evaluation Methods

Since the MC REU program's inception in 2015, a total of 268 different students have participated over five summers. For this paper, the students were grouped into cohorts according to the year they entered Penn State as freshmen. For example, a 2013 freshman cohort is defined

as first-time, full-time baccalaureate-seeking students who started in the summer and continued their enrollment in fall 2013, or students who started in fall 2013. This designation is regardless of the college they were admitted into. Of the 268 total participants, 177 students started at a regional campus according to the freshman cohort definition and are the subjects for this paper. Reasons that students were excluded from a freshman cohort include: they started as a first-time freshman at University Park; they started as a first-time freshman in the spring semester; they did not start at Penn State as a first-time freshman due to transfer or being readmitted.

A summary of the cohort demographics is provided in Table 1. On average, the freshman cohorts included about twice as many men as women. The demographics also reflect the regional campus population of fewer underrepresented minority (URM) students and higher percentage of first generation college students. In general, first generation students are less likely to participate in undergraduate research [14].

Table 1. Demographics of Research Program Participants Grouped by Cohort

Freshman Cohort	Total Head Count	Gender		URM	INT	FIRST GEN
		F	M			
2012	7	43%	57%	29%	0%	57%
2013	20	15%	85%	10%	5%	25%
2014	38	24%	76%	11%	5%	24%
2015	25	28%	72%	8%	8%	32%
2016	40	23%	78%	18%	28%	33%
2017	37	27%	73%	8%	22%	22%
2018	10	20%	80%	0%	10%	30%
Total	177	24%	76%	11%	14%	28%

A subset of the students (101 of 177) in Table 1 started college as engineering pre-majors. Table 2 summarizes the demographics for these 101 students, again grouped by freshman cohort. For the most part, the demographics of the engineering students were similar to the entire data set, with the exception of slightly fewer women.

Table 2. Demographics of Research Program Participants Who Started as Engineering Pre-majors (Grouped by Cohort)

Freshman Cohort	Total Head Count	Gender		URM	INT	FIRST GEN
		F	M			
2012	3	0%	100%	67%	0%	67%
2013	8	25%	75%	13%	13%	13%
2014	23	22%	78%	4%	9%	26%
2015	14	21%	79%	14%	7%	29%
2016	21	5%	95%	10%	33%	43%
2017	25	24%	76%	8%	24%	20%
2018	7	14%	86%	0%	14%	29%
Total	101	18%	82%	10%	18%	29%

Due to the smaller number of students in cohorts 2012 and 2018, we focused our analysis on the 2013 – 2017 freshmen cohorts. Regional campus students can take several paths to finish their degrees. Some students choose to remain at one campus through graduation, while other students spend their first two years at one campus and transition to another to finish their degree. In a typical year, about 60% of University students follow the path of a 2 + 2 plan.

Using Penn State enrollment data, we were able to calculate the following success metrics: retention per year after research program, GPA by semester, and 6-year graduation rate. Retention rate is the percent of a given cohort that remains enrolled at the university. The number of those students who are still enrolled in subsequent fall semesters are counted and divided by the cohort size to determine the retention rate of each year. Their average term and cumulative GPAs were tracked for each term following the research experience. Finally, the graduation rate represents the percentage of students who had completed a bachelor’s degree six years after they started.

For this paper, we were particularly interested in the impact of the research program on the retention rates and GPAs for students who started their engineering degree at a regional campus and transitioned to the University Park campus to finish their degree in a 2 + 2 format. Although, a relatively small number of research program participants fit this category, associated retention values are reported in the results.

Results

An important indication of the success of the research program for regional campus students is whether it influenced a participant’s decision to stay at Penn State. Table 3 shows the retention rate for each freshman cohort of regional students for each year of their academic career. As a comparison, the retention rate for all regional campus students that fit the definition of a cohort is also provided. While the retention rate for research participants is always higher than their counterparts, that difference grows in the years after the research experience (3 years to 6 years). The data in Table 3 clearly show that students who participated in the research program are more likely to stay at the university to finish their degrees than regional campus students who did not engage in the research program.

Table 3. Retention Rates for Regional Campus Students

Cohort	Group	Head Count	Retention Rate					
			1Y	2Y	3Y	4Y	5Y	6Y
2013	In REU	20	95%	85%	85%	90%	90%	90%
	All Students	7796	76%	65%	62%	58%	56%	56%
2014	In REU	38	97%	97%	100%	92%	89%	
	All Students	8142	78%	67%	64%	61%	59%	
2015	In REU	25	96%	92%	92%	96%		
	All Students	7967	78%	67%	64%	61%		
2016	In REU	40	98%	95%	90%			
	All Students	7948	78%	68%	65%			

The idea of retention rate for research program participants was also applied to engineering students who transitioned to University Park after completing the research program to finish their degrees. As shown in Table 4, a higher percentage of engineering research participants were likely to transfer to the University Park campus as well as stay at Penn State in the years after transition. Again, the difference in retention rates between groups increases with time beyond research program participation.

Table 4. Retention Rates for Regional Campus Students in the College of Engineering who transitioned to the University Park campus

Cohort	Starting Campus	In REU Program?	Head Count	Transferred to University Park	Retention Rate		
					3Y	4Y	5Y
2013	Regional	Yes	8	75%	83%	83%	83%
	Regional	No	1244	47%	60%	58%	57%
2014	Regional	Yes	23	65%	87%	80%	
	Regional	No	1283	52%	60%	58%	
2015	Regional	Yes	14	71%	80%		
	Regional	No	1280	49%	62%		

Another measure of academic success is grade point average (GPA). The literature tells us we may see a dip in cumulative GPA the semester after students transfer to another university campus. For Penn State, students typically transition from a regional campus to the University Park campus between their 4th and 5th academic semesters. Table 5 provides a summary of 4th and 5th term GPAs for the total of five regional campus cohorts (fall 2013 to fall 2017) based on when they completed the research program, either after their freshman (1st) year or sophomore (2nd) year. Interestingly, although all students experienced a drop in Term GPA from their 4th to 5th semester, the relative decrease was much higher for students who had completed the research program.

Table 5. Regional Campus Student GPAs

	Research Program Timing		
	After 1 st Year	After 2 nd Year	Never
Number of Students	28	42	6590
4 th Term GPA	3.25	3.30	2.92
5 th Term GPA (of those transferred to University Park)	2.73	2.52	2.70
Cumulative GPA by the end of 4 th Term	3.44	3.46	3.02
Cumulative GPA by the end of 5 th Term (of those transferred to University Park)	3.27	3.27	3.11

Finally, we started looking at the 6-year graduation rate for comparison with national averages. At this time, we only have 6 years of data for one freshman cohort (2013), and it is relatively small with 8 engineering students. Of these 8 students, the 6-year graduation rate was 75% for

finishing at any campus and 63% for the students who transferred and graduated from the University Park campus.

Discussion and Conclusions

A multi-campus research program has a significant effect on student retention and graduation rates for students starting their degrees on a regional campus. Both retention rates and 6-year graduation rates were higher for students who completed the research program than for students who did not. The MC REU program seems particularly helpful for students who start at a regional campus and then transfer to the University Park campus to finish their degrees. Although a small dataset, the 6-year graduation rate for research program participants showed a positive increase and exceeded the national average for students attending 4-year or 2-year postsecondary institutions [19]. We plan to continue to follow the later cohorts to confirm this outcome with more data.

The data also show that the students who participated in the research program and then transferred to the University Park campus, experienced a dip in their term and cumulative GPAs. Surprisingly, this decrease was more significant for research program participants than for those students who did not participate. However, the GPA dip for research program participants does not correlate with an increase in attrition as it does for other students. One explanation for this discrepancy is the intrinsic value of the research program to equip students with the resources and faculty relationships to adapt and overcome academic challenges. According to Laugerman *et al.* [20], one of the most influential predictors of retention of engineering transfer students was the university GPA after transfer. Our study shows that a summer research experience prior to transferring could also be a strong predictor of retention.

We think this research program model can be applied across other institutions where students are following the 2 + 2 path for their engineering education. Co-locating the program between a student's home and future transfer university will provide resources to help facilitate a participant's transition. This partnership approach could be especially helpful for students at community colleges where there are often limited faculty resources for research. Thus, this type of program has the potential to not only improve the retention of 2 + 2 transfer students, but also encourage them to consider graduate school as well as promote collaboration among faculty across universities.

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