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Enhancing Retention and Academic Success of Undergraduate Engineering Students

Dr. Anant R. Kukreti, University of Cincinnati

ANANT R. KUKRETI, Ph.D., is Director for Engineering Outreach and Professor in the Department of Biomedical, Chemical and Environmental Engineering at the University of Cincinnati (UC), Cincinnati Ohio, USA. He joined UC on 8/15/00 and before that worked 22 years at University of Oklahoma. He teaches structural mechanics, with research in steel structures, seismic analysis and design, and engineering education. He has won five major university teaching awards, two Professorships, two national ASEE teaching awards, and is internationally recognized in his primary research field.

Dr. Temesgen Wondimu Aure, University of Cincinnati

TEMESGEN W. AURE, Ph.D., is the STEM Program Coordinator working under Dr. Kukreti on the NSF Type 1 STEP and S-STEM Projects in the Department of Biomedical, Chemical and Environmental Engineering at the University of Cincinnati (UC), Cincinnati, Ohio, USA. Temesgen joined UC as a graduate student in 2008 Fall and completed his doctoral degree in Civil Engineering in 2013. He started working on his current position at UC in January 2014. He plans, designs, evaluates and modifies programs supported by the NSF Type 1 STEP and S-STEM Grants in the College of Engineering and Applied Science.

Enhancing Retention and Achievement of Undergraduate Engineering Students (To be presented at NSF Grantees' Poster Session)

INTRODUCTION

This paper presents the impact of three key strategies that we have implemented for improving retention and student success for engineering undergraduates, as part of a National Science Foundation (NSF) project funded by the Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP) at the University of Cincinnati (UC). The project targets recruitment and retention of engineering ethnic minorities, women, and economically disadvantaged and/or First Generation college-bound students. **Figure 1** shows the three strategies implemented in our program. These include cohort building, networking, and pathways to graduate school. The strategies are interconnected and thus in addition to their individual impact they do also have a holistic impact on student success. **Cohort building** includes building productive academic relationships among students, between students and faculty, and between students and the university administration. The **networking** strategies include building and upholding a professional network with all people the students meet within their education and future career field, such as advisors, faculty members from whom they take classes, professors in their major, internship supervisors, employers or administrators, and through volunteer/community activities, seminars/workshops, and conferences. The **pathway-to-graduate school** strategy is intended to encourage all promising undergraduate students to apply for graduate school and assist them in creating a portfolio which will make them competitive to receive financial support. This strategy enriches the intellectual fabric of the University by developing a mechanism that integrates the experience and expertise of the engineering undergraduate students into the College's scholarship – such as conducting research and presenting the findings.

UC is an urban, comprehensive, research-intensive, public institution with over 40,000 students. The program was executed in its College of Engineering and Applied Science (CEAS), which has over 3,000 undergraduate and 650 graduate students, and grants B.S./M.S./Ph.D. degrees in 9 Engineering disciplines (Aerospace, Architecture, Biomedical, Chemical, Civil, Computer, Electrical, Environmental, and Mechanical), a B.S./M.S./Ph.D. in Computer Science, and B.S. degrees in 6 Engineering Technology programs (Architecture, Construction Management, Electrical, Fire and Safety, and Mechanical). All CEAS degree programs are five years in duration, because of a mandatory paid cooperative (co-op) education requirement. Through co-op, students alternate semesters of classwork and industry for the middle three years, gaining over 1.5 years of full-time work experience. Also, UC's CEAS includes the ACCEND (ACCelerated Engineering Degree) program, which offers these students the opportunity to complete both a B.S. and an M.S. degree in an engineering major in five years plus a summer. An option for M.S. in Business Administration is also available. Students admitted into the ACCEND program have Advance Placement (AP) credits in mathematics, science and humanities. The STEP program included students from all 9 Engineering disciplines and 6 Engineering Technology programs.

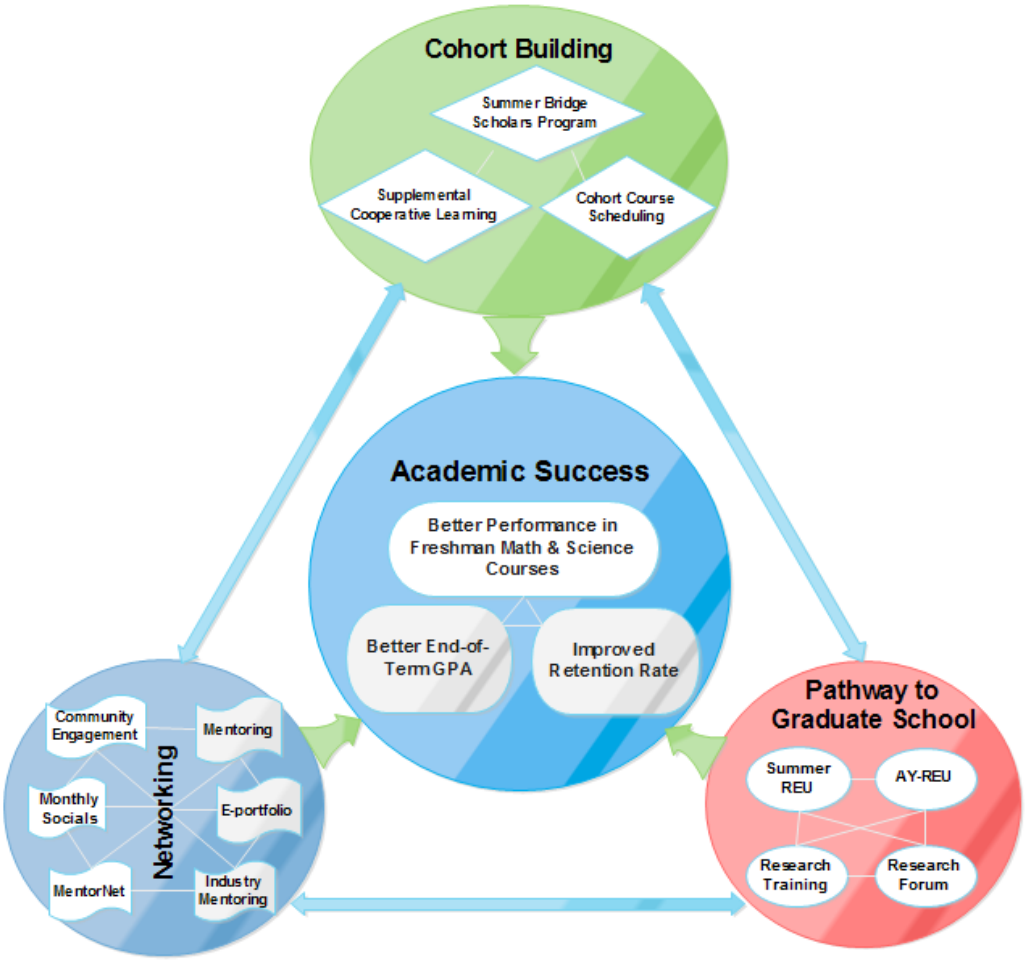


Figure 1: Three Strategies Implemented in the STEP Program

Three key issues negatively impact student success in engineering; these issues are especially relevant to the target student population addressed in this paper. ***Issue I***: inadequate academic preparedness from high school. The target students, by definition, fall into this category. Their ACT scores are 2-4 points below their peer cohort admitted in the CEAS at UC. In addition, on the UC Math Placement Test (MPT), which is used as a basis for first math course placement, the target students typically score below the cutoff for placement in Calculus I, the first course in the engineering math sequence and a prerequisite for Physics I. ***Issue II***: inability of the students to adapt socially to their new environment[1, 2]. As mentioned earlier, UC is an urban university with over 40,000 students on its main campus and CEAS has close to 3,000 students. This environment presents particularly unique challenges to ethnic minorities, women, First Generation, economically challenged students, and students from small, rural schools, or from large urban public schools. The target student population is demographically diverse but, relative to direct-admit students, it has a significantly larger population of students that face greater challenges to socialization. ***Issue III***: incoming students have no prior understanding of the expected workload or level of commitment required of an engineering or engineering technology curriculum. Students from economically challenged families often must work long hours to cover expenses, have difficulty maintaining good grades, and experience higher dropout rates. Interventions are needed to ease the transition into college, to address cultural conflicts

between home and college, and to create a supportive learning environment[3]. The need for cultivating learning environments to support and stimulate undergraduate student learning in engineering and sciences is well established[4-17]. Involvement in the academic life of the institution distinguishes undergraduates who thrive from those who do not[18-21].

The STEP project at UC was started in June 2008 and the first cohort of 20 students started in the Summer Bridge Program of 2008, and consisted only of ethnic minority students. Since these students were recruited prior to obtaining the grant, their participation in program activities, starting from freshmen year, was voluntary. In 2009, we obtained a scholarship grant, Choose Ohio First Scholarship Program (COFSP), from the Ohio Board of Regents (OBR). Since then participation in project activities was made a requirement for continuation. The grant was leveraged to provide scholarships to deserving Ohio resident STEP students for five-year undergraduate study, and was expanded to include, economically disadvantaged and/or first generation college bound engineering students, in addition to underrepresented (women and ethnic minority) engineering students. **Table 1** shows the number of students who have participated in the STEP program in CEAS at UC. The gender and demographic distribution of the total number of students is as follows: (a) *Gender distribution:* 147 (69%) men and 71 (31%) female students; and (b) *Ethnicity distribution:* 108 (70%) ethnic minority, 95 (27%) white Caucasians, 8 (2%) Asian American, and 7 (2%) in "other" category. As of the beginning of 2014 Spring Semester, a total of 148 students remain in the STEP program and their demographics is shown in **Table 2** and the total number is broken down as follows: (a) *Gender distribution:* 99 (67%) men and 49 (33%) female students; and (b) *Ethnicity distribution:* 72 (49%) ethnic minority, 60 (41%) white Caucasians, 6 (4%) Asian American, and 10 (6%) in "other" category.

The three strategies shown in **Figure 1** and their impacts on student success are discussed in the following sections.

Table 1: Total Number of Students who have Participated in the STEP Program

Cohort # (Starting Year)	Total # of students who participated	Gender Distribution		Ethnicity Distribution			
		Number of Men (%)	Number of Women (%)	Number of URM (%)	Number of White (%)	Number of Asian (%)	Number of Others (%)
Cohort 1 (2008-09)	21	14 (67%)	7 (33%)	21 (100%)	0 (0%)	0 (0%)	0 (0%)
Cohort 2 (2009-10)	79	55 (70%)	24 (30%)	24 (30%)	44 (57%)	8 (10%)	3 (4%)
Cohort 3 (2010-11)	78	49 (63%)	29 (37%)	23 (29%)	47 (60%)	1 (1%)	7 (10%)
Cohort 4 (2011-12)	26	18 (69%)	8 (31%)	24 (92%)	2 (8%)	0 (0%)	0 (0%)
Cohort 5 (2011-12)	20	12 (60%)	8 (40%)	19 (95%)	1 (5%)	0 (0%)	0 (0%)
Cohort 6 (2013-14)	20	16 (80%)	4 (20%)	17 (85%)	0 (0%)	0 (0%)	3 (15%)
TOTAL	**244**	**164 (67%)**	**80 (33%)**	**128 (52%)**	**94 (39%)**	**9 (4%)**	**13 (6%)**

Table 2: Total Number of Students who were in the STEP Program at the Beginning of 2014 Spring

Cohort # (Starting Year)	Total # of students who participated	Gender Distribution		Ethnicity Distribution			
		Number of Men (%)	Number of Women (%)	Number of URM (%)	Number of White (%)	Number of Asian (%)	Number of Others (%)
Cohort 1 (2008-09)	3	2 (67%)	1 (33%)	3 (100%)	0 (0%)	0 (0%)	0 (0%)
Cohort 2 (2009-10)	42	28 (67%)	14 (33%)	10 (24%)	25 (60%)	5 (12%)	2 (5%)
Cohort 3 (2010-11)	51	32 (63%)	19 (37%)	12 (24%)	33 (65%)	1 (2%)	5 (10%)
Cohort 4 (2011-12)	17	11 (65%)	6 (35%)	15 (88%)	2 (12%)	0 (0%)	0 (0%)
Cohort 5 (2011-12)	15	10 (67%)	5 (33%)	15 (100%)	0 (0%)	0 (0%)	0 (0%)
Cohort 6 (2013-14)	20	16 (80%)	4 (20%)	17 (85%)	0 (0%)	0 (0%)	3 (15%)
TOTAL	**148**	**99 (67%)**	**49 (33%)**	**72 (49%)**	**60 (41%)**	**6 (4%)**	**10 (6%)**

COHORT BUILDING

Cohort Building includes the following activities: Summer Bridge Scholars Program; cohort course scheduling; and freshman supplemental collaborative learning math and science courses. Each activity is described below.

Summer Bridge Scholars Program

The Summer Bridge Scholars Program is a 7–week residential summer program recommended for all incoming freshmen STEP students. The objective of the program includes: 1) Creating a "learning community" of students and to help them develop the academic and social skills necessary for achieving academic excellence, while at the same time building their self- confidence, strengthening their academic skills, and acclimatizing them to the campus environment; and 2) . Preparing students for their prospective math and science courses taken in the freshman year. This is achieved by enrolling the students in Pre-Calculus, Calculus, Chemistry, Physics, and English courses. Students experience the volume and pace of college courses and develop self-confidence to improve their chances of above-average academic performance during the freshman year.

Since the Summer Bridge Scholars Program was first offered in 1988, several enhancements have been made. First, in 2009 it was decided to invite the Bridge students to participate in a Math College Readiness Program called ALEKS (Assessment and LEarning in Knowledge Spaces). Summer Bridge Calculus 0 students took ALEKS Prep for Calculus program and the Calculus I Bridge students took ALEKS Pre-Calculus program. Students completed part of ALEKS during the summer and finished the rest in the beginning of the fall of their freshman year. The second program enhancement made in the Summer Bridge Scholars Program was implementation of a course "Introduction to 3-Dimensional (3-D) Spatial Visualization" for the first time in the summer of 2010 and continued since then. The objective of the course is to develop the spatial visualization skills of the Bridge students through a series of modules using a

textbook and software. Research indicates that engineering students, particularly ethnic minority and women engineering students, have difficulty visualizing in three dimensions[22]. This cognitive skill is essential for engineering education, but a significant number of these students have not had experience in this area. In order to expose STEP students to computing or programming and enhance their success in required freshman Engineering Models I & II courses, a MATLAB component has been added to the Introduction to 3-D Spatial Visualization course in the 2012 Summer Bridge Scholars Program.

Cohort Course Scheduling

After completing the Summer Bridge Scholars Program, the students enroll in the freshman math and science courses as a cohort. During the last week of the Summer Bridge Scholars Program students complete their final exams and attend an exit interview for each course. All students are required to prepare a written assessment of their performance, and they receive a written assessment from each instructor. The objective of the assessments and exit interview is to give students specific information as it relates to their academic and social development. During the exit interviews, the students are given specific information about their placement in freshman year for Calculus and English courses, in which they pre-enroll as a cohort for each class before they leave for home.

Supplemental Cooperative Learning Courses (SCLC)

These courses are first-year SCLC in Calculus 0, I, II and Physics 0, I taken by the students along with the regular courses which are part of their curriculum. All Bridge students enroll in SCLC. The SCLCs are one-credit courses, and the students meet twice a week for two hours with an instructor dedicated specifically for the course. The students enrolled in SCLCs are provided with additional instruction and time for problem-solving. This instruction requires students to interact in heterogeneous groups of 3-4 to master the course material using cooperative learning strategy[23, 24], and grades are based on mandatory attendance and participation in the cooperative learning process. It further strengthens the learning community built in the Summer Bridge Scholars Program.

NETWORKING

The networking strategies include: academic assessment and monitoring program; monthly socials; MentorNet; community engagement program; industry-mentoring program; and E-Portfolio. The networking experiences are designed to help students become more comfortable in their college, the university and their future work environment. These experiences provide the skills for students to work and communicate in small or large groups, and to interact with peers and professionals in ways that will benefit both their academic and professional careers.

Academic Assessment and Monitoring Program

Research indicates that [25, 26] faculty/professionals-student interactions outside the classroom positively affect retention by providing opportunities for building community and capacity through academic/social networks. An academic undergraduate degree Program Advisor is identified for each STEP student, and the students are required to meet with this advisor during the pre-advising week (7th week of the semester) to discuss progress towards degree and to plan their course schedule. Each advisor completes an Academic Progress Report Form for student records. Additionally, each STEP student is assigned a STEP Mentor to monitor student's

matriculation in the college. Students meet their STEP Mentor at least once every semester. The meetings facilitate discussion on instructor reports (described in the next paragraph), course work, special opportunities for community engagement, and personal and academic concerns. STEP Mentors can make recommendations for students to take certain actions to improve their grades, co-op opportunities or housing/roommate issues.

All STEP students are required to turn in a minimum of two progress reports per semester from faculty instructors for courses taken. The instructors provide feedback to students on their performance, often with specific recommendations on what can be done to improve their class standing. While the primary purpose of instructor progress reports is to provide students the feedback they need to be successful in the classroom, the progress reports also play a key role in networking. The reports require that students interact with their instructors and this interaction provides an opportunity for students to develop long-term relationships with their instructors.

Monthly Socials

Eight STEP monthly socials are organized each academic year to provide the experiences that make students better prepared to navigate both the academic and professional worlds. The monthly socials bring students together to meet representatives from the university faculty and industry to discuss academic strategies for success; career trends; to learn about co-op opportunities; to investigate undergraduate research experience options; to explore graduate school and how to prepare for it; and to connect with each other. Socials bring students together to: interact with individuals and groups – improving their communication skills. Students are often given a leadership role to choose the social's theme and invite speakers, and this requires further interaction with fellow students and/or industry representatives.

MentorNet Program

Incoming freshman students in the STEP program are required to register for MentorNet, and sophomores through seniors are encouraged to continue, but it is not a requirement for them. The MentorNet Program is an e-mentoring network that matches student protégés studying in STEM fields with mentors from industry and academia. A strong, though not exclusive, focus is placed on providing support to women and underrepresented students within these fields. We also have an excellent opportunity to recruit mentors from our strong alumni network, industry partners, and faculty. Once students are paired with a mentor, they typically communicate with their mentor via email and interact frequently with the MentorNet website (http://www.mentornetwork.net/).

Community Engagement Program

The purpose of this program is to demonstrate the need for becoming participating agents who provide service to both their university and community. The students are required to perform 15 hours of voluntary service for each semester they enroll at UC for classes. Several structured K-12 outreach programs are made available for the community engagement program (summer academies, tutoring program and STEM clubs organized by the CEAS Emerging Ethnic Engineering (E3) Program; and Gifted Girls Program, Science Career Fair and Summer Camps organized by the Society of Women Engineers; and many more). Students document each experience in a Service Learning Activity Hours Report Form and also write a reflection on their community engagement experience for the semester.

Industry-Mentoring Program

The industry-mentoring program provides an opportunity for students to interact with engineering professionals. The key outcomes of this mentoring program are the professional development of the student, increased student awareness, readiness, and disposition towards engineering careers, and educational training needed. It provides an opportunity to the student to experience the various work environments and opportunities, and make informed decisions on their career choice, and to gradually build an education portfolio to best market themselves for it. Two programs are offered: 1) Corporate mentoring program, which is developed between the CEAS Emerging Ethnic Engineering (E3) Program and General Electric (GE) Aviation for ethnic minority engineering students. Students are assigned mentors from GE who periodically monitor the students' performances till graduation. 2) Paid industrial cooperative program (Co-Op). This program places students in co-op paid jobs by the UC's Division of Professional Practice (DPP) during the sophomore, pre-junior and junior years. Mentorship is provided by DPP faculty (one for each degree program) to guide them to appropriate paid co-op jobs to suit their career aspirations.

E-Portfolio

As the STEP project evolved, it was decided to utilize electronic portfolios to enable STEP students, faculty, and staff to track and manage program requirements, academic progress, degree progress, program participation online, and encourage accountability. The main purpose of the E-Portfolio for faculty and staff is early intervention when a student is struggling in a course, degree program or in completing the requirements of the program. The STEP Mentors are able to review student progress prior to meeting with the students. The main purpose of the E-Portfolio for the students is the ability to track their participation online, and have access to documentation for use at any time for interviews, application to graduate school or any other use. Program requirements tracked in the E-Portfolio include: updated resumes; signed program contracts; instructor course progress reports; academic progress report form by the academic degree Program Advisor; STEP Mentor student consultation reports with recommended actions and follow-up; community engagement service-learning activity hours reports; and co-operative education reports. The E-Portfolio also archives the reflective essays prepared by the students documenting: professional career aspirations and their relationship to their college education at the beginning of freshman, pre-junior and senior year; and special programs attended (orientation, monthly socials, special seminars, MentorNet, REU, etc.).

PATHWAY TO GRADUATE SCHOOL

Educators recognize that undergraduate research motivates students to apply to graduate school - ethnic minorities and women groups in engineering must become an integral part of such a technical workforce. Research experience for undergraduates (REU) fosters the pursuit of an undergraduate degree[27]; increased interest in pursuing graduate education[28, 29]; and gains in skills by REU alumni over comparison groups (in conducting research, acquiring information, and speaking effectively)[30]. REUs develop career pathways, increasing minority retention[25] and the pursuit of graduate degrees[31]. In view of these observations, Summer REU and Academic Year (AY) REU, the associated Research Training Program, and a Research Forum are offered each year in the STEP project. The programs expose the students to the broad range of interdisciplinary research being conducted in the College, and provide them an opportunity to consider graduate study.

Summer and Academic Year (AY) REU Programs

The Summer REU program is an 8-week full-time in-residence program in which teams of 2-3 students pursue research, each under the mentorship of a Faculty Mentor and a Graduate Student Mentor. In the AY-REU Program, a student pair works for 18 weeks during two quarters (14 weeks during a semester in the semester system) under the mentorship of a Faculty Mentor. Priority is given to women and minority students. Each REU team produces three deliverables: Technical Paper/Report, Display Poster, and PowerPoint Presentation, which are presented on the last day of the program and juried by external professional judges.

The primary goal of the STEP REU program is to introduce undergraduate students to, and encourage them to pursue, careers in research. A REU website (http://www.ceas3.uc.edu/reu/) has been developed to inform students outside UC about the program, to present summaries of research projects completed, and elicit communication from REU alumni. All past REU students are asked to fill a Web-based Tracking Form every year, up to 5 years beyond participation. Internal and external evaluation of the project is provided by participants and judges. The students complete a pre-site survey documenting their prior exposure to research and two post-site surveys on the last day. Feedback on the effectiveness of the whole REU program is obtained from the judges, who fill out a scoring rubric evaluating: 1) each team's technical paper, 2) each student's presentation skills; and 3) each team's poster.

Research Training Program

The first and the second weeks in the Summer REU Program and the first month in the AY-REU Program are mainly devoted to seminars specially structured to educate the students on the content of the research topic to be pursued, train them on the use of the laboratory facilities, related software and statistical analysis techniques, and procedures to test, analyze, interpret, and report their research results. A series of research skills training workshops are held to train the participants to become proficient disseminators of research - written reports, papers, posters, and oral presentations. Each year, the following seven interactive workshops are provided: Safety Training; Technical Writing and Presentation; Online Literature Search; Project Documentation (Photography and Video Recording); Statistical and Uncertainty Analysis; Poster Making; and Public Speaking and Communications.

An enrichment training seminar series introduces the role of interdisciplinary research in modern society, the scientific research process, and the opportunities it creates. The following four seminars are organized: Ethics in Engineering Research; Research in an Academic Setting; Taking Research from Lab to Real World; and Graduate Education Opportunities and Application Process. The students are asked to prepare a reflective write-up for each seminar and workshop following a prescribed format.

Research Forum

Each year in Spring, UC holds a week-long REU Poster Forum, which includes poster presentations, an awards banquet, a distinguished guest lecture, "People's Choice Awards," and GRE preparation sessions. All UC STEP REU participants are required to make one presentation in an organized student group meeting (e.g., a Professional Society Student Chapter Meeting, First-Year Experience and Learning Community Meeting, UC Research Forum, etc.),

which is documented and reported by an advisor. Additionally, all UC STEP REU participants are required to participate and present a poster at the UC Research Forum, if they are on campus.

OUTCOMES OF OUR STRATEGIES

In order to evaluate the impact of our STEP project strategies and measure the performances of the STEP students, the following students Comparator Groups are considered:

- **Bridge**: Includes STEP Students who start by participating in Summer Bridge Scholars Program, prior to the freshman year.
- **Non-Bridge**: Includes STEP students who start by participating in the programs for the Networking strategy. These include some students in Cohort 2 (2009-2010) and Cohort 3 (2010-2011) who received the COFSP award.
- **Peer**: Includes same cohort non-STEP students who are enrolled in a degree program in CEAS, but not in the ACCEND Program, in the comparisons.
- **EASE** (Engineering and Applied Science Entrance): These include engineering and engineering technology degrees students who do not qualify for direct admission to a degree program but are given three semesters to achieve the necessary math and science course grades and overall end of semester GPA needed to transfer to a degree program. EASE and Bridge students have similar academic background and they both enter the university with similar pre college academic preparation (average ACT for EASE = 24, Bridge = 25.2 and Peer = 27.7; and average MPT for EASE = 695, Bridge (prior to ALEKS) = 677 and Peer = 793, cut off for Calc I placement = 750+). A few STEP Bridge students are also part of EASE (about 3%), but in our comparisons they are not considered as part of EASE students.

The Impact of Summer Bridge Scholars Program

As mentioned in the previous section, because of the success of ALEKS, it was decided in 2012 that the Bridge students will be required to complete ALEKS during the summer as part of their respective Bridge Calculus course. We compared the student's scores on the UC's Math Placement Test (MPT), which is used as a basis for first math course placement at UC, before ALEKS and after ALEKS and we tracked the success of each individual student. All high school graduates admitted into CEAS are required to complete the MPT prior to registration for freshman courses. The students who took ALEKS as part of the Summer Bridge Program did show an improvement by 12% and 22% in summer 2012 and 2013, respectively.

In order to study the impact of the Summer Bridge Scholars Program on the students' freshmen math course placement, the number of Bridge students placed in different math courses was compared with Peer and EASE students from 2008 to 2013, and the results are summarized as follows:

Cohort	% Students Placed in:		
	Math Below Calc 0	In Calc 0	In Calc I
Bridge	24 (19%)	24 (19%)	78 (62%)
EASE	194 (40%)	137 (28%)	159 (32%)
Peer	831 (25%)	816 (25%)	1683 (50%)

It can be seen that because of participation in the Summer Bridge Scholars Program and completing ALEKS, about two-third of the Bridge students acquire the content knowledge and skills to qualify for placement in the required freshman Calculus course (i.e., Calc I), whereas only half of the Peer and one-third of the EASE students attain this goal. Furthermore, attainment of this goal by the Bridge and EASE students differs by a factor of two (higher for Bridge students), which is significant. It should be pointed out that EASE and Bridge students have similar academic background and they both enter the university with weaker pre-college academic preparation. Therefore, the Summer Bridge Scholars Program prepares a larger number of Bridge students with needed mathematics skills to start their engineering degree curriculum as planned for all entering freshman. This lays the foundation for on-time graduation in five years. Lesser percentage (< 19%) of Bridge students are placed in a College Algebra or Trigonometry course, which puts these students behind at least by one full academic year.

The Impact of Cohort Course Scheduling

After completing the Summer Bridge Scholars Program, the students enroll in the freshman math and science courses as a cohort. During the last week of the Summer Bridge Program students complete their final exams and attend an exit interview for each course. Based on the students' performance, the instructors made the following recommendations for the 2008 to 2013 Summer Bridge cohorts:

Cohort	**1 (2008-09)**	**2 (2009-10)**	**3 (2010-11)**	**4 (2011-12)**	**5 (2012-13)**	**6 (2013-14)**
Total # of students in the cohort	20	22	19 [1]	25 [3]	19 [4]	20 [5]
No. recommended to take Calc 0	4 (20%)	5 (23%)	13 (72%) [2]	13 (52%)	13 (68%) [4]	12 (71%)
No. recommended to take Calc I	16 (80%)	17 (77%)	6 (33%) [2]	9 (36%)	4 (23%) [4]	5 (29%)
No. receiving credit for Eng. Comp. I	20 (100%)	21 (95%).	19 (100%)	23 (92%)	17 (90%) [4]	18 (90%)

[1] One student is not a U.S. citizen and not counted in reporting the statistics.
[2] One student had Advanced Placement out of Calc I, so 18 students are considered in calculating this percentage
[3] One student was recommended for College Algebra and two students were recommended for Calc II
[4] One student transferred out of CEAS, 1 student withdrew from Calc I and 1 student is recommended for College Algebra.
[5] Three students had Advanced Placement out of Calc I and were placed in Calc II, so 17 students are considered in calculating the percentages reported for Calc 0 and Calc I placements in this column.

It is important to note that the Summer Bridge Scholars Program is not in isolation from the academic year, it is first step of a comprehensive infrastructure that continues to develop the community building strategies necessary for success. Specifically, during the bridge program the students participate in the university orientation for freshmen, at this time, they register as a cohort for all of their classes, especially in the recommended Calculus course for the fall semester.

The Impact of Supplemental Cooperative Learning Courses (SCLC)

Three measurements of success are used to document the impact of the SCLC: 1) performance in the individual freshman math and science courses; 2) the D, W and F grade rates in these freshmen math and science courses; and 3) the overall cumulative GPA at the end of the freshmen year. All comparisons were made with Peer and EASE students who did not participate in the Summer Bridge Scholars Program. The required freshman math and science

courses for which the student grades are compared include Calculus 0 and I, Chemistry I and Physics I, which are taken by all freshman engineering students.

Impact on Freshmen Math and Science Courses: The mean course grade point average (GPA) of STEP Cohorts who enrolled in freshman math and science courses are summarized in **Tables 3** and compared with corresponding Peer and EASE Cohorts. It should be noted that Calculus I (Calc I) is the first required math course for engineering students. But students, who are not prepared, as indicated by the UC Math Placement Test and/or Summer Bridge Scholars Program recommendation, take Calculus 0 (Calc 0) as a deficiency course in the Fall Semester and then Calculus I in the Spring Semester.

From **Table 3** it can be seen that the STEP Bridge students outperformed their Peers by 16% to 55% in the first Calculus course, and even by a larger magnitude (45% to 63%) than the EASE students. However, it is observed that their performance in the Chem I and Phys I is about 4% to 7% lower than their Peers, but higher by 14% to 17% than the EASE students. Even through the Bridge students under-performed (on average 4% and 5% lower in Chemi I and Phys I, respectively) as compared to their Peer Cohort, one can say that their participation in *Programs to Enhance Retention (PER)* (Summer Bridge Program and Networking activities) prepared them better than their EASE counterpart students, who performed on the average about 16% lower in Chem I and 21% lower in Phys I than their Peer Cohort.

Table 3: Mean Course Grade in Freshmen Math and Science Courses: Comparison of STEP Bridge, STEP Non Bridge, Peer and EASE Student Cohorts

Student Groups and Performance		Freshmen Courses			
		Calc 0	**Calc I**	**Chem I**	**Phys I**
STEP Bridge	No. of Students	53	92	94	65
	Mean Grade	2.72	2.65	2.64	2.49
	Std Dev	1.04	1.03	0.86	0.78
STEP Non-Bridge	No. of Students	1	47	71	67
	Mean Grade	3.33	2.9	3.2	2.98
	Std Dev		1.09	0.87	1.13
Total STEP	No. of Stu	54	139	165	132
	Mean Grade	2.73	2.73	2.89	2.74
	Std Dev	1.04	1.05	0.9	1
Peer	No. of Students	497	2216	2658	1578
	Mean Grade	1.75	2.29	2.75	2.68
	Std Dev	1.09	1.18	0.91	1.04
EASE	No. of Students	204	386	490	246
	Mean Grade	1.67	1.83	2.31	2.12
	Std Dev	1.08	1.16	0.95	0.96
Course Grade Comparison	Bridge ÷ Peer	1.55	1.16	0.96	0.93
	Non-Bridge ÷Peer	1.90	1.27	1.16	1.11
	Total STEP ÷ Peer	1.56	1.2	1.05	1.02
	Bridge ÷ EASE	1.63	1.45	1.14	1.17
	Non-Bridge ÷ EASE	1.99	1.58	1.39	1.41
	Total STEP÷ EASE	1.63	1.49	1.25	1.29

Thus, the impact of PER on the Bridge students can be considered to be significant, because considering the fact that the Bridge and EASE students come with similar pre-college math and science preparation backgrounds, the Bridge students would have otherwise performed like their EASE student counterparts. It is also worth noting from **Table 3** data that overall the STEP (Bridge + non-Bridge) students outperformed the Peer and EASE Cohorts in all the freshman math and science courses.

It is stipulated that participation in PER prepares the students for academic success in not only the freshman math and science courses, but also prepares the students' overall academic, personal, and social development. PER helps students' transition and adjust to university life and improve their academic performance and persistence rate. It also helps students adjust and adapt to university life and become members of the campus community. It should be pointed out that all the non-Bridge students in STEP Cohorts 2 and 3 were required to participate in the networking strategy programs and enroll in the **Freshman Learning Community Courses (FLCC)**. UC has implemented a program within their First-Year Experience (FYE) called Learning Communities (LC). A LC is a group of 20 First-Year students who share the same class schedule. The STEP Cohorts 2 and Cohort 3 students, who did not enroll in SCLC, were required to enroll in the UC's First-Year Experience Freshman Learning Community Courses (FYE-FLCC). Bridge STEP students were also encouraged to enroll in the FYE-FLCC, if it could be accommodated in their class schedule. Each LC meets twice per week with its Peer Leader (PL). A PL is an upper-class student trained by the Office of First Year Experience to manage the LC and be a resource for the 20 First Year students.

Based on our analysis of student degree completion in CEAS, the grade in the first Calculus course is a good indicator of completion of the bachelor's degree in engineering. The UC Institution Research did a study for undergraduate engineering entering classes of 2002 to 2006 (5 graduating classes of 2007 to 2011) and found that 79.7% of the students who obtained a grade of ≥ C+ in the first Calculus (Calc I) or Pre-Calculus (Calc 0) course matriculated with a B.S. degree in engineering. The percentage of Bridge, non-Bridge, EASE and Peer students who scored a grade of ≥ C+ in Calc 0 and Calc I for Cohort 2+3+4+5+6 are shown in **Figure 2**. It is observed that 65% of Bridge students and 71% of non-Bridge have scored a grade of ≥ C+ in the first freshman Calculus course in comparison to 30% of the EASE and only 48% of the Peer students. This is a very significant success of the STEP program.

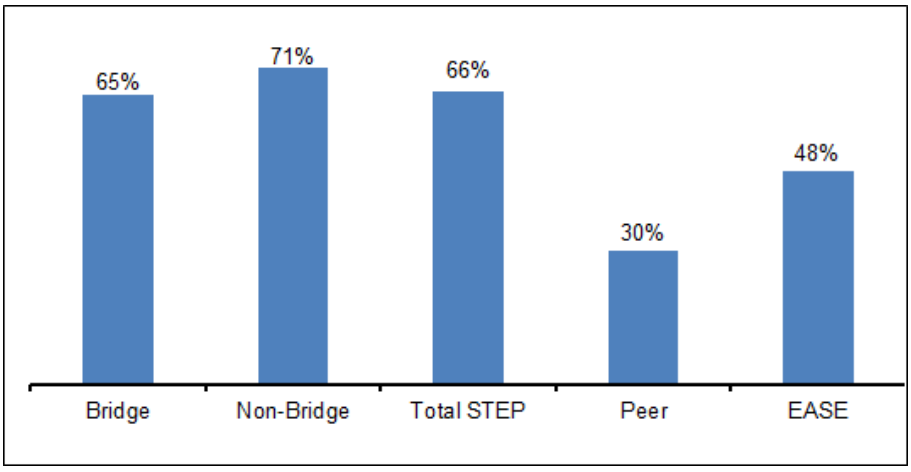


Figure 2: Percentage of Students Receiving ≥ C+ in Calc I and Calc 0

Impact on D, W, and F Rate: Another measure of the impact of the summer Bridge program and SCLC classes on first freshman Calculus, Physics and Chemistry course performance of STEP students is the difference in their D, W, and F grade rate compared to EASE and Peer CEAS students. Historically, Bridge students' D, W, and F rate for the freshmen math and science courses has been lower than the Peer cohort. The D, W, and F rate of total STEP students and STEP Bridge students who enrolled in the first freshman math and science courses is compared to the D, W, and F rate of Peer and EASE students who enrolled in the same courses and is shown in **Figure 3**. From the results it can be seen that: 1) the percentage of STEP students receiving D, W, and F grades in the first-Calculus courses is significantly lower than the Peer and EASE students; 2) the percentage of STEP students receiving D, W, and F grades in the first-Chemistry course is slightly higher than the Peer students and significantly lower than the EASE students; and 3) the percentage of the STEP Bridge and Total STEP students receiving D, W, and F grades in the first-Physics course is almost the same as the Peer students but lower than EASE students.

Impact on Overall Academic Success from Freshmen to Senior Year

Participation in PER activities has also enhanced the cumulative GPA of the STEP students in comparison to their Peer and EASE Cohorts. To compare academic preparedness of the STEP students (Bridge and non-Bridge) with that of the non-STEP (Peer and EASE) students, the average (computed considering Cohorts 2 to 6) freshman, sophomore, pre-junior, junior, and senior year cumulative GPA of STEP (Bridge and non-Bridge), Peer and EASE cohorts are compared. These average GPAs are presented in **Table 4**.

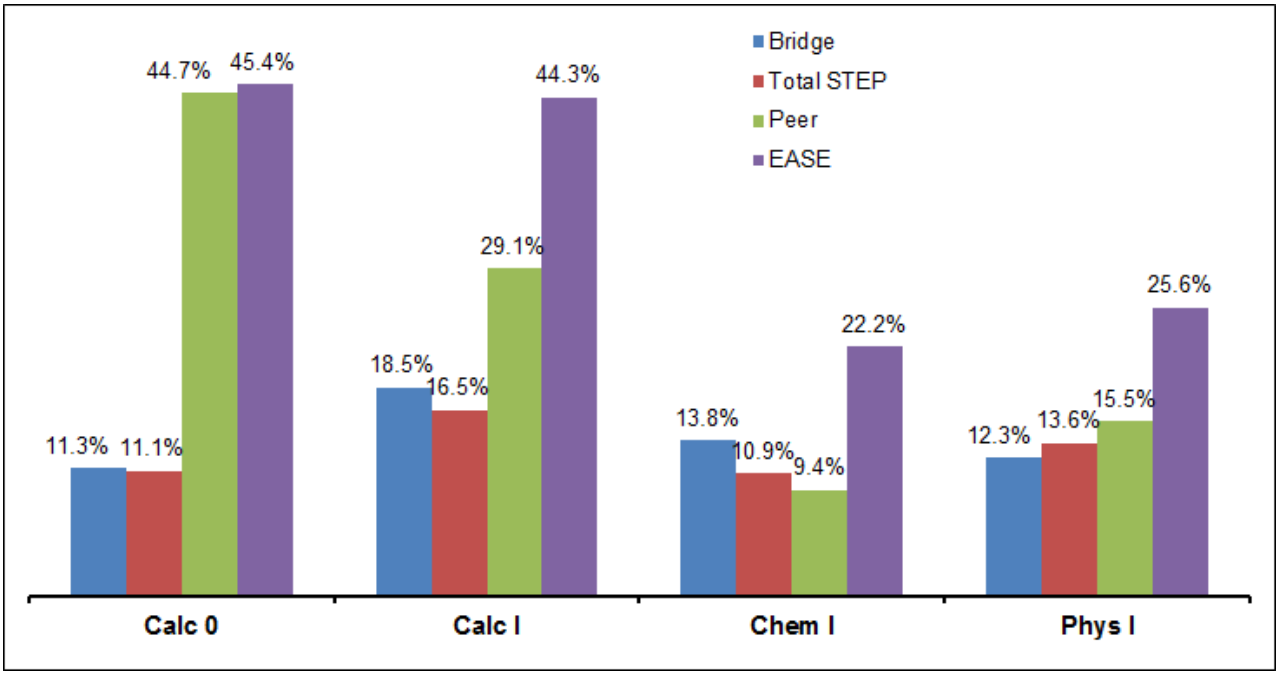


Figure 3: Percentage of Students Receiving D, W, and F Grades in Freshmen Math and Science Courses

Table 4: Cumulative Average GPA Comparison of STEP with Peer and EASE Student Cohorts

Year	STEP			EASE[1]	Peer	Bridge /EASE	Non-Bridge /EASE	Total STEP/ EASE	Bridge /Peer	Non-Bridge/ Peer	Total STEP /Peer
	Bridge	Non-Bridge	Total STEP								
Freshman	2.89	3.27	3.07	2.43	2.89	1.19	1.35	1.27	1.00	1.13	1.06
Sophomore	2.68	3.20	2.97	2.44	2.89	1.10	1.31	1.22	0.93	1.11	1.03
Pre-Junior	2.76	3.20	3.06	2.51	2.95	1.10	1.28	1.22	0.94	1.09	1.04
Junior	2.84	3.20	3.07	2.76	3.01	1.03	1.16	1.11	0.95	1.06	1.02
Senior	2.82	3.20	3.07	NA	3.06	NA	NA	NA	0.92	1.05	1.00

[1] No data reported since EASE started in 2010 Fall Quarter with Cohort 3 who will be seniors in 2014-2015

From the above table it is observed that Bridge students' GPA is comparable (2%-8% lower) to that of Peer cohorts, but the non-Bridge and Total STEP students outperform their Peer cohorts. It can also be seen that STEP (Bridge, non-Bridge and Total) students perform significantly better than their EASE cohorts as evidenced by higher cumulative GPA in freshman, sophomore, pre-junior and junior years. This performance is expected to continue into the senior year as well.

Impact of Our Strategies on Retention and Graduation Rates

The goal of the STEP project is to achieve a graduation rate of 61%. The success of the program can thus be ascertained by the attainment of this goal. To assess this goal the retention of each cohort is analyzed and reported in following two ways: 1) year-to-year, and 2) with respect to the starting year.

Year-to-Year Retention and Graduation

The year-to-year retention of the Bridge and all (Bridge + non-Bridge) STEP students is presented in **Table 5** and **Table 6**, respectively, for all the cohorts in the program as of end of 2013 Fall Semester. The numbers in the white cells are the actual head count numbers, whereas the numbers in the grey cells of the tables are projected using the proposed retention rates (76%, 86%, 93% and 100% for end of freshman, sophomore, pre-junior and junior year, respectively) to achieve the 61% graduation rate.

Table 5 shows that the overall average first-year retention rate for Bridge STEP students including Cohort 1 is 79.0%. If Cohort 1 students are not included, the overall average first-year retention rate is 87.1%. Note that Cohort 1 students' participation in the program was not a requirement and following the Summer Bridge their participation was significantly less. Students, in this cohort, who began the STEP program in 2008 Fall Quarter were given the opportunity to participate in PER during the academic year, but less than half chose to participate. Thus, it is observed that the target retention rate of 76%, as originally proposed, is achieved and even exceeded for the first-year. However, a drop of 1.4% to 13% is observed to occur from end of freshman to end of sophomore year, as Bridge students make up their mind to continue to pursue a degree in engineering or not. An anomaly for the retention rate of Cohort 2 Bridge students can be seen as per the numbers reported in **Table 5** for the end of sophomore year. The retention rate is below the target retention rate of 86% originally proposed. This is

Table 5: STEP Bridge Year-To-Year Student Retention as of End of 2013 Fall Semester

Cohort #	Freshmen to Sophomore			Sophomore to Pre-Junior			Pre-Junior to Junior			Junior to Senior			Graduation #	Graduation Rate (%)
(Starting Year)	# Start Fall	# Return Fall	Retention (%)	# Start Fall	# Return Fall	Retention (%)	# Start Fall	# Return Fall	Retention (%)	# Start Fall	# Return Fall	Retention (%)		
Cohort 1 (2008-09)[1]	20	9[2]	45.0	9	9[3]	100.0	9	8	88.9	8	8	100.0	9[4]	**45.0**
Cohort 2 (2009-10)	22	19	86.4	19	11[5]	57.9	11	10[6]	90.9	10	10	100.0	10	**45.5**
Cohort 3 (2010-11)	20	17[7]	85.0	17	14[8]	82.4	14	10[9]	71.4	10	10	100.0	10	**50.0**
Cohort 4 (2011-12)	25[10]	22	88.0	22	18	81.8	18	17	93.0	17	17	100.0	17	**70.8**
Cohort 5 (2012-13)	18[11]	16	88.9	16	14	86.0	14	13	93.0	13	13	100.0	13	**72.2**
Cohort 6 (2013-14)	20	15	76.0	15	13	86.0	13	12	93.0	12	12	100.0	12	**60.0**
Average Retention (Including Cohort 1)	125		79.0			77.6			82.4			100.0	71	**56.8**
Average Retention (Excluding Cohort 1)	105		87.1			74.1			80.0			100.0	62	**59.1**
Projected Retention	**125**	**95**	**76**	**95**	**82**	**86**	**82**	**76**	**93**	**76**	**76**	**100**	**76**	**61**
CEAS Avg. Retention[12]			**73**			**85**			**94**			**99**		

[1] Students in Cohort 1 were not held to the same requirements as later cohorts
[2] 4 students were in special program and were not included
[3] 2 students from the original Cohort 1 returned to CEAS who had transferred to A&S
[4] 6 of these students graduated in Spring 2013; 1 is on track for graduating in Spring 2014; 1 student from original Cohort 1 returned in Fall 2013
[5] 2 students transferred to STEM degree program, 3 students transferred to non-STEM degree program at UC, and 2 students are in a special program
[6] 2 students has returned to STEP and 3 transferred to STEM program at UC
[7] 2 students left STEP and UC in Summer 2012 and 1 student transferred to STEM program at UC
[8] 2 students left STEP and UC and 1 student transferred to non-STEM program at UC
[9] 4 students left STEP and UC
[10] 1 student left STEP at the end of Summer Bridge 2012 and one student is added
[11] 1 student did not join the STEP program after the Summer Bridge
[12] From 2012 Manpower Report of UC CEAS

attributed to the fact that a total of 8 Bridge students (out of 19) from this cohort transferred, based on personal interest, to other non-engineering majors (5 to STEM and 3 to non-STEM), even though based on their GPA they were qualified to continue in engineering at the time of transfer. Their GPAs at transfer ranged between 2.24 and 3.32, and the average was 2.68 with a standard deviation of 0.41.

Table 6 shows that the first-, second-, third- and fourth-year retention is on the average 80.5%, 83.0%, 91.6% and 100.0%, respectively, for all STEP students including Cohort 1. If Cohort 1 is not considered, the first-, second-, third- and fourth-year retention rate for all STEP students is on average 84.4%, 82.1%, 92.2% and 100.0%, respectively. The second- and third-year retention rates of all STEP students are also slightly below the estimated retention rate of 86% and 93%, respectively, for sophomore and pre-junior year for the same reason outlined

Table 6: STEP Total Year-To-Year Student Retention as of End of 2013 Fall Semester

Cohort #	Freshmen to Sophomore			Sophomore to Pre-Junior			Pre-Junior to Junior			Junior to Senior			Graduation #	Graduation Rate (%)
(Starting Year)	# Start Fall	# Return Fall	Retention (%)	# Start Fall	# Return Fall	Retention (%)	# Start Fall	# Return Fall	Retention (%)	# Start Fall	# Return Fall	Retention (%)		
Cohort 1 (2008-09)[1]	20	9	45.0	9	9[2]	100.0	9	8	88.9	8	8	100.0	9[3]	**45.0**
Cohort 2 (2009-10)	**59**	**47**	**79.7**	**66**	**52**	**78.8**	**52**	**50**	**96.2**	**50**	**50**	100.0	50	**64.1**[4]
Cohort 3 (2010-11)	**78**	**67**	**85.9**	**68**	**58**	**85.3**	**58**	**51**	**87.9**	**51**	**51**	**100.0**	**51**[5]	**65.4**
Cohort 4 (2011-12)	25[6]	22	88.0	22	18	81.8	18	17	93.0	17	17	100.0	17	**65.4**
Cohort 5 (2012-13)	18[7]	16	88.9	16	14	86.0	14	13	93.0	13	13	100.0	13	**72.2**
Cohort 6 (2013-14)	20	15	76.0	15	13	86.0	13	12	93.0	12	12	100.0	12	**60.0**
Average Retention (Including Cohort 1)	200	161	80.5	165	137	83.0	119	109	91.6	58	58	100.0	140	63.9[8]
Average Retention (Excluding Cohort 1)	180	152	84.4	156	128	82.1	128	118	92.2	50	50	100.0	131	65.8[8]
Projected Retention	**220**	**167**	**76**	**167**	**144**	**86**	**144**	**134**	**93**	**134**	**134**	**100**	**134**	**61**
CEAS Average Retention[9]			**73**			**85**			**94**			**99**		

[1] Students in Cohort 1 were not held to the same requirements of the program as later cohorts
[2] 2 students from the original Cohort 1 returned to CEAS who had transferred to A&S
[3] 6 of these students graduated in Spring 2013, 1 is on track for graduating in Spring 2014 and 1 student returned
[4] Out of 78 students total (Bridge + non-Bridge + Transfer Students + Replacements)
[5] 2 students have applied to graduate in Spring 2014
[6] 1 replacement student was added in 2011-2012
[7] 1 student did not join the STEP program after the Summer Bridge and is not included in this number.
[8] Includes the 19 Transfer and Replacement students of Cohort 2
[9] From 2012 Manpower Report of UC CEAS

above. However, these rates are expected to increase as the students from Cohort 5 and 6 enter their second and third year, respectively. The impact of the STEP program is clear; it provides support for progress towards graduation. Graduation of these students will then lead to UC graduates as professionals who represent the university and the college globally. The projected graduation rates for the program, assuming the estimated annual retention rates originally proposed, will be above the university average (59% for students seeking bachelor's degrees starting in 2005) for Cohorts 2, 3, 4, 5 and 6 for all STEP participants on average (see **Table 6)**. Cohort 2 will graduate with a 64.1% graduation rate, assuming 100% retention from junior to senior year. Cohort 3 will have a 65.4% graduation rate, assuming 100% from junior to senior year. Cohort 4 will have a 65.4% graduation rate, assuming 93% retention from pre-junior to junior year, and 100% from junior to senior year. Cohort 5 will have a 72.2% graduation rate, assuming 86.0% from sophomore to junior year, 93% from pre-junior to senior year, and 100% from junior to senior year. Cohort 6 will have 60.0% graduation rate assuming the estimates set

in the proposal. The overall projected graduation rate for all STEP students excluding Cohort 1 is 65.8%, which is above the goal of 61% set for the STEP Program.

Retention and Graduation With Respect to Starting Year

The retention of the Bridge and all (Bridge + non-Bridge) STEP students with respect to the starting year is presented in **Table 7** for all the cohorts in the program as of the end of the 2013 Fall Semester. It should be noted that if transfer students and/or replacement students were added to a cohort they were tracked separately. As shown in **Table 7**, the average retention rate for STEP Cohorts 1 to 6 with respect to start year is 66.0%, and an additional 7.4% were retained in a non-engineering STEM program at UC. Thus, from Cohorts 1 to 6 a total of 73.4% STEP students have stayed in UC to pursue a STEM degree program. If Cohort 1 is not considered, as shown in **Table 7**, the average retention rate for STEP Cohorts 2 to 6 with respect to start year is 68.2%, and an additional 7.6% were retained in a non-engineering STEM program at UC. Thus, from Cohorts 2 to 6 a total of 75.8% STEP students have stayed in UC to pursue a STEM degree program.

Impact of the REU Programs

The primary goal of the REU program is to introduce undergraduate students to, and encourage them to pursue, careers in research. The evaluation tools used to assess this goal are the following:

1. Number of students impacted, particularly underrepresented (women and minority) students because that is the main focus of our STEP program.
2. The students complete a pre-REU site survey, which is an Exposure to Research Questionnaire, designed to obtain a general picture of a student's past exposure to research. The students complete two surveys on the last day, one with specific questions to assess their satisfaction with the individual REU program activities, and the second one to measure changes in attitudes and opinions (or efficacy) about graduate school and research.

Table 7: Retention Results With Respect to Start Year

Cohort	# of Students in Cohort at Start Year	# of Students in Cohort at end of Fall 2013					
		In STEP in CEAS			Left STEP but Remained at UC		Remain at UC
		Bridge	Non-Bridge	Total STEP	In STEM	In Non-STEM	
Cohort 1 (2008-2009)	21	3	0	3		1	4
Cohort 2 (2009-2010)	78	9	33	42	7	5	54
Cohort 3 (2010-2011)	79	10	41	51	5	9	65
Cohort 4 (2011-2012)	26	16	1	17	1	1	19
Cohort 5 (2012-2013)	20	15		15	0	4	19
Cohort 6 (2013-2014)	20	20		20	0	0	20
Total for Cohorts 1 to 6	244	73	75	148	13	20	181
Average % Retention for Cohorts 1 to 6[‡]				66.0%	7.4%	9.8%	83.2%

Total for Cohorts 2 to 6	223	70	75	145	13	19	177
Average % Retention for Cohorts 2 to 6[‡]				68.2%	7.6%	9.9%	86.1%

[‡] Note that 13 students who graduated in STEP (6 from cohort 1 and 7 from cohort 2), 5 students who graduated in STEM (1 each from cohort 1 & 3 and 3 from cohort 2) and 4 students who graduated in non-STEM (1 each from cohorts 1 & 2, and 2 from cohort 3) are included while calculating retention.

3. A direct measure of the effectiveness of the whole REU program is provided by the external judges, who evaluate the deliverables (technical paper/report, PowerPoint presentation, and display poster) produced by the REU participants. The judges fill out a scoring rubric evaluating each team's technical paper/report for their content, organization, clarity, technical merit and grammar, and visual appeal. Also they fill out a scoring rubric for evaluating their PowerPoint oral presentation and poster display presentation for their content, organization, clarity, use of visual aids, and presence in presentation. The judges evaluate each deliverable on a 4-point scale (4 = Excellent, 3 = Very Good, 2 = Good and 1 = Fair) rubric. The judges also provide suggestions for improving the overall project activities.
4. To obtain degree completion information, enrollment in graduate school, presentations and publications authored and/or co-authored, and submission of research papers to peer-reviewed conferences and journals, the REU students are asked to fill a Web-based *Tracking Form* every year up to five years after graduation.

Results for items described above, except the attitudinal survey results, are presented in this section. The results of the attitudinal survey (see item # 2 above) are used as formative evaluation tools to make changes that ensure continuous improvement.

Number of Students Impacted

As of the end of 2013 Fall, a total of 167 Students have participated in STEP REU Programs; 59 students in the Summer and 108 in Academic Year REU Programs (17 repeated twice). The cumulative growth of the REU participants is shown in **Figure 4(a)**. The gender and ethnic distribution of the students is shown in **Figure 4(b)** and it is observed that the students consisted of 61.7% men and 38.3% women. The total number of underrepresented participants is, as shown in **Figure 4(c)**, is **91 (54.5%).**

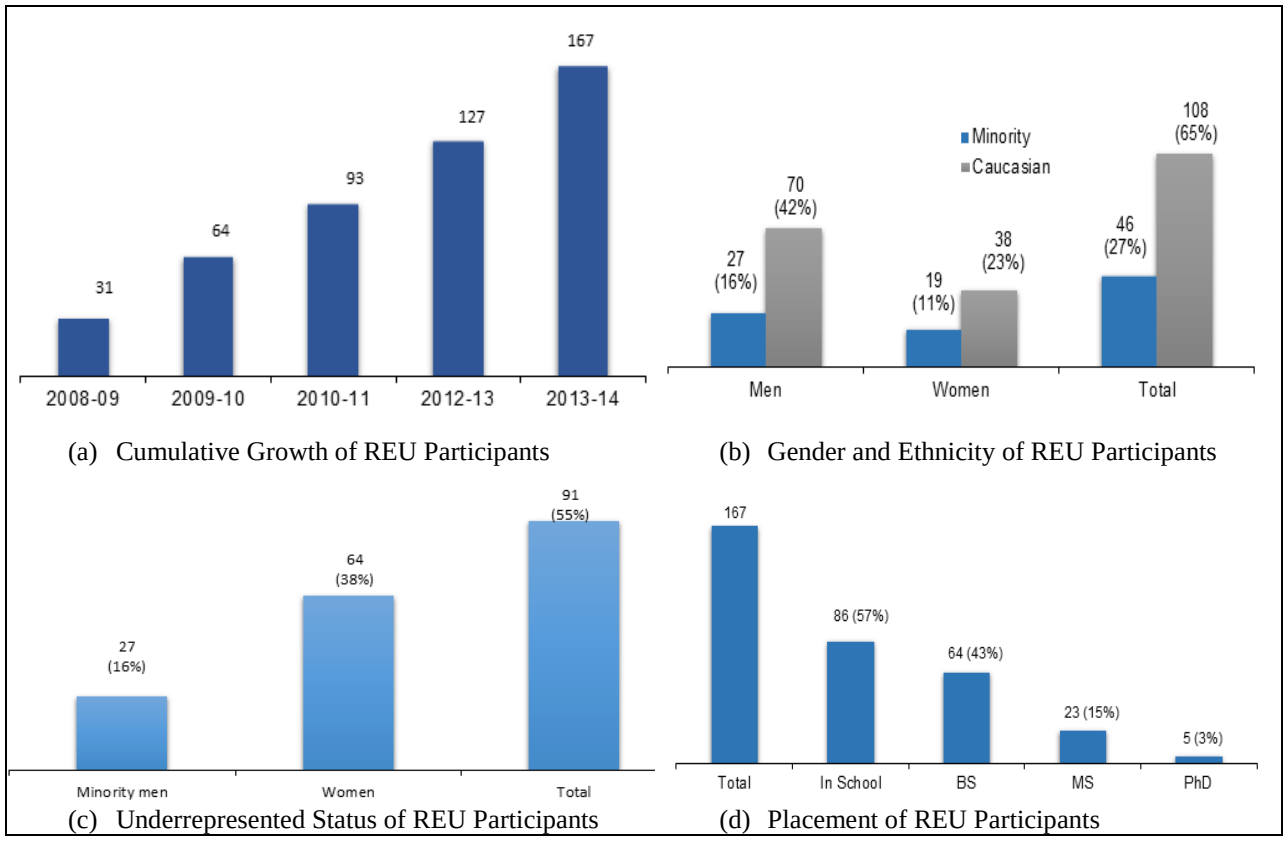
Judges Evaluation of REU Programs

The overall judges' composite scores for all deliverables submitted by Summer REU participants from 2009 to 2013 ranged from 3.26 to 3.52/4.00 with the overall average of 3.41/4.00. Similarly the overall judges' composite scores for all deliverables submitted by AY-REU participants from 2009 to 2013 ranged from 3.19 to 3.46/4.00 with the overall average score of 3.34/4.00. These scores indicate that the REU participants have produced high quality research deliverables.

Results of the Student Satisfaction of the REU Training Program

To assess the success of the various experiences and activities executed in both the Summer and AY REU Programs, the students were asked to complete a *Project Satisfaction Survey Questionnaire* on the last day of their REU experience (after they present their Poster and PowerPoint Presentation to the judges).

The student feedbacks obtained from the *Questionnaire* can be summarized as follows: 1) good exposure to research which they would have otherwise not gotten as undergraduate students; 2) significantly improved technical writing and presentation skills due to participation in the REU project; 3) exposure to journal papers, how to read and understand them, and to use the information in preparing their final technical research paper.



(a) Cumulative Growth of REU Participants

(b) Gender and Ethnicity of REU Participants

(c) Underrepresented Status of REU Participants

(d) Placement of REU Participants

Figure 4: Number, Gender, Ethnicity and Placement of REU Participants

Degree Completion, Placement and Publications

The results of the tracking survey completed by the REU participants every year following the completion of the program is plotted in **Figure 4(d)**. It is observed that 42.7% have finished their B.S. degree and 57.3% are pursuing undergraduate engineering degree programs. Among those who have finished their undergraduate degree 82.1% and 17.9% went to pursue M.S. and Ph.D. engineering degrees, respectively. The REU participants have made 96 paper / poster presentations and the students and faculty mentors have co-authored 13 journal papers. These results indicate that our STEP program have enhanced students' interest to pursue graduate school.

CONCLUSION

The key implementation strategies for improving retention and student success in the STEP Project are: Cohort Building; Networking; and Pathway to Graduate School. These strategies have proven successful in improving first-year success and retention, and are projected to improve graduation rates for the demographic groups supported by the project.

The success highlights of the STEP program include: 1) Summer Bridge performance was used to place students in the first freshman Calculus course, either Calculus 0 or Calculus I; 2) a "structured" freshman year including cohort course scheduling of regular and SCLC freshman Calculus and Physics courses; 3) positive impact of ALEKS on MPT scores during the Summer Bridge Scholars Program; 4) student retention on average is exceeding program goals; 5) higher success rate of STEP students in beginning freshmen math and science courses in comparison to Peer and EASE students; 6) lower D, W and F rate of STEP students in beginning freshmen math and science courses in comparison to Peer and EASE students; 7) the end-of-term GPA of STEP students are comparable or better than Peer and EASE students; 8) and early participation in REU fosters the persistence to pursue an undergraduate degree and gains in skills in conducting research, acquiring information, and communicating effectively.

Several challenges have been faced in the implementation for the STEP program. The first challenge has been recruitment for the Summer Bridge Scholars Program, as the current financial and academic support given by the program is not enough to draw students to participate, particularly minority students. An important element of the strategy must include a financial aid package that is competitive. The second challenge is coordinating student participation in various programs by the Bridge and non-Bridge STEP students. The level of self-commitment by these two groups does not appear to be the same. The level of immersion in cohort building experienced by the Bridge students is different than that for the students who do not participate in the Summer Bridge Scholars Program. The cohort building and learning community creation occurs in the Summer Bridge Scholars Program as the students live together for seven weeks prior to their freshman year, and study as cohorts during the required evening/night study sessions. The Bridge cohorts study together in their freshman year as they take the SCLC in math and science besides their regular courses. Thus, the Bridge students form a social and academic learning community for a longer time, and it is guided and supervised. On the other hand, the non-Bridge STEP students, who do not participate in the Summer Bridge Scholars Program, form a learning community as part of the FLCC they are required to enroll in it. The FLCC is more of a social network of students with similar academic interests, and is different from the learning community formed in the Summer Bridge Scholars Program and continued in the SCLC. An E-Portfolio system has been implemented for the purpose of enhancing student participation in the program. The E-Portfolio allows students, faculty and staff to track student participation in real time online. This encourages students to take responsibility for their participation in the program, which then impacts their success at the institution.

The lessons learned from the STEP program are: 1) the prior un-proctored MPT Score varied from the proctored MPT score for pre-Bridge; 2) for success participation in designated freshmen to senior year retention activities included in the STEP program must be made mandatory; 3) students need a financial incentive to complete the requirements of the program and university administration needs to make university-supported Financial Aid as a Strategy for increasing yield of underrepresented ethnic students; 4) requiring mandatory compliance of completion of designated STEP activities has been much easier from students who were awarded a Choose O First Scholarship (COFS), than the students selected for the Summer Bridge Scholars Program who sign a contract to participate in all STEP activities in their freshman to senior years but are not awarded a COFS; 5) identifying key activities for which measurable assessment instruments and benchmarks can be established to evaluate impact on student

performance and retention; 6) and the creation of the E-Portfolio has enabled advising and tracking of student progress in the program online and encouraged accountability.

The UC STEP Project is implemented as part of a comprehensive *K-17* Pathway Program which uses the UC's Emerging Ethnic Engineering (E^3) Program as a vehicle to encourage female, minority and economically disadvantaged students to interact with CEAS as early as Grades 4-7 through our 6-week Family Science Academy program, a comprehensive 5-week Summer Institute program for students from grades 8-12, and through a Robotics Competition held for local area middle and high school students.

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