Minority-focused Engagement through Research and Innovative Teaching (MERIT)

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1. Introduction:

This paper will present the implement of MERIT, a Department of Education funded project to engage, mentor and retain minority engineering students in the first two years. MERIT is comprised of two primary programs. an Engaging Mentoring and Tutoring program (EMT), and a three week Summer Research Program (SRP). Since EMT has been addressed in another paper, the focus of this paper is SRP. The funded project just closed the end of the first year cycle. The project design, operating challenges and lessons learned, as well as some data collected in the first year will be presented in this paper.

2. Motivation and Program Summary

Retention of first two-year students in engineering is complicated since many bottleneck courses in this early period are taught outside of engineering. MERIT takes a collaborative approach incorporating faculty from the Colleges of Arts & Sciences and Engineering to address the recognized needs including improving retention rates, improving graduation rates, and increasing recruitment of minority students. Program starts by developing hands-on learning modules to be used in supplemental mentoring and tutoring for bottleneck courses in the academic year, which is called EMT, the first component of the MERIT. The second is to engage engineering students in the first two years and community college students in a Summer Research Program (SRP). The SRP also prepares students for difficult concepts in the bottleneck courses in engineering education through project-based learning and mentoring support.

In EMT, a selected group of faculty members work with student mentors to develop engaging learning modules that will be used to address difficult concepts in bottleneck courses in the first two years (e.g. Calculus, Physics and Chemistry). Student mentors (junior and senior engineering students) receive continuous training and support from the STEM faculty mentors on how to effectively mentor and tutor students. The student mentors will provide peer mentoring and tutoring to first two-year college students for bottleneck STEM courses. The EMT program aims to provide support and guidance to minority students, especially minority women and high- need students to persist, succeed and progress toward graduation.

A three-week summer research program is offered to TAMU-K students in their freshman or sophomore years who have actively participated in the EMT program and to community college students in South Texas. The SRP aims to provide academic preparation to first two-year college students with focus on difficult principles and concepts in first two-year college STEM courses identified in each department through project-based learning. Twenty student participants in SRP are selected through a selection process as SRP trainees. There are five teams each year with each team comprised of four students. Each of the five teams are supervised by a STEM faculty member and mentored by a SRP Student Mentor who is selected from student mentors in the EMT academic year program. The SRP trainees complete a research project related to first two-year college bottleneck courses within three weeks. Each team is required to prepare a poster, presentation, and report. Exposing undergraduate students to research projects early in their

academic career has been demonstrated, with strong evidence of success, to improve student-persistence. The survey data from the first year SRP also supports this approach.

3. First Year SRP

SRP is an integral part of the MERIT program. This activity was offered for the first time during summer 2014 to TAMU-K students in their freshman or sophomore year who had actively participated in the EMT program and to community college students from South Texas. The total number of students participated in 2014 summer was 24, which exceeded the proposed number of students of 20.The program was hosted from June 9, 2014 to June 28, 2014. Students were divided into six groups with four students in each group. Each group was supervised by one STEM faculty and one Junior or Senior engineering student. Other than the individual group meetings, all the participants met with the project administrators, faculty mentors, and student mentors on the initial meeting, weekly meeting, and end-of-project conference and ceremony. Participants' parents and family were invited to the end-of-project conference and ceremony.

Activity objective 1: Summer Research Program developed to attract engineering majors to TAMU-K and retain students in engineering majors.

Six faculty members and six student mentors were hired to lead six groups to conduct the research projects. Program recruited twenty four students to attend a three-week training program on research methods specifically tied to skills needed for success in bottleneck courses. A total of 51 TAMUK and community college students submitted applications for the SRP. The demographic information of this group of participants is as follows: 17 Hispanics, 4 Whites, and 3 African Americans; 19 Males, 5 females; and 7 students were currently enrolled at TAMUK, 9 students are currently enrolled at Del Mar College, 3 students are currently enrolled at South Texas College, 4 students are currently enrolled at Laredo Community College, and 1 student is currently enrolled at Victoria College. Each of these community colleges serves as pipeline institutions to TAMUK. All the participates showed increased interests in retaining in the engineering majors.

Activity objective 2: Identify and train student mentors.

Mentors were hired who had experience during the fall and spring semesters. The selection of students for the SRP followed identified criteria. Applications were received and reviewed during the spring semester prior to the summer research program (SRP). All six student mentors are current excellent TAMU-K engineering students and they are the role models of the participants.

Activity objective 3: Create projects to work with students during the summer program.

All six faculty mentors have active scholarly activities. The SRP projects were developed by the faculty mentors based on their current research projects and teaching experiences in teaching the bottleneck courses. Here are the brief introduction of each project.

PROJECT 1. Title: Chemical Process Simulation (Chemical Engineering)
The purpose of this project is to introduce and interpret chemical processes by chemical process simulation with commercial software-Aspen HYSYS. The knowledge and skills required for chemical processes are integrated to understand the open-ended design problems. This project introduces students to methods and background needed for conceptual design of continuously operating chemical plants. The basis of interpreting chemical processes, the principal diagrams that routinely used describe chemical processes, including the block flow diagram (BFD), the process flow diagram (PFD), and the piping and instrumentation diagram (P&ID), are introduced. A comprehensive design project a chemical process is practiced.

PROJECT 2. Title: Design and Optimization of Active Disassembly using Smart Materials (Mechanical/Industrial Engineering)

Active disassembly is one of the disassembling methods by which the product will be automatically disassembled under a particular trigger. This is one of the effective methods to improve the recycling efficiency and reuse rate of complex products, such as electronic and electrical products, and to reduce the environmental impacts caused by hazardous substances during recycling processes. In this project, the students design and manufacture a prototype to showcase the active disassembly concept using smart materials, i.e. shape memory polymer. The design parameters will be further optimized to reduce the disassembly time.

PROJECT 3. Title: Wind Mill and Wind Farm Design (Mechanical/Industrial Engineering)

This project introduces the basic knowledge about wind energy. Students work on the wind turbine design using Lego packages, AutoCAD, 3D printer and other materials. Then students will use the wind mills to set up a wind farm to test and understand the wake effect. After this project students will understand the main factors affecting the energy output.

PROJECT 4. Title: NanoChem (Chemistry)
This project provides learning materials for students to gain the fundamental knowledge in chemistry which will enhance their skill and competitiveness to pursue careers in STEM fields. This project also provides hands-on experience for students. It focuses on the solar-hydrogen fuel cells composed of nanocatalyst. The students are trained to understand Nano-science, a chemistry sub-discipline.

PROJECT 5. Title: Understanding and Measuring Physical Quantities in Athletic Performance (Physics)

This project gives the student participants the opportunity to learn to describe the performance of athletic tasks in terms of physical quantities: acceleration, force, power, momentum and their

rotational analogues. Students measure, weigh and time athletes performing basic exercises including running, weight lifting, plyometric and other exercises. They then analyze the data thus obtained, and calculate quantities that cannot be directly measured, and construct a complete physics-based description of the activity in question.

PROJECT 6. Title: Modeling Real World Problems With Trigonometry (Mathematics)
This project includes six mini projects to let student practice real world problem modeling using trigonometry. One sample mini project is length of day at a particular location. For the particular latitude, the students record the length of day for the various days of the year, then they use the data to draw a scatter diagram and determine the sinusoidal function of best fit. Finally, students use their model to answer various questions concerning the length of the day at a particular time of the year.

These projects progress were presented on the weekly meeting by each group. The final project results were presented and evaluated on the end-of-project conference. Each group also submitted a project report. The first place team was recognized on the ceremony and awarded $500 scholarship to each team member if s/he retain or transfer to TAMU-K engineering program. The scholarship was provided by the TAMU-K engineering student success center.

Activity objective 4: Track and monitor progress of faculty and students who participated in SRP.

Pre and Post surveys were created to gather information on the implementation and for improvement. Student success will be measured with course grades and number of students who are retained at TAMU-K engineering and with the number of participants who transfer from the community colleges to TAMU-K.

4. Best practice experiences and lessons learned for continue improvement

4.1 Early recruiting and program promotion

The program flyer and application packages were sent out to local students and community colleges that have been served as feeder colleges in the early of Feb. The SRP program was also promoted on the EMT sections. The early recruiting and promotion activities lead a good pool of application from 51 applicants. The review committee used a score system to evaluation the applications based on GPA, personal statement, and reference letters. 24 participants were selected. Among them, seven are current enrolling students and 17 are from four different feeder community colleges.

4.2 Match students interests with the available projects

In order to best match students' research interests with the projects, short project description of each project was sent to participants once they are selected. Participants ranked the project based on their preference. Then students were teamed and assigned to project based on their ranking

preference. The surprise turnout is we were able match all the students to their first or second preferred project.

4.3 Motivate students

Both knowledge level and motivation levels are various among the participants. To motivate all students participate in the activities, weekly meeting and oral presentation from each team on the project progress was organized. Each participant is required to present on the meeting. A scholarship competition was also held. Every participant from the first place team won a $500 scholarship.

4.4 Better organizing

Minor things may cause big problem, which is the important lesson we learned from the first year SRP. Since all the participants lived on campus during the program, logistic and other supporting services are also important to the success of the program. In the first week of the program, many participants had difficulties with the school's IT account to access the wireless internet connection. Some of them felt frustrated. We recognized that other than the faculty mentors, the program coordinator is also a critical role.

4.5 Innovative data collection approach

The pre- and after program survey were used to collect participants' responses. An innovative data collection approach should be used in the future to collect more detail information and how SRP improves students' knowledge and interests in STEM.