
Engagement in Practice: Engineering Minority Student Engagement Project (EM-STEP)

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Abstract: The US is in greater need of STEM graduates to keep its competitive edge. Various US government agencies have raised concerns about shortage of STEM graduates for 35 years. It is equally important to keep US in technologically superior position. One way to grow the STEM workforce is to increase enrollment, retention, and graduation rates. It has been reported that incoming students are weak in Mathematics and thereby having great difficulty in engineering courses. As a result, they are dropping out of engineering programs resulting in low retention and graduation rates. It is desired to reinforce mathematical concepts. It is desired to engage, mentor and tutor them to keep them from dropping. There are three objectives in this project. One is to increase recruitment; the second goal is to improvement via engagement and providing help. The third goal of increasing graduation rates will be automatically achieved by enhancing retention rates. To meet this objective, Engineering Minority student Engagement Project (EM-STEP) is using an innovative five prong approach of offering Saturday Academy, peer lead group, professional lecture series, freshman seminar and summer research projects. Four high D, withdrawals, incomplete and F grade rates courses have been identified and they are Fundamentals of Electric Circuit Analysis, Engineering Mechanics: Statics and Dynamics, Introduction to Fluid Mechanics and Introduction to Thermodynamics. Students in these courses are from four engineering disciplines of Chemical, Electrical, Mechanical and Petroleum Engineering. These courses are being taught in the Saturday Academy and twenty students are working as peer group leaders. We are also offering motivating lectures in the professional lecture series. Summer research project for 8-week duration is also offered.

Keywords: STEM, Retention, Minority, Saturday Academy, Peer Group Leader, Professional, Hispanic, Demographic

1. Introduction

National Aeronautics and Space Administration (NASA) and the Department of Defense (DOD) have raised concerns about shortage of scientists and engineers since the mid-eighties. It is noted in engineering conferences and events that during launching of Apollo 11 era in the 70's, significant number of STEM graduates opted to work for NASA and DOD. However, that generation of employees have been retiring for number of years now, and it is difficult to replace

the retiring U.S. scientists and engineers currently with highly qualified personnel.

Recently it was reported that number of high-quality research publications in Artificial Intelligence would exceed that of the United States within three years. A high-profile report [1] documented in 2007, indicates the dire need for science and engineering education in the U.S. It is the responsibility of the science and engineering educational community to retain students who have already entered the field of science and engineering to ensure they graduate in

their respective fields. Therefore, there is a strong need to promote the STEM education all over the country. On the contrary, if the new generation of scientists and engineers are not educated to meet the need of the nation, U.S. may risk its technical advantage facing stiff competition from global contenders.

The University of Texas Permian Basin (UTPB) is a Minority Serving Institution (MSI). It includes large percentage of Hispanic students as this Permian Basin region has 58% Latino population. Retention rates for the College of Engineering students at the UTPB are in the range of 50% to 70% during 2014 to 2018 period. Engineering Minority Student Engagement Project (EM-STEP) has been established in October 2020 with the help of a grant from the US Department of Education. Its aim is to improve recruitment, retention, and graduation via innovative approaches. The project will re-enforce mathematical concepts, problem solving skills, summer research projects, freshman seminars, and professional lecture series. It will also promote the “how to learn” techniques and conducting research.

The approach in this project, improving STEM education to enhance recruitment, retention, and graduation rates of Hispanic students, is based on a model, which has three main objectives. They are as follows:

- Increase recruitment with emphasis on minorities and female students in Engineering.

- Improve the retention rate of freshman and sophomore engineering majors.

- Increase graduation rate of engineering students in 6 years.

2. Results

The EM-STEP project results in improved performance among the minority students due to their involvements in different tasks of the program as depicted in Figure 1. There are five different components in this project coming together to increase recruitment, retention, and graduation rates. Project consists of five components of Saturday Academy, peer lead group learning, professional lecture series, freshman seminar and summer research projects. Four departments namely Chemical, Electrical, Petroleum, and Mechanical Engineering are participating in this program. EM-STEP operates on an innovative model that integrates engaging, mentoring, tutoring and innovative teaching such as techniques on “how to learn” to improve retention and graduation of minority students especially women in engineering majors [2]. The project utilizes experiential learning and engineering projects to engage students while illustrating difficult concepts in mathematics through on-target Saturday Academy for courses in the first two year of engineering curriculum. Student engagement has been shown to increase retention rate especially for women [12]. Transfer of knowledge in various forms and contexts is shown to be an effective way to improve deep learning.

- Saturday Academy (Activity # 1)

- Saturday Academy

- Establish Virtual Saturday Academy to reinforce mathematical concepts, problem solving and teach students as how to learn. Four engineering professors involved in this project will take turns to teach and solve problems in four high D, withdrawals, incomplete and F grade rates.

- Fundamentals of Electric Circuit Analysis

- Engineering Mechanics: Statics and Dynamics

- Introduction to Fluid Mechanics

- Introduction to Thermodynamics

It has been observed by number of engineering faculty that reinforcement in math courses is needed to be successful in junior and senior level courses. Covid-19 added more complexities to minority populations. Training and education efforts focused on increasing minority representation in these segments of the workforce are critical because these jobs are critical [17]. In such situation, virtual Saturday Academy will help students from failing these courses and thereby contributing to an increase in retention and graduation rates. Saturday Mathematics Academy is running virtually from 10:00 am to 12:30 pm and 1:00 to 2:30 pm. The focus is on minority students. Students can use recorded session 24/7 in a virtual environment. We are reaching out to students via emails and flyers around Engineering building. Faculty will collect demographic information for attendees.

- Peer Lead Group Learning (Activity # 2)

We are engaging students in Peer Lead Group Learning environment working in a virtual environment. Twenty students will work 10 hours per week providing an availability of 200 hours per week. The goal of Peer Lead Group Learning Program is to help retain high-risk students and offer help and guidance to minority students, females, and other needy students. These peer group leaders are helping and supporting freshman, sophomore, and other years engineering students in a virtual environment. Peer Group Leaders will also advise students to be mindful of their class and work schedule and time needed to study and digest material covered during the week. PGL will remind students also need to balance study, work and various cultural, sports and other entertainment activities. PGL are helpful in the areas of cultural adaptation, campus environment and engagement in an informal setting. Peer mentorship, which does not adhere to traditional hierarchies, is perhaps more accessible for underrepresented groups, including women and minorities [18]. They offer advice and motivational support. PGLs are collecting attendance and demographic data from mentees and keep records of their concerns and issues. PGLs will provide report to the engineering faculty team on type of questions asked and type of help requested, and any difficulties encountered. Data will be compiled and analyzed collected information on monthly basis with an eye on continuous improvement. Peer Lead Group Learning will have positive effect on their success [3-5] contributing to increase in retention and graduation rates.

- Summer Projects (Activity # 3)

An eight-week virtual summer research project is being offered in a virtual environment. Student projects will offer practical experience. The Engineering faculty team and other

interested faculty will conduct summer research projects virtually. The goal is to provide hands-on-design experiences on various projects that may be defined by the faculty, industry or proposed by students. Students will work in a group of three students in a virtual environment. There is no course credit for this work. Incentives to work on summer project is to get hands on experience and work closely with the faculty. Students will get a stipend of \$ 2000. Time commitment would be around 20 hours per week. The project incentivizes students, as the ultimate product of this summer research project would be presentation and publication of their work in undergraduate conferences and other venues. Publishing a paper in a conference proceeding is a third-party testimony that their work was valuable and worthy of publication. It will also be another marketing tool beside their resume and transcript for obtaining internships and leading to a good paying job. Employers will look very positively when they see a well-written project report and presentation. Summer projects will not only help in their graduation and retention but also boost their self-esteem, moral and finally be financially fruitful [16].

Project presentation should be at general level may be at Today's Show level. Employers will look very positively when they see a well-written project report and presentation. Summer projects will not only help in their graduation and retention but also boost their self-esteem, moral and finally be financially fruitful. Choy [6] and others have found that engaging students on hands-on activities can increase number of students interested in science and engineering programs. When students connect theory, with practical aspects, this approach helps in knowledge retention and students will take ownership of their education. Student project experience is also attributed to achieving success and student-persistence [3-5, 7-9].

Applications will be due just before the spring break. Project teams and their supervising faculty will be announced by the 12th week of classes. Conduct initial meetings during 13th and 14th week of classes of the spring semester. Start projects in the summer. Meet weekly with students and they will provide weekly report with power point presentations. Engineering faculty will be available and during the week for questions and answers. Organize final presentations of the project on the last day of the 8th week. Search for possible publications of their work and presentations in other venues. Students will be required to present their work at the Department of Education organized conference. We will collect demographic data on the participants and incorporate it in future publications.

Professional Lecture Series (Activity # 4)

Professional Lecture Series is being offered on monthly basis in a virtual environment. The goal of Professional Lecture Series is to keep students engaged and motivated. This will help in retention and eventually graduation rates. We are working with student organizations and their faculty to provide us time slots in their monthly meetings to present lectures on various topics. We are also inviting speakers from the industry covering wide variety of topics. We are

advertising lecture series complete with abstract of the talk and speaker's biography to maximize participation.

Some examples of topics are:

Promoting innovation and efficiency

How to learn and how to be good note takers and how to prepare for allowed formula sheets during the examination

Development of self-esteem and motivations

How to be successful

Time management balancing school, work, and family

Personal finance including watching credit scores

How to make dollar go farther

Knowledge of markets and economics

Knowledge of higher education financing and repayment

How to write cover letter, resume and prepare for interview including Skype/Zoom interview

How to prepare and give power point presentation

Importance on diversity and tolerance of opposite point of views.

Internship opportunities in the industry

Undergraduate research and graduate school information

Lecture series complete with abstract of the talk and speaker's biography is advertised in advance to maximize participation. We will use evaluation form to evaluate speaker, importance of the topic and future topic suggestions. This would be necessary to gauge interest of students and their preferences in an effort for constant improvement. We will incorporate participant data, student interest, preferences and draw conclusions in future publications.

Freshman Seminars (Virtual) (Activity # 5)

Implementation of freshman seminars in various institutions is on the rise and their effectiveness has been well documented in many research studies [10, 11]. It is shown that active participation of students and instructors in freshman seminars lead to increase in persistence and retention of students in their sophomore year and beyond. Freshman Seminars at UTPB are designed to have a lasting impact on students' success. It is being offered in a virtual environment. In this seminar course, two complementary objectives are accomplished. The first focus area is to increase academic performance and persistence through academic and social integration. Students will learn about college life and how to navigate through college procedures and what services are available to them in addition to what is expected from them. Freshman students should feel comfortable with their new college life and know where to seek help with their academics and social life on campus. The second focus area of the Freshman Seminars is to deliver college-specific information. This activity presents a great opportunity to expose engineering and engineering-intended students to the engineering profession and plant the seeds of students becoming future engineers. EM-STEP is utilizing this seminar course to provide an exciting but realistic view of what it takes to become an engineer and will equip the students with skills and motivation necessary to stay the course.

In particular, the goals of EM-STEP in the college freshman seminars are as follows:

Introduce what engineering is and what do engineers do, link engineering and science through life examples and common technology.

Teach students how to learn a STEM subject and apply them to real problems.

Motivate students to focus on the destination of becoming successful engineers with good-paying careers; faculty and guest speakers can provide personal experiences.

Help each student to see a clear roadmap to their final goal and introduce each engineering discipline for them to decide.

Connect students with professional organizations to

cultivate the sense of belonging and contribution.

Introduce them to peer mentors and emphasize help is always available through various resources (e.g., Saturday Academy)

We have reached out to instructor of freshman seminar to offer our help. Team members have presented interesting talk on various topics. We have prepared 30 minutes presentation possibly multi-media and deliver it to students via MS Team. We have collected student interests and other comments to improve on it.

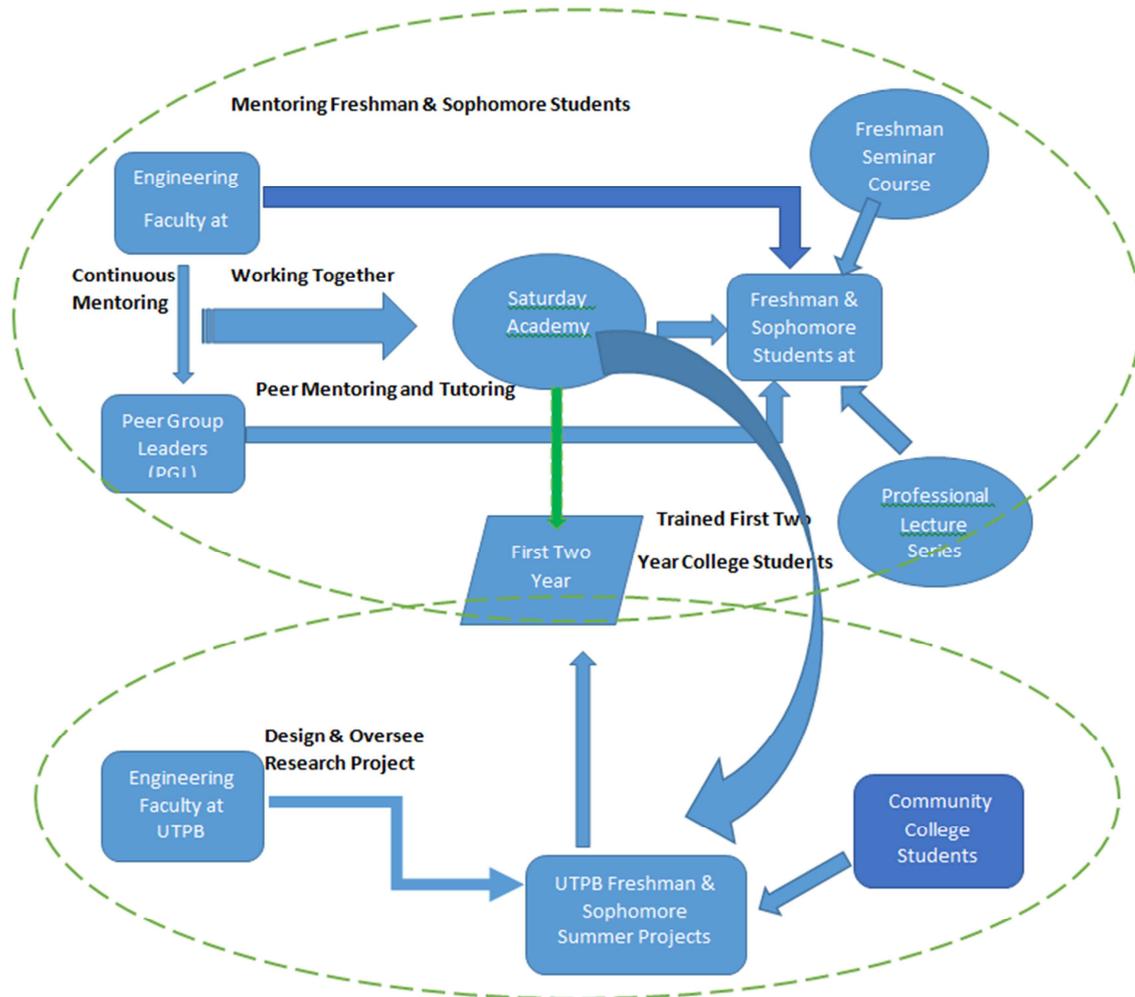


Figure 1. Engineering Minority Student Engagement Project (EM-STEP).

3. Conclusions

The UTPB is a Hispanic Serving Institution and large number of students belong to minority community. EM-STEP efforts will help in increasing the number of Hispanic and low-income students and assist them achieving their American dream by successfully completing the engineering program. Saturday Academy, summer projects, Professional lecture series and peer engagement activities will enhance their understanding of engineering profession contributing towards building U.S. based engineering workforce. The

EM-STEP project will strive to build mutual connection with each student to follow their progress to improve retention and graduation rates starting from Freshman Seminar course followed by SMA, PGLs’ assistance, Professional lecture series, and summer projects.

The unique location of UTPB College of Engineering, at the center of highest U.S. energy production region, is unmatched. EM-STEP will immensely benefit from this exclusive advantage to fulfill its objectives and produce scientific and educational value for Minority Science and Engineering Improvement Program. Through a strong institutional commitment and planning, this proposed model

will be sustained and evaluated continuously for improvement. This project is designed to leave no student behind. We will compile information from all five activities and incorporate them for future publications. We will discuss results and brainstorm with the team. This will help us to improve the project by incorporating lesson learned, problems encountered for future activities every semester. In summary, EM-STEP incorporates activities that build on strong evidence of success documented in the literature in terms of their impact in engaging minority students [12-15].

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