

AC 2008-477: INCREASING STUDENT SUCCESS IN ENGINEERING AND SCIENCE THROUGH A FRESHMAN ENRICHMENT PROGRAM

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Increasing Student Success in Engineering and Science through a Freshman Enrichment Program

Abstract

Our College of Engineering and Science (COES) has implemented a Freshman Enrichment Program (FrEP) to help meet our overall goal of increasing the number of STEM (Science, Technology, Engineering, and Mathematics) graduates prepared to successfully enter the workforce. Approximately half of the students who enroll in the COES are prepared to begin either our Integrated Engineering Curriculum or Integrated Science Curriculum. The remaining students must complete one or more preliminary mathematics courses prior to enrolling in Calculus. As a consequence, these students must delay beginning several critically important classes which often leads to a full year delay in graduation. Understandably, many students become discouraged. A weak mathematics background, frequently coupled with poor study and time management skills, causes many students to fall further behind, ultimately resulting in withdrawal from the university or a change to a non-STEM degree program. Our overall goal is an annual increase in STEM graduation rates from 220 students per year to a sustainable 300 students per year.

As part of the FrEP, students enroll in a five-week program during the summer before their freshman year. This program consists of a three-credit-hour college algebra course, enrichment topics, and an optional three-credit-hour general education course. Enrichment topics for the summer program include study skills, time management, career decision making and acclimation to the University. In addition, the students participate in many community-building activities, both structured and unstructured. The summer program, as a whole, establishes consistent expectations of the intensity of college life and creates an immediate place of fit when the students return in the fall. The FrEP project, supported by NSF STEP and S-STEM grants, continues to provide scholarships for these FrEP students through their freshman year. Our Integrated Curricula are structured such that students register for a block of core classes, and the S-STEM student cohort comprises one of these blocks. Throughout the academic year, student mentors are assigned to this cohort to conduct Supplemental Instruction sessions each week.

At present, 85% of this initial FrEP cohort has been retained in a STEM discipline. Data from the previous three years show an average freshman to sophomore STEM retention rate for a similar cohort of 59%. These students also have displayed more confidence, positive attitudes, respect, and a greater understanding of the demands of college life.

Introduction

Louisiana Tech University's STEM Talent Expansion Program (LaTechSTEP) has two major components that will yield increased numbers of graduates in STEM disciplines. One component focuses on recruitment of new students, while the second component increases retention. The Freshman Enrichment Program (FrEP) described in this paper focuses on recruiting and retaining students who have demonstrated academic potential but likely would not be successful in a STEM degree program without significant student development support.

According to the National Science Board's *Science and Engineering Indicators 2004*, enrollment in undergraduate engineering and science programs decreased sharply during the 1980s,

followed by slower declines in the 1990s.¹ Since 2000, enrollment numbers have begun to increase again; but the report also indicates that, of those students who do enroll in engineering and science programs, fewer than 50% earn an engineering or science degree within six years. Clearly, there is a continued need for increased enrollment and retention in science and engineering. In *The Science and Engineering Workforce: Realizing America's Potential*, the Board strongly recommends national-level action to provide an adequate number of science and engineering graduates to ensure competitiveness in the ever changing global economy (NSB 2003).²

When considering student persistence, the first year of college is a critical time; it is then that a student either finds his/her fit or feels isolated and drawn to leave.³ The first year holds much uncertainty, and the student needs to move from marginality to a place of mattering within the larger campus environment.⁴ Tinto, through vast research on college student persistence, cites academic integration and social integration as two main influences on persistence; both in-class and outside-of-class experiences are important.⁵ Comprehensive learning communities like the Freshman Enrichment Program provide a network of students with like interests, which encourages involvement in both the academic and social aspects of that community.^{6, 7} In addition to peer interaction, a student's interactions with his/her academic faculty highly impact the level of integration and therefore persistence in college.³ The overall atmosphere of a first-year program should foster these characteristics that lead to student success. Pascarella and Terenzini have found that "the environmental factors that maximize persistence and educational attainment include a peer culture in which students develop close on-campus friendships, participate frequently in college-sponsored activities, and perceive their college to be highly concerned about the individual student, as well as a college emphasis on supportive services (including advising, orientation, and individualized general education courses that develop academic survival skills)".⁸ The Freshman Enrichment Program aims to provide each of those attributes.

Why Do We Need a Freshman Enrichment Program?

Approximately half of the students who enroll in the College of Engineering and Science at Louisiana Tech are prepared to begin our Integrated Curricula. The remaining students must complete one or more preliminary mathematics courses prior to enrolling in Calculus I. The Integrated Engineering Curriculum is structured such that students register for a block of classes including a class in each of mathematics, science and engineering. The block of classes for the Integrated Science Curriculum includes a mathematics, science and science lab. In each case, there are 40 students per block.

Since Calculus I is in the first block of classes in each curriculum, approximately half of our incoming freshmen must delay beginning several critically important classes. Though they are able to take other general education courses that are in their curriculum, the prerequisite structure is such that this delay in the first quarter often leads to a full year delay in graduation. Understandably, many students become discouraged. A weak mathematics background, frequently coupled with poor study and time management skills, causes many students to fall further behind, ultimately resulting in withdrawal from the university or a change to a non-STEM degree program.

Even though we have achieved significant increases in retention and graduation through several programs such as our Integrated Curricula, our data revealed a significant difference between the graduation rates of our “lead” students (those who start in Calculus I) and our “lag” students (those who start in an algebra or trigonometry course). The data showed that lead students graduated at a rate of 51% while the lag students graduated at a rate of 26%. This paper presents a Freshman Enrichment Program targeted toward at-risk lag students.

The Freshman Enrichment Program (FrEP)

As part of the FrEP, 40 students enrolled in a five-week program during the summer before their freshman year. Eligible students were first time freshmen with a math ACT between 22 and 26. These students were partially supported by an NSF sponsored S-STEM scholarship. Scholarship recipients were selected by the project management team. The selection process included high school teacher recommendation and a written essay from each applicant. In addition, a tuition waiver was provided by the University. The makeup of the 2007 FrEP cohort was 20% female with a 32.5% minority population. The students selected for the program represented most regions of the state and both urban and rural areas were represented.

The FrEP program consisted of a three-credit-hour college algebra course, enrichment topics, and an optional three-credit-hour general education course such as English, history, sociology or art appreciation. Enrichment topics for the summer program included study skills, time management, career decision making and acclimation to the University. Other activities included field trips to research centers on campus and engineering and science facilities in the surrounding area in addition to guest lectures by scientists and engineers from these facilities, cookouts, birthday parties, and movie/game nights. A typical daily schedule for the summer component of FrEP is shown in Table 1.

8:30 – 9:30	Enrichment Topics
9:30 – 11:00	College Algebra with Engineering/Science Applications
11:00 – 12:00	Team Building/Creative Problem Solving
12:00 – 1:00	Lunch
1:00 – 2:30	Optional General Education Course
3:30 – 5:00	Study Sessions with Mentor Tutoring
6:30 – until	Evening Study Sessions

The college algebra course was team taught by a mathematics professor and an engineering professor and included engineering/science applications. Additionally, these students were required to use ALEKS, a web-based individualized learning assistant, to reinforce the algebra course topics. ALEKS uses diagnostic testing to rapidly identify weaknesses of individual students and focuses practice problems in those areas where an individual student needs the most help. The Mathematics Program at Louisiana Tech began using ALEKS to increase student retention and success in freshman-level mathematics courses in 2001. Statistical analysis of student performance data indicates that use of ALEKS is highly correlated with student retention/success.

Originally, an engineering design project was included in the schedule. Half-way through the term we decided to suspend the project because we recognized that the students needed to devote more time focusing on the mathematics course. Even though students thoroughly enjoyed the project, we had built enough trust that they understood the reasoning behind the decision.

During the summer component of the Freshman Enrichment Program, college algebra was supported by two student mentors. One of the responsibilities of these mentors was to conduct regular study sessions following the Supplemental Instruction (SI) model. SI is an academic assistance program that utilizes regularly-scheduled study sessions directed by trained peer student mentors (<http://www.umkc.edu/cad/si>). The mentors helped students integrate course content and learning/study strategies and also served as role models and helped them adapt to college life through non-instructional interactions.

FrEP students continue as a cohort throughout their freshman year; they take classes together, live in the same residence halls, benefit from SI sessions, and participate in community building activities. Additionally, these students will continue to receive S-STEM scholarships throughout their freshman year as long as they maintain a 3.0 GPA.

Results from the First FrEP Cohort

Thirty-five of the forty FrEP students successfully completed college algebra with a C or better. We counseled the other five students regarding career choices, and some of them successfully repeated the course and are still enrolled in a STEM discipline. At present, 85% of the initial FrEP cohort has been retained in a STEM discipline with 65% “on track” to graduate in four years. Data from the 2005 through 2007 cohorts show an average freshman to sophomore STEM retention rate of 59% for comparable cohorts. Data from the Fall 1999 and Fall 2000 show a 26% graduation rate for cohorts that are comparable to our FrEP students.

The FrEP students have displayed more confidence, positive attitudes, respect, and a greater understanding of the demands of college life. As faculty and mentors, we recognize some of the difficulties incoming freshmen will face. We do not intentionally build obstacles into the transition between high school and college, but neither do we remove them. The FrEP students learn to deal with these challenges during the summer, when we can provide more attention and support. The following are comments gathered from focus groups and surveys of FrEP students in the summer and fall concerning these barriers.

On Hitting Barriers:

There is a sense of unity among FrEP students – if someone is struggling, people will ask about it.

I didn't have to spend time at the beginning of the fall getting used to college... The summer challenged me and got me prepared for the academic challenges I would see.

The biggest challenge has been learning study habits because I didn't really study in high school.

The teachers have been great. They are really understanding and try to help. They are not “out to get you” like the stories people try to scare you with.

The summer challenged me and got me prepared for the academic challenges I would see... Even though I had to repeat math, I'm glad I came this summer. It would have been worse to sit out of math all summer. Having it in the summer made it fresher in my mind.

We also saw a positive transition in student attitudes and perspectives from the beginning of the summer term to the end of the summer. The following comments reflect some of this transition.

After the First Week:

There is a sink or swim adjustment to time management.

I do like this program; however, it takes a little while to get comfortable with it.

I'm exhausted!

I think this program is very good and is a great idea except for the fact that the students have no free time to just relax because we're in class all day and we're doing homework all night.

End of the Summer:

The past few weeks I've had a blast. I have made so many memories and have grown as a person... I got the chance to get a handle on the campus, teachers, and college life.

I am glad that I did the program because I feel prepared for my fall semester... I met peers that I feel will be friends for a while. I learned that you need to study a few days in advance so you don't stress on test day. Overall I had a great time and I can't wait until the fall semester starts and I can see everyone again.

Sometimes it's hard to juggle everything, but you need those times to get your mind off the stress. And you meet so many new people – that's the great part.

One of the main benefits of FrEP is building a community of support for this group of students. They become comfortable with each other and with their professors, which prevents them from feeling isolated in the fall quarter.

Building Community:

Summer school made it easy to get to know each other . . . it's cool to walk around campus and have friends everywhere. I don't feel secluded like other freshmen from my high school.

You walk in [the fall] and already know a lot of people and can branch out from there.

FrEP has made us comfortable talking to people and being in study groups. And we're comfortable cutting up with each other too!

Activities on Which the Freshman Enrichment Program Builds

Louisiana Tech has already begun to address the need for an increase in workforce-ready STEM graduates through several innovative and connected programs. These programs have been designed around a common goal of recruiting, retaining and graduating STEM majors prepared to enter the national workforce and be successful. An overview of these programs is shown below.

- **Integrated Engineering Curriculum (IEC)** – NSF-997279 – provides freshman and sophomore engineering majors with team-based, hands-on, active learning while integrating fundamental math, science and engineering topics.
- **Integrated Science Curriculum (ISC)** – NSF-0311481 – provides freshman and sophomore math and science majors with integrated, experiential learning similar to the IEC.
- **Louisiana Tech’s STEM Talent Expansion Program (LaTechSTEP)** – NSF-0622462 – stimulates interest in STEM topics at the high school level by partnering with area high school math and science teachers in Discovery Weekends for high school students.
- **Louisiana Tech’s S-STEM Scholarship Program** – NSF-0631083 – scholarship program supporting the Freshman Enrichment Program (FrEP) students.
- **Innovation through Multidisciplinary Projects and Collaborative Teams (IMPACT)** – NSF-0536082 – motivates students to look at the “big picture” in a horizontally and vertically integrated program centered on year-long design projects.
- **Living with the Lab** – NSF-0618288 – encourages students to develop a “can do” attitude by giving students ownership of a mobile experiment platform.
- **University Seminar** – provides first-quarter freshmen with life-skills necessary to make a successful transition from high school to university.
- **Living and Learning Communities** – increases student learning by building residential communities of STEM majors, merging the classroom environment with student life.
- **Student Achievement Center** – expands learning assistance, supplemental instruction, tutoring, writing assistance, and student advising for undeclared majors.
- **Tech’s Building Engineers and Scientist for Tomorrow (Tech’s BEST)** – provides scholarship support for qualified engineering and science students at the sophomore through senior level.

The Future of FrEP

We have targeted a specific cohort of incoming freshmen who will benefit from additional academic and social support. Based on the results of this first year, we will expand FrEP to include 75 students next year (Fall 2008). The intersection of FrEP with our Integrated Curricula and our Living/Learning Communities will provide an environment where students can be successful. Placing these students in a single cohort and providing the support programs and activities outlined above will continue to produce a Community of Scholars – with individuals supporting each other in both academic and professional as well as personal environments.

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