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Dr. Warren N. Waggenspack Jr., Louisiana State University

Warren N. Waggenspack, Jr. is currently the Associate Dean for Academic Programs in the College of Engineering and holder of the Ned Adler Professorship in mechanical engineering at Louisiana State University. He obtained both his bachelor’s and master’s degrees from LSU ME and his doctorate from Purdue University’s School of Mechanical Engineering. He has been actively engaged in teaching, research, and curricula development since joining the LSU faculty in 1988. As Associate Dean, he has acquired funding from NSF to support the development of several initiatives aimed at improving student retention and graduation rates as well as supporting faculty with development with effective learning and teaching pedagogies. This work in this manuscript was funded in part by NSF STEP Grant DUE 0622524, 2006.
Implementing a Bridge Camp and Intro Course, Lessons Learned from a STEP Grant

In 2007, LSU University implemented *Engineering Engagement for Student Success*, a STEM Talent Expansion Program grant funded by the National Science Foundation. The ultimate goal of STEP is to increase the number of STEM graduates; for LSU University the primary goal was to increase engineering graduates. To determine if the STEP grant was meeting this goal, retention in the College and in the university was tracked throughout the duration of the grant. The LSU STEP grant consisted of several components aimed at building a community for incoming freshmen students to get them engaged and connected to the College of Engineering.

The main freshmen components are the $E^2$ - *Encounter Engineering Bridge* camp and the ENGR 1050, *Introduction to Engineering* freshmen class. Based on student, instructor and industry feedback, activities have continuously been adapted and implemented to improve the quality of the program. For example, development and growth of a strong peer-mentoring component has helped support scaling the project for larger numbers of students. Additional adjustments to staffing and funding have been necessary through the years to accommodate the changing enrollment. In addition, the information presented as been updated and revised to best meet the needs of the students and meet the overall goals of the NSF STEP program.

*Research and Background*

Student recruitment and retention have received a great deal of attention in the educational and educational research literature over the past two or three decades. In spite of the well established body of research knowledge concerning factors affecting recruitment and retention, the success of widespread efforts and programs to both attract and retain students in the STEM disciplines has been somewhat limited. However, dramatic improvement has been reported by individual institutions and colleges.

Various studies have recorded the historical losses suffered by STEM disciplines as students transition from high school to college, a large percentage of which occurred in the freshman year. Astin and Astin (1992) found a relative student loss of 40% in the STEM disciplines between freshman and senior years. Whereas such data are not always readily available for public review, a study by the Engineering Dean’s Council (1988) found losses of engineering students to other majors and withdrawal from the university vary between 30 and 70% at four year engineering schools. However, these overall results mask that substantial differences exist between race and gender. For example, Adelman (1999) found bachelor degree completion rates of 86.9%, 75.4%, 60.8%, 45.1%, and for Asians, Whites, Latinos, and Blacks, respectively.

The most comprehensive study of STEM student retention was reported by Seymour and Hewitt, “Talking About Leaving-Why Undergraduates Leave the Sciences” (1997). They used an ethnographical research approach that encompassed 335 students at seven four-year institutions over a three year period. The majority of the data (75%) were derived from personal interviews with the remaining data coming from focus group discussions. As stated by Seymour and Hewitt, the single most important generalization from their study was that they found no significant differences between the switchers and non-switchers in terms of individual attributes of performance, attitude and behavior.
Further, they discovered that the problems prompting students to switch were also troublesome to non-switchers, and were consistent across the seven participating campuses. Issues affecting students’ decisions to stay in or leave a degree program fell roughly into 23 categories. Variations by group and, to some extent, by race and gender were noted in the perceived importance of these factors. Thus, while the results point to general factors impacting the decisions to switch or not, the complexities and interactions of factors affecting the perseverance of a student must be tied back to the individual institution.

Anderson-Rowland (1997) conducted a survey of engineering freshmen at Arizona State University and found that the lack of, or minimal engineering contact during the first semester or first year may be insufficient to reinforce the students’ original reasons for entering engineering. French, et al. (2005) concluded that student persistence requires a strong academic background, achievement of good grades and academic motivation. Their findings suggest that retention programs should focus on academic achievement. Johnson (1997) found that the most distinguishing characteristics between retained and dropout students were faculty and staff-student interaction and connection.

Tinto (1997) found that modifying faculty-student interaction within and outside the classroom to be more collaborative resulted in the actual classroom activities influencing persistence. Tinto (1998) also reported that structuring an academic organization to promote greater community among students, faculty and staff positively influenced persistence. In another paper, Tinto (2002) stated that setting high expectations for student success; providing clear and consistent advice; providing for academic, social and personal support; involving students in the activities of the institution; and promoting active learning stand out as being supportive of retention. Brown (2005) examined the relationship between “social capital” (defined to consist of social; networks, social norms and the value of these networks and norms for achieving mutual goals) and engineering retention. In his review, he noted: “It is clear from the literature that social integration into the community, both academic and extra curricular, is vital to both the personal development and retention of students in higher education” and is particularly important for minority students. His study indicates positive interactions with faculty, peers and advisors are important to enhance retention and counter the adverse effect of the “weed-out“ culture in engineering. He concludes that multiple changes with potential impact and having multiple positive impacts are needed to improve retention. Specifically suggested were active and cooperative learning in-class practices and a variety of out of class experiences including service learning and learning communities. Padilla (1999) argued that student success should be the foundation of student retention efforts. Tinto (1990) equated successful retention to successful education, not requiring sophisticated machinery but a reaffirmation of the basic foundations of higher education. Craft (2004) found that collaborative teaching strategies and extensive active learning techniques were cornerstones of their successful efforts.

Beckett and Marrero (2005) described a freshman interest group (FIG) seminar conducted at the University of Missouri-Columbia as a means to improve engineering student retention by integrating social and academic issues. They also noted earlier papers by Tokuno (1993) and Pike, et al (1997) that observed improved retention rates of 4% to 5% between the first and second semester freshman year and from the freshman to
sophomore year, respectively. The Tokuno and Pike, et al studies were conducted at the University of Washington and the University of Missouri-Columbia, respectively. The Pike, et al paper cited that FIGs had a “substantial positive effect on student-faculty interaction” and “positive effects on social integration and institutional commitment.” The Beckett and Marrero study of the entering class of 2003 found freshman to sophomore retention rates of 78% and 90% for non-FIG and FIG students, respectively. For the class of 1998, degree attainment in all fields ranged from 64% for the non-FIG students to 76% for the FIG students. In engineering only, 41% of the non-FIG students received degrees whereas almost 56% of the FIG students received degrees. The authors cautioned readers to be “careful before drawing too many firm conclusions.” They also noted that the students self-select the program, thus it is possible that FIG students have a higher commitment to engineering. Levitz, et al, (1999) concluded: “Getting students started right on the path through the institution to graduation begins with anticipating and meeting their transition and adjustment needs when they enter. Freshmen need a prevention plan. Intrusive, proactive strategies must be used to reach freshmen before the students have an opportunity to experience feelings of failure, disappointment, and confusion.”

Demel, et al, (2002) reported the results of a study conducted by the Ohio State University COE for more than a decade starting in 1993. During the study period, the College moved from a series of separate freshman courses to a dual offering of integrated course sequences in the Introduction to Engineering Program (IEP) and the Freshman Engineering Honors (FEH) Programs. These courses were an adaptation of Drexel University’s E4 curriculum undertaken by the NSF Gateway Engineering Education Coalition. In 1988, the College’s retention rate to the junior year ranged between 40% and 50%. Retention rates of nearly 58% to almost 84% were achieved through introduction of the FIP and the FEH programs. They concluded: “Systematically exploring educational practices that improve retention and then integrating them into the planning and implementation of a set of new courses has worked well at Ohio State. It would be difficult to pick out one of the processes or educational practices that has been the most effective. In the opinion of the authors, it is consistent regard for the students as individuals shown to them through personal interactions provided by the programs that is the key to our success.” Similarly, Kuh (2001-02) concluded: “Just as no single experience has a profound impact on student development, the introduction of individual programs or policies will not by themselves change a campus culture and students’ perceptions of whether the institution is supportive and affirming. Only a web of interlocking initiatives can over time shape an institutional culture that promotes student success.”

Shuman, et al, (1999) studied the issue of engineering attrition at the University of Pittsburgh by focusing on student characteristics and educational initiatives. They found, as did Budney, et al (1998), that the first semester is critical to student success. Surveys of engineering leavers indicated the principal two reasons for leaving engineering as “came to dislike engineering/studying engineering” and “lost interest/developed new interests”. They also found that although a high percentage of the students talked to someone before leaving engineering, very few sought career counseling services. Following their studies, the COE implemented a number of actions to improve student retention. Top among these changes were the addition of two problem-based learning
courses and a freshman engineering seminar to the curricula. The latter course used specially trained undergraduate freshman leadership mentors to lead small group discussions. Subsequently, they found that the number of engineering students that transferred out of engineering in good standing decreased from almost 13% to less than 5%. Based on their findings, they concluded that 65% was a realistic graduation rate for students that entered the university as freshmen. Campbell and Campbell (1997) found that mentored students outperformed non-mentored students. Wilson, et al, (1997) indicated that students who received counseling had a 14% higher retention rate compared to non-counseled students.

Based on the research, the College of Engineering applied for and implemented a STEP grant to increase the retention rate and thus the graduation rate of students from the college. The LSU STEP grant includes the Encounter Engineering Bridge Camp for freshmen, ENGR 1050, Introduction to Engineering course, a laptop loan system for students, tutoring through the Center for Academic Success, and a faculty development workshop that provides teaching strategies to STEM faculty. This paper focuses on the two freshmen components only.

Participants and Program

For the past five years, participants for the student programs have been recruited during the LSU Spring Invitational, campus orientations and recruiting events for high school students, direct mailings, university recruiting events and at other activities hosted by partners of the College of Engineering. In order to participate in the summer bridge camp, students were required to have indicated an intent to major in engineering or construction management. The E^2 bridge camp has grown from 45 students in 2007 to 140 students in 2011. Initially, the team lead and college staff performed all recruiting efforts for the freshmen programs. In 2009, peer mentors (PM), upper-level majors who have been through college leadership and mentoring training, were engaged in recruiting freshmen, primarily at events such as spring invitational, orientations for incoming freshmen and on-campus high school recruiting days. Peer mentors also hosted information tables and gave tours to interested high school students. It was noted after 2009 that freshmen students more readily identified with college students and were more likely to ask questions or obtain advice from the students than college staff.

Freshmen also had the opportunity to register for ENGR 1050, at the spring invitational and the orientations. ENGR 1050 is open to all students, not just engineering and construction management majors. There is no minimum prerequisite to enroll in this course, as one course objective is to allow students an opportunity to gain additional information on engineering/construction management majors before they commit their academic career to a major that does not fit their desires and talents. Students are encouraged to choose between the camp or the class.

The main goal of the bridge program and the course is to provide activities and events that facilitate students connecting with one another and with College of Engineering (CoE) faculty, staff, student organizations and industry. Other objectives of the STEP freshmen programs include: generating interest in and educating incoming students about the LSU CoE disciplines; providing opportunities to perform hands-on engineering activities for developing problem solving skills and thought patterns characteristic of all engineering disciplines; introducing students to the academic rigors
required by an engineering/construction management program; providing activities to develop personal habits that enable being successful in the university and professional environments; and providing opportunities to meet others on campus who provide academic, personal and community support. After each bridge camp and at the end of the course, survey and focus group data are evaluated and, where feasible, changes are incorporated into the following year’s program.

**Academic Sessions, E² Camp**

The goals of the academic courses in E² are to provide content knowledge and an opportunity for the students to perform in a team based environment. The academic sessions provided in E² are physics, math and engineering design. For the past 5 years, physics instructors have presented concepts selected from the first six weeks of the introductory physics course. The first year physics class was chosen because all engineering students would eventually have to take this course.

In 2008, based on feedback from students, the first math component (calculus) was incorporated into the camp. Approximately 1/3 of the students had not placed into calculus and, on their surveys, expressed frustration or feelings of being overwhelmed. As a result, for 2009 through 2011, E² scheduled a range of math sessions: Algebra, Trigonometry, Calculus I or Calculus II. Session schedules and group formation accommodated each student’s university math placement. All students took a computer based pre-test on the first day of camp, then had follow-up sessions in the lab at their particular skill level. This allowed the students to find their way across campus to the math lab used by the math department for several courses and to experience the computer based testing/homework environment used in those courses. This exposure to math and physics is E² specific and is not contained in ENGR 1050.

**Design Competition, Camp & Course**

The engineering design project in E² and ENGR 1050 presented the basic steps in engineering design and project management. Over the years the design project has changed and adapted based on feedback from prior participants. In 2007, it was based on a high school camp robotic competition. Students were given a set of KNex kits and asked to design anything that related to their field of interest. Student prototypes ranged from helicopters to buildings. In 2008 and 2009 the design tasks for the E² camp were a Rube Goldberg contraption that raised a team flag (2008) and launched a ping pong ball at a target (2009) respectively. The following year (2010), peer mentors adapted a remote control (R/C) car contest from the 2009 Texas A&M Regional Engineering Conference (TREC), and built the obstacle course track for the contest. Lastly, for 2011, the design task returned to Rube Goldberg in which the main goal was to launch a ping pong ball into a “Zen Garden.”

Similar to the camp, the design project for the course has been adapted each year, and initially it encompassed only conceptual design. In 2007 and 2008 students selected one of two alternative tasks: design a hurricane survival kit for the gulf coast regions; or design a K-12 educational demonstration that conveys an engineering concept. Students also completed an additional research project on their discipline of interest. For 2009, the design task was to conceptualize a “baseball” (ping pong ball) robot that could compete in the ASEE 2010 student design competition. Student teams were provided the incentive of an all expenses paid trip to compete with the hope that some would take on
the prototyping/testing tasks the following semester through independent study. Unfortunately, there were no takers on the offer and survey feedback indicated students would much rather design and build a project all in the same semester.

Table 1. Number and Demographics of Freshmen Participants

<table>
<thead>
<tr>
<th>Program</th>
<th>Year</th>
<th># of Participants</th>
<th>Demographics</th>
</tr>
</thead>
<tbody>
<tr>
<td>E² Camp</td>
<td>Year 1</td>
<td>45</td>
<td>80/20% male: female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>22% minority</td>
</tr>
<tr>
<td></td>
<td>Year 2</td>
<td>84</td>
<td>82/18% male: female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6% minority</td>
</tr>
<tr>
<td></td>
<td>Year 3</td>
<td>106</td>
<td>85/15% male: female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8% minority</td>
</tr>
<tr>
<td></td>
<td>Year 4</td>
<td>125</td>
<td>81/19% male: female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15% minority</td>
</tr>
<tr>
<td></td>
<td>Year 5</td>
<td>140</td>
<td>85/15% male: female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>11% minority</td>
</tr>
<tr>
<td>ENGR 1050</td>
<td>Year 1</td>
<td>56</td>
<td>69/31% male: female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>33% minority</td>
</tr>
<tr>
<td></td>
<td>Year 2</td>
<td>74</td>
<td>74/26% male: female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>28% minority</td>
</tr>
<tr>
<td></td>
<td>Year 3</td>
<td>70</td>
<td>67/33% male: female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15% minority</td>
</tr>
<tr>
<td></td>
<td>Year 4</td>
<td>45</td>
<td>82/18% male: female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>18% minority</td>
</tr>
<tr>
<td></td>
<td>Year 5</td>
<td>62</td>
<td>77/23% male: female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>85/15% minority</td>
</tr>
</tbody>
</table>
In order to meet the request for a “design and build” type semester long project, the class design task for 2010 and 2011 was a modified version of the TREC R/C car contest. This annual undergraduate engineering design competition is held early in the year to foster communication and friendly competition between universities from around the area. The track used for the class was the track developed and built for the 2010 E² camp. For 2011, each team modified a remote control car to maneuver through the obstacle course while collecting BB’s. In all cases students are assigned teams of four to five and given an upper-level peer mentor to help guide them through the design project. Additionally, peer mentor “leaders” run each of the competitions and report results back to faculty and staff.

For 2011, a second research project was reincorporated into the class based on survey feedback. However, instead of individual research projects, students were grouped by math placement and career interests and asked to compare and contrast two engineering disciplines. Each team was given a math formula/principle at their level and asked to interview engineers in the field or the college to find out how it might be used in engineering practice. At the conclusion of each task, students participated in a poster session to convey to others in the class what they had discovered.

Personal & Professional Development

Personal and professional development for the camp and the course included time management, goal setting, industry lunch (E² only), effective learning strategies, money management and an introduction to LSU’s Communication Across the Curriculum (CxC) initiative. Industry professionals and student organization leaders were recruited to participate or present activities specifically to introduce the incoming freshmen to the professional and university communities. Activities for both programs included mock interviewing, resume writing and planning for internships.

For both the camp and the class, academic and industrial professionals give presentations and have informal discussions about their careers and disciplines. All students are exposed to the 10 degree programs/disciplines offered in the college.

Peer Mentors

The ongoing STEP mentoring program was an outgrowth of the E² peer mentoring efforts. Starting with only five E² peer mentors (PM’s) in 2007 and growing to 52 by 2011, a total of 126 different students have served the STEP initiative (Table 2). In 2009 due to their success in the camp, peer mentors were incorporated into the class as design leads. Whenever possible, peer mentors are assigned to teams with students in their majors, maintaining an approximate 1:5 PM:student ratio. With one exception, the team and the peer mentors assignments remained the same throughout the program. For 2011, teams and peer mentors were reassigned and distributed for each project.

Logistically as the number of program participants grew, so did the challenges of coordinating peer mentors and their teams of protégés. A basic tiered structure was established in 2009 with four peer mentor “ambassadors” recruited to assist in the operations of the camp and help younger peer mentors work with freshmen teams. In 2010 and 2011 a third tier was added: each team of 4-5
protégés is assigned a peer mentor; groups of four teams and their mentors are each assigned a peer mentor leader as backup and to help activities run smoothly; and, lastly, the more senior PM’s were given planning and execution responsibilities for various activities within the camp.

Table 2. Participants in Peer Mentoring (PM) Program

<table>
<thead>
<tr>
<th>Program</th>
<th>Program Year</th>
<th># of Students</th>
<th>Demographics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Year 1</td>
<td>5 Peer Mentors</td>
<td>60/40% male: female</td>
</tr>
<tr>
<td>E² Mentoring</td>
<td></td>
<td></td>
<td>21% minority</td>
</tr>
<tr>
<td></td>
<td>Year 2</td>
<td>15 Peer Mentors</td>
<td>60/40% male: female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>21% minority</td>
</tr>
<tr>
<td></td>
<td>Year 3</td>
<td>31 Peer Mentors</td>
<td>71/29% male: female</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 Ambassadors</td>
<td>15% minority</td>
</tr>
<tr>
<td></td>
<td>Year 4</td>
<td>30 Peer Mentors</td>
<td>71/29% male: female</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11 PM Leaders</td>
<td>7% minority</td>
</tr>
<tr>
<td></td>
<td>Year 5</td>
<td>36 Peer Mentors</td>
<td>60/40% male: female</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12 Leaders</td>
<td>16% minority</td>
</tr>
<tr>
<td>1050 Mentoring</td>
<td>Year 3</td>
<td>14 Peer Mentors</td>
<td>60/40% male: female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20% minority</td>
</tr>
<tr>
<td></td>
<td>Year 4</td>
<td>9 Peer Mentors*</td>
<td>56/44% male: female</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 PM Leader</td>
<td>11% minority</td>
</tr>
<tr>
<td></td>
<td>Year 5</td>
<td>15 Peer Mentors*</td>
<td>60/40% male: female</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 PM Leader</td>
<td>20% minority</td>
</tr>
</tbody>
</table>

As noted above, peer mentor responsibilities evolved from basic interaction to developing activities and leading design teams. The newest peer mentors help freshmen acclimate to university life, lead design teams and facilitate activity logistics. Experienced, effective peer mentors who continue with the program after one year are invited to be peer mentor leaders (oversee a collection of new peer mentors) or session leaders for the camp and the class. Sessions for the camp include design lead, 7 Habits and The Challenge Course. Sessions for the class include design competition, teaching assistant and summer experiences such as REUs, programs abroad and student organizations. Additionally junior and senior peer mentor leaders have often been called upon to present their capstone design projects, internship/Co-op and research experiences to the class.
In 2011 peer mentor leaders were responsible for obtaining resumes, hosting group interviews for the camp/class and writing thank you notes to industry partners. This recent group of student leaders took their experiences one step farther with formally establishing a “Society of Peer Mentors” organization at the University.

**Overall STEP Assessment**

The STEP program is primarily interested in quantifying the success of its different programs designed to improve retention rates among freshman engineering students. Students who participated in the E^2 Bridge program and ENGR 1050 are grouped and collectively referred to as “STEP” students. Included in this analysis are students who were also in the college’s Engineering Residential College which opened at the start of this grant but not officially supported by its funds. These students are compared to the remainder of the declared engineering freshmen who have not participated in any of the programs and are designated as “NonSTEP.”

Data have been collected on each freshmen cohort for the past five years with the first cohort starting fall 2007 and with its corresponding four year graduates finishing May 2011. Retention in the college is determined by a student’s designated major on the 14th day of the fall semester. After 4 years, the “retention” rate reported is actually a persistence rate as it also includes that portion of students who graduated (persistence = retention + cumulative graduation). For contrast, the same evaluation is reported for engineering majors retained at LSU but not necessarily in engineering.

Data is taken on an annual basis, thus Cohort 1 has 4 years of data, Cohort 2 has three and so on. Cohort 5 is in their first semester at LSU. Graphs 1-4 present the retention of four cohorts in the college of engineering and at LSU. Other information collected were grades for math and physics, basic demographics, ACT scores (particularly math ACT) and overall university GPA. To determine the impact of STEP participation on retention, independent factors t-tests were calculated (a = .05) to compare retention in the college of engineering, STEM disciplines, and at LSU of STEP participants with non-STEP participants for each cohort and year combination (cohort 1 in 2007, cohort 1 in 2008, etc. for 10 total groupings)

The analysis indicates that students participating in at least one of the STEP programs are retained in the college of engineering at higher rates than those who do not participate. The historical retention reported is an 11 year average prior to the awarding of the grant. The projected targets were based on this average and were developed to increase the number of graduates by approximately 100 students if all incoming students were actively participating in the programs. On average the retention in engineering of the STEP students is 20.5% higher than the non STEP students at the end of four years (cohort 1), 11.3% higher after three years (cohorts 1 and 2), 10.3% higher after two years (cohorts 1, 2, and 3), and 7.2% higher after one year (cohorts 1, 2, 3, and 4). Retention of the students in the non STEP group tends to be closer to the historical rates (Charts 1-4).

In addition to higher retention in the College of Engineering, retention of STEP students in any STEM program was also significantly higher than non-STEP counterparts. Retention in STEM programs for STEP participants was 20.5% higher after four years, 11.9% higher after three years, 9.5% higher after two years, and 6.3% higher after one year. Finally, retention at LSU was also higher for STEP participants than non-STEP
participants, although the difference was only statistically significant for cohort 1. Retention at LSU for STEP participants was 14.0% higher after four years, 9.1% higher after three years, 6.2% higher after two years, and 4.2% higher after one year.

**STEP Retention in College of Engineering**

Chart 1. STEP Retention in the College of Engineering
Chart 2. Non STEP retention in the College of Engineering

Non Step Retention in College of Engineering

YEAR OF PROGRAM

% Retention in the College

Yr 1 Yr 2 Yr 3 Yr 4

Cohort 1 (n=685)
Cohort 2 (n=590)
Cohort 3 (n=493)
Cohort 4 (n=594)
Historical

Chart 3. STEP retention at LSU

STEP Retention at LSU

YEAR OF PROGRAM

% Retention in the College

Yr 1 Yr 2 Yr 3 Yr 4

Cohort 1 (n=168)
Cohort 2 (n=268)
Cohort 3 (n=285)
Cohort 4 (n=305)
Historical
Program Component Assessment

Charts 5-6 depict retention in the College of Engineering for students who participated in the camp or the class and generally show that retention of students participating in either of these programs is greater than non-STEP students. A more in depth analysis was performed on the camp and class participants to determine what factors were affecting the retention of the camp and class participants. ANOVA analyses were performed comparing the bridge camp, class and non-step students for Cohorts 1, 2, & 3 for the year 2011. If a significant difference was noted on the ANOVA, an independent t-test was then run to identify which program had the significant difference.

The first comparison was of the overall GPAs of the camp students, class students and non-STEP students. Mean GPAs of class and camp participants for all cohorts were essentially the same as non-STEP participants with mean GPAs ranging from 2.5 to 2.8. (Table 3) GPAs tended to go down with each subsequent year at LSU; however, within years, no significant difference was noted between students.

With little difference noted in GPAs, and alternate completion ratio metric was evaluated for math and physics courses to see what impact, if any, might the camp or the class have on student performance. A completion ratio is the number of successfully completed courses divided by the number of attempts needed to successfully complete the courses. The optimal ratio one means a student successfully completes courses on the very first attempt. It provides a comparison measure for those students repeating classes multiple times for earning a (D)FW where only grades of A,B or C are acceptable to move on. Student grades were tracked through second calculus and the second physics –
the engineering preparatory courses. Based on placement, students may take up to 4 math classes in completing the first two years of the curriculum: college algebra, college trigonometry, a combined algebra/trigonometry course, calculus I and calculus III. For physics, students could start in either Physics 1100 or Physics 2101. Several curricula also require Physics 2102.

Analysis of the groups revealed that participants in the bridge camp had a significant difference in the completion of physics for all three cohorts (positive), Table 3. For Cohort 2, the impact was significant for completion of physics. The bridge participants show no major difference in math completion rates; however, math was not offered for the first cohort and only calculus was offered for the second cohort. Students in the third cohort could still be working towards their upper level courses.

![Bridge Retention in CoE](chart5.png)

Chart 5. Retention of Bridge Students in College of Engineering
Table 3. Comparison of GPA Means and Completion Ratios for Program Components and Non STEP Students

<table>
<thead>
<tr>
<th>Cohort</th>
<th>E2 Bridge</th>
<th>Class</th>
<th>Non STEP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GPA</td>
<td>Math Ratio</td>
<td>Physics Ratio</td>
</tr>
<tr>
<td>Cohort 1</td>
<td>2.5</td>
<td>0.71</td>
<td>0.64*</td>
</tr>
<tr>
<td>Cohort 2</td>
<td>2.6</td>
<td>0.74</td>
<td>0.61*</td>
</tr>
<tr>
<td>Cohort 3</td>
<td>2.6</td>
<td>0.73</td>
<td>0.59*</td>
</tr>
</tbody>
</table>

Note: Ratio is # Completed Course compared to Attempted; * indicates significant difference in the mean, a=0.05.

The academic preparation of incoming students varies from cohort to cohort. As a basis for comparison, a ratio of the number of incoming Engr/CM majors with math ACT ≥ 26 divided by the number with ACT <26 was calculated for each cohort, see Table 4. On average STEP students have higher math ACT scores with the ERC consistently higher than either the bridge camp or class. To date the retention of Cohort 2 is the lowest and Cohort 4 is the highest. This coincides with the math ACT for both groups. Even for the class with the lowest math ACT ratio of all programs, the retention numbers are consistently 6 to 7% higher than non-STEP students in that cohort.
Table 4. Ratio of MATH ACT greater than or equal 26 to Math ACT less than 26

<table>
<thead>
<tr>
<th></th>
<th>STEP</th>
<th>Non-STEP</th>
<th>Bridge</th>
<th>Class</th>
<th>ERC</th>
<th>PM*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cohort 1</td>
<td>0.69</td>
<td>0.55</td>
<td>0.73</td>
<td>0.52</td>
<td>0.72</td>
<td>0.92</td>
</tr>
<tr>
<td>Cohort 2</td>
<td>0.60</td>
<td>0.54</td>
<td>0.55</td>
<td>0.55</td>
<td>0.66</td>
<td>0.76</td>
</tr>
<tr>
<td>Cohort 3</td>
<td>0.63</td>
<td>0.55</td>
<td>0.59</td>
<td>0.58</td>
<td>0.66</td>
<td>0.50</td>
</tr>
<tr>
<td>Cohort 4</td>
<td>0.79</td>
<td>0.59</td>
<td>0.84</td>
<td>0.65</td>
<td>0.81</td>
<td>0.92</td>
</tr>
</tbody>
</table>

* PM from FYP only; does not include transitional

Summary & Conclusions

The results of the analysis indicate that participation in one of the STEP programs increases a student’s retention in the College of Engineering and at LSU. It appears that the camp and class appeal to different types of students. The success of the STEP program depends on:

1. *An enthusiastic support system/staff:* Paid staff and faculty work closely with the peer mentors and freshmen students and spend several hours a week meeting informally with them as mentors and guides.

2. *Peer mentors:* These students help with the transition of the freshmen, assist in recruiting and provide valuable feedback for improvements in the programs. Freshmen reported that they feel more comfortable in their first interactions with upper-level majors. The peer mentors act as intermediaries between freshmen and staff.

3. *Appropriate level courses* (camp) and *discipline specific projects* in the class: Because the engineering students enter the university at all levels of academic preparedness, one class for all students was not appropriate. Additionally, students continue to request and investigate discipline specific projects. Giving them opportunities to meet with engineers from various fields and research their majors seems to provide confidence in their chosen field or allows them to determine early on that engineering may not be the career for them.

4. *Flexibility:* The team surveyed participants after each program and the upperclass students and typically implemented modifications to the following year’s program. Portions of the camp and class that the students did not like or did not achieve goals were removed. Examples of this were the 2009 class project or having staff teach 7 Habits for the camp. Other sessions were added like the various levels of math and a design and build type project for the class.

5. *Partnerships:* The team members work with the faculty of each the departments and with industry professionals to build and maintain partnerships to give the students multiple opportunities to interact with engineers in their field.

6. *Coordination with other Campus Units:* Logistically as the camp grew and the class changed into a more project based course, having appropriate sized spaces on
campus became a more important criteria. As the university encourages more of these activities, several units on campus are having to share large spaces and instructive resources.

7. **Data collection:** Data for the STEP grant has been collected manually. As the program grew, more time and effort had to be dedicated to data collection. For the next portion of the STEP project the team has implemented codes on student records through its Office of Budget and Planning. This should ease the data collection and student tracking.

Overall, LSU Encounter Engineering camp and class successfully address the stated goals of the NSF STEP program by retaining more students and increasing STEM graduation rates for the university. Both of these programs will be hosted for a 6th year and will be sustained through the college. The team will periodically survey students and implement modifications for continual improvements in these programs.

**References:**


