AC 2012-4443: SUMMARY RESULTS FROM SEVEN YEARS OF LATECHSTEP: A HIGH SCHOOL TEACHER DEVELOPMENT AND STUDENT RECRUITING PROGRAM

Dr. Kelly B. Crittenden, Louisiana Tech University

Kelly Crittenden earned his B.S. and Ph.D. in biomedical engineering from Louisiana Tech University. He currently serves as an Associate professor of engineering within the College of Engineering and Science at Louisiana Tech. Crittenden's primary focus is on multidisciplinary engineering education, curriculum development, and product development.

Dr. James D. Nelson, Louisiana Tech University
Prof. Galen E. Turner III, Louisiana Tech University
Ms. Jane A. Petrus, Louisiana Tech University

Jane Petrus is the Student Success Specialist for the College of Engineering and Science at Louisiana Tech University. In her role, she assists engineering and science students in academic advising, career planning, and more. She also helps coordinate K-12 outreach programs like TechSTEP. Petrus has a degree in mechanical engineering and spent two years working for the Dow Chemical Company before working at Louisiana Tech University.

Summary Results from Seven Years of LaTechSTEP: A High-School Teacher Development and Student Recruiting Program

Abstract
LaTechSTEP is a collaborative program between Louisiana Tech University faculty and high school teachers in the region. LaTechSTEP has two primary goals 1) to recruit new STEM majors to Louisiana Tech, and 2) to build relationships between the faculty and teachers. Through this program, high school students are brought on the university campus three times each year to explore a topic such as fuel cells. The high school math and science teachers of these students are brought on campus six times each year: three training workshops, and three times with the students.

This paper will present several outcomes of Louisiana Tech University's LaTechSTEP program. This program was initially piloted during the 2005-06 academic year with one high school and has grown to twelve high schools during the 2011-12 academic year. In 2007, NSF funding was awarded for the further development of LaTechSTEP (#062462). Over 300 students and over 50 teachers from 17 high schools have participated in this program since its inception.
The mechanics of the LaTechSTEP program have been presented in previous publications [1-5]; therefore, only a brief overview of the program logistics will be presented in this paper. Instead, this paper will focus on the outcomes of the project and will quantify the effect of LaTechSTEP on STEM enrollment and on university faculty/high school teacher collaboration.

Data will be presented to show the effect of LaTechSTEP on STEM enrollment at Louisiana Tech University. Additionally, the performance of students who enrolled in STEM after completing LaTechSTEP will be compared with STEM students who did not participate in the program. Retention rates of these students will be compared with their peers who did not participate in LaTechSTEP. On a larger scale, STEM enrollment trends for Louisiana Tech University will be discussed.

In order to attempt to measure the effect of LaTechSTEP on the teachers themselves, this paper will compare student performance from schools that participated in LaTechSTEP with the performance of students from schools which did not participate. Performance indicators will include mathematics and engineering GPAs, D/F/W rates, and ACT scores. Another measure of the effect on teachers will be the number of other Louisiana Tech University sponsored programs that the teachers attend. Qualitative responses from the teachers themselves will also be presented.

An additional outcome of the LaTechSTEP program has been several spin-off projects. These projects will be briefly discussed. Although not a primary goal of LaTechSTEP, these new programs have provided alternative paths to the realization of the primary goals: 1) increasing STEM enrollment, and 2) building relationships with regional high school teachers.

Introduction

There is growing concern that the higher education system in the United States is not producing a sufficient number of STEM graduates each year to meet the increasing demand. Factors such as low math and science proficiency rates among high school students[6], the impending retirements of baby boomers, and up to two-thirds of STEM graduates who do not take jobs in STEM fields[7] have combined to create an burgeoning need for more STEM graduates. At Louisiana Tech University, we have confronted this need through multiple initiatives. Over the past seven years, one program in particular has been at the nexus of our efforts to increase the number of STEM graduates at Louisiana Tech. This paper will describe this program in general terms, and will discuss various results of this program.

The premise behind LaTechSTEP is that in order to be effective at recruiting new STEM students we need to build meaningful relationships with our feeder schools. However, we cannot reach each prospective high school STEM *student* in our region every year. Instead we have focused this program on reaching out to the regional high school STEM *teachers*. We do have direct involvement with a small group of high school students, but the lasting effects on student recruitment have been achieved through relationships built between our university faculty and the high school teachers. Data collected over the span of this project show an average increase of more than 35% in the number of students enrolling in STEM majors at Louisiana Tech from schools who participate in LaTechSTEP.

As mentioned previously, LaTechSTEP is an annual project that cycles through a series of three different themes from year to year. The themes are: fuel cells, bridges, and catapults. These topics may sound very common; however, they are presented in such a way as to expose fundamental concepts. For example, the goal of the catapult project is not to launch a ball as far as possible, but to predict the landing spot of the ball before any test firing of the catapult. This leads the participants through an exploration of conservation of energy – very different from the traditional projectile motion that is most often presented at the high school level. At the same time that participants are learning fundamental principles, they are also building their communication skill set as well as exploring basic control circuits to automatically trigger the launch of their catapults.

Each LaTechSTEP theme lasts for an entire year. A typical year will have six meetings. The meetings are arranged in a pattern of teacher weekends followed by student weekends. The final teacher weekend is used to take topics to a deeper level with the teachers than we can with the students. Going deeper with the teachers follows our mantra of "teaching from the overflow of you knowledge." The final student weekend is centered on a challenge that the students must complete related to that year's theme. A graphical representation of a typical year is shown in Figure 1. The first pair of teacher/student events occurs during the fall of the academic year, the second during the winter, and the third either later winter or early spring. It is necessary to schedule these events far in advance as students will be required to be absent from school three Friday's during the academic year.

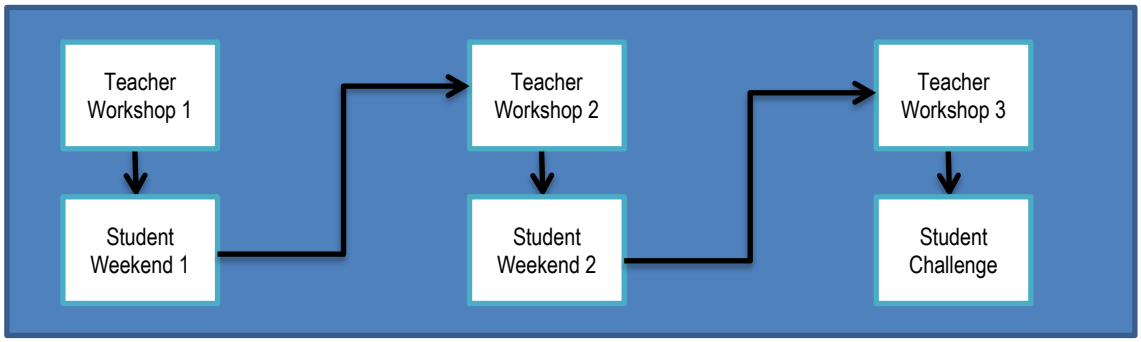

Figure 1. Schematic layout of a typical year of LaTechSTEP.

An important lesson we learned early in the process of developing this program was to show the high school teachers exactly what was going to happen during the following student weekend. Therefore, we lead the teachers through the same material that the students will be shown. This process accomplishes at least three things.

1) The teachers are not going to be caught off guard by any of the material presented during the student weekend,

2) Teachers are better prepared to include any class room lessons that they think their students will need during prior to the student weekend, and

3) The teachers have often given us great feedback on the potential effectiveness of the material we planned to present to their students.

Seven years of LATechSTEP participation

The LaTechSTEP program has grown significantly over its seven years. The first two years of the program were self-funded pilot studies that comprised one school and three teachers. Significant growth of the program was seen during the third year, as this was the first year of NSF funding. Table 1 shows the number of schools, teachers, and students participating in in the program each year. Over the life of the program, a total of 341 students (with 77 or 23% of those being female) and 53 different teachers have participated.

Table 1. The number of schools, teachers, and students participating in LaTechSTEP over seven years.

Academic Year	Number of Schools	Number of Teachers	Number of Students
2005 – 06	1	3	25
2006 – 07	1	3	25
2007 – 08	7	18	63
2008 – 09	8	19	46
2009 – 10	6	15	33
2010 – 11	12	30	85
2011 – 12	13	23	64

Table 1 clearly shows the growth of the program since 2005. Several methods have been attempted to manage the growing interest in the program. One method that was tried and discarded was to run two separate sets of events during a single year. Splitting the schools into two groups did make the individual groups more manageable, but there was an adverse effect for the university faculty. Since the individual events were held on Saturday, the faculty had to commit 12 Saturday's that year to the program. The solution to overloading the faculty was to hold the teacher workshops on Saturday and move the student weekends to the following Friday.

Having all of the students attend on the same Friday meant that either the schools would need to be split into two groups or a larger venue was needed to hold everyone. We attempted both solutions and found that both have their advantages and disadvantages. When we split the schools into two groups, the faculty also had to be split so that material could be covered simultaneously in two locations. Currently (2011-12), we have moved to a larger venue and have everyone in one location. This arrangement creates an exciting event with many faculty available to roam the room to help with any sticky points in the activities. The downside of combining everyone is the space needed to hold 30+ teachers, 5 or more faculty, over 60 students, and any visitors can be hard to find. Fortunately, Louisiana Tech has made a conscience effort to create reconfigurable spaces specifically for events such as this.

Is LaTechSTEP having a positive effect on STEM enrollment at Louisiana Tech University?

While it is difficult to track students who attend LaTechSTEP and go to other universities, we have attempted to track those students who enroll at Louisiana Tech and major in a STEM degree. For our purposes, STEM includes any engineering, mathematics, physics, chemistry, and biology. Eight of the schools participating in LaTechSTEP have been with the program long enough to have students complete the program and enroll in college. Looking at these schools before entering the program and after participating in the program, there has been a 33% increase in the number of students enrolling in STEM majors from these schools. When normalizing the enrollment data to account for changing high school enrollments, the increase in students enrolling in STEM majors from participant schools is approximately 31%. Table 2 shows the data in raw form for more detail. There are not enough samples (as they are only taken once a year) to determine significance in the difference of the yearly before and after enrollments for most of the schools, but there does appear to be a trend that shows LaTechSTEP could be contributing to an increase STEM enrollment at Louisiana Tech University.

A few things to point out about the data from Table 2 include the few decreases seen from participant schools. Bolton is a medium sized urban school located approximately 100 miles south of Louisiana Tech. This school only participated twice in the program; however, this year (2011-12) two students are participating from this school on their own initiative without teachers from their school. Ringgold is a very small rural school 60 miles from campus. This school also only participated in the program for two years until the STEM champion teacher moved to another school. Ruston is the local school and already has strong ties to the university, making it difficult to further increase their STEM enrollments.

Table 2. Average yearly STEM enrollment data from eight schools participating in LaTechSTEP.

	Years in TechSTEP *including this year	Average High School Enrollment	Before	After	% Change	P-Value for one-sided, independent T-Test
Airline	7	1401	6.5	10.3	59	0.006154
Benton	5	644	3.5	7.0	100.0	0.050565
Bolton	3	775	3.0	2.8	-8.3	0.500000
Capt. Shreve	5	1294	5.5	5.8	4.5	0.447665
Ouachita	3	1227	6.3	6.5	4.0	0.469750
Parkway	3	1054	3.5	10.0	186.0	0.133087
Ringgold	3	274	0.8	0.5	-33.3	0.336847
Ruston	5	1140	10.5	9.8	-7.1	0.375139
			Total: 39.5	Total: 52.5	Average: 33.1	

Also interesting are the two large gains seen from Benton and Parkway. Benton is a large (for this region) rural school in the suburbs of a developing city. This school is 80 miles from campus and has been heavily involved in multiple projects with Louisiana Tech in addition to LaTechSTEP. Another interesting fact about this school is the teachers who are leading the charge are retired STEM professionals. Parkway is a large school in a metropolitan area 70 miles from campus. Parkway joined the LaTechSTEP program during the 2008-9 academic school year, and has teachers who are passionate about STEM education. These teachers, along with teachers from Benton have created a junior version of LaTechSTEP to help encourage middle school teachers and students.

College enrollment data for 249 of the 341 LaTechSTEP participant students currently exists; the 2011-12 cohort as well as a portion of the 2010-11 is still in high school, and the data for the 2005-06 group (the original pilot) is not available. Considering the data in the aggregate, we see that of 249 participants, 113 subsequently enrolled at Louisiana Tech University in any major and 77 of those enrolled in a STEM major. Therefore, 45% of participants enrolled at Louisiana Tech, and 31% of the participants enrolled in STEM majors. Of those participants who enrolled at Louisiana Tech, 68% chose a STEM major. It is difficult to determine how many of these students would have enrolled at Louisiana Tech and majored in STEM had they not attended LaTechSTEP, but combining these data with the data presented in Table 2 an argument can be made that LaTechSTEP is having a positive effect on STEM enrollment at Louisiana Tech University.

Is LaTechSTEP having an effect on the quality of engineering student enrolling at Louisiana Tech University?

Metrics for determining if LaTechSTEP is increasing the quality of engineering student enrolling at Louisiana Tech are difficult to decouple from other variables. To this end, this paper will

compare and contrast LaTechSTEP students who enrolled at Tech with similar students who enrolled at Tech but did not participate in LaTechSTEP. We will focus on engineering majors since they are the largest group, and their first quarter experience is more homogenous than the other STEM majors.

For the student grade data we are only looking at GPAs in two freshman classes: ENGR 120 the first of three freshman engineering classes that all engineering students take, and MATH 240 the first of six Calculus classes that all engineering students take. GPA data for the students majoring in mathematics, physics, chemistry, and biology is not available at this time. For GPA data we are not looking past these introductory classes at this time as we feel that any potential effects of LaTechSTEP would have been replaced by the effects of our engineering curriculum after these introductory courses. Also, LaTechSTEP is a recruitment effort, not a retention effort. We do have additional papers available on our Freshman Enrichment Program (FrEP), one of our related retention efforts.[8]

It is quite difficult to determine which effects, if any, are attributable to the LaTechSTEP program when it comes to student achievement in STEM majors. Table 3 below shows the average ACT scores, and performance of LaTechSTEP students compared with a typical cohort of engineering majors at Louisiana Tech. The last column lists the significance levels for a one-sided, independent T-Test comparing the means of the LaTechSTEP students with the means of the engineering students across the various categories. While the means of the LaTechSTEP students do show generally better trends, they do not appear to be statistically different from the engineering cohort. The data will need to be looked at much closer in order to make any final conclusions on the effectiveness of LaTechSTEP on student quality. For instance, the engineering cohort contains a large number of honor students whereas the LaTechSTEP cohort does contain honor students, but not as large of a percentage. Also, the LaTechSTEP students are grouped across multiple years (2008-2011) where the engineering cohort data is from a single year (2010-11). Graduation data is sparse at this point and it is not possible to see if the LaTechSTEP students are being retained at a higher rate than a non-LaTechSTEP student.

Table 3. Comparison of LaTechSTEP students with a typical cohort of engineering students.

	LaTechSTEP students	Similar Cohort of ENGR students	P-Value for one-sided, independent T-Test
Math ACT	27.3	26.9	0.169
Comp. ACT	26.1	26.2	0.388
ENGR 120 1st Attempt	2.89	2.61	0.128
ENGR 120 D/F/W rate	27%	34%	0.198
Math 240 1st Attempt	2.47	2.47	0.495
Math 240 D/F/W rate	31%	35%	0.453

What do the participants have to say about LaTechSTEP?

Qualitative data is useful for gaging participant reaction to the program. We have collected survey data and open ended responses from participant teachers. After the most recently completed year of LaTechSTEP, 30 teachers were surveyed and we received 22 responses. The

majority of the responses are open ended, in this paper we will not attempt to decode the responses beyond a simple "yes" or "no".

One goal of LaTechSTEP is to help teachers see connections between the mathematics and science they teach and engineering. We asked, "*Having participated in the LaTechSTEP program, are you better able to see a connection between engineering and the fields of mathematics and science?*" Eighty-six percent of the respondents said that LaTechSTEP had helped them better see these connections. The three respondents who replied in the negative, explained that they already had a good understanding and appreciation of the connections between engineering and the sciences.

Another goal of LaTechSTEP is to help teachers answer the "why?" question. We asked, "*Has LaTechSTEP helped you answer the common student question of 'Why do I need to know this?*'" Ninety-five percent of the respondents said that LaTechSTEP has helped them answer this question. The one respondent who replied in the negative said that their background in engineering had allowed them to answer this question before attending LaTechSTEP.

A third goal of LaTechSTEP is to provide examples of material that the teachers can take back to their classrooms and incorporate in their daily lessons. We asked, "*Are there any aspects of the LaTechSTEP program that you have taken back to your classroom?*" Ninety-five of the respondents claimed that they had taken specific examples back to their classrooms, the one participant that responded in the negative explained that they had some ideas, but had not implemented anything at the time of the survey.

The survey also gives us a range for the teacher experience, with 22 teachers responding the average number of years in education is 11 years with a standard deviation of 7 years. The teacher experience ranged from 31 years to less than 2 years. Half of the respondents had completed more than one year with the LaTechSTEP program, while the other half had just finished their first year.

Several other questions were also asked as part of this survey. One of the more interesting questions was, "*If you had to define "engineering", what would you say?*" We hope that the responses to this question will indicate a broader understanding of engineering by the teachers. These responses will be encoded and presented at a future date.

Conclusion

The LaTechSTEP program at Louisiana Tech University has been ongoing for seven years, beginning in the fall of 2005. During that time span, we have seen an increase (although not statistically significant across the board) in STEM enrollment from schools that participate in LaTechSTEP. We believe that a focus on fundamental STEM topics with relationship building activities (between faculty and teachers, teachers and students, and faculty and students) leads to an increase in STEM interest among high school teachers and students. We believe that this model will continue to produce results through increased interactions with area STEM teachers and college faculty. We believe that these collaborations will result in an increased enrollment of STEM students at Louisiana Tech in the future.

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