AC 2009-615: STEM RECRUITMENT, RETENTION, AND GRADUATION: PROGRESS TO DATE

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STEM Recruitment, Retention, and Graduation: Progress to Date

Abstract

Strategies employed to recruit, retain, and educate students in science, mathematics, and engineering include a variety of approaches, such as hands-on activities, field trips, summer workshops, competitions, tutoring, research experiences, and software training programs. This paper describes a new program, STEM Recruitment, Retention, and Graduation (STEM-RRG), geared toward increasing the number of minority students pursuing degrees in Science, Technology, Engineering, and Mathematics (STEM) fields at Texas A&M International University (TAMIU). STEM-RRG consists of several projects that implement a number of activities, including enrichment programs, scholarships, internships, research experiences, mentoring and tutoring, advising and career counseling, experiential training, recruitment of high-potential students, and faculty professional development. This paper briefly describes the program activities and presents progress to date.

Introduction

Recruitment and retention of students in science and engineering fields have received great attention in recent years. Institutions of higher education have employed a variety of initiatives to recruit and retain students from underrepresented populations for more than a decade. Such initiatives have included hands-on activities[1-3], field trips[4, 5], summer workshops[6, 7], competitions[8], and software training[9]. This paper describes a new program, STEM Recruitment, Retention, and Graduation (STEM-RRG), designed to increase the number of minority students who graduate with a degree in science, engineering, or mathematics. Specifically, the goals and objectives to be accomplished under STEM-RRG are:

a. Recruit minority students into STEM majors at TAMIU;
b. Provide summer enrichment workshops to minority students;
c. Provide internships and research assistantships to minority students;
d. Provide professional development activities to STEM faculty who teach introductory science courses, including mathematics, engineering, physics, and biology;
e. Provide tutoring and supplemental instruction opportunities to minority students in College Algebra;
f. Develop a model transfer system that builds on our current articulation agreement with Laredo Community College (LCC) to increase the number of minority students majoring in STEM who transfer to our university;
g. Provide advising, counseling, and mentoring to minority students;
h. Establish a STEM endowment that provides minority students a continuous source of scholarships;
i. Create STEM cohorts and learning communities and provide advising to minority students in these cohorts.

The following sections provide details about the program and briefly describe a recent workshop that served 23 participants.

STEM RRG Projects

STEM-RRG consists of several projects that implement a number of activities, including enrichment workshops, scholarships, internships, research experiences, mentoring and tutoring, advising and career counseling, experiential training, recruitment of high-potential students, and faculty professional development. These projects have been classified as recruitment or retention and are briefly described below.

<u>Recruitment Projects</u>

1. STEM Recruitment and Enrichment Project (STEM-REP):
   The goal of this project is to improve the recruitment and preparation of minority students through participation in summer workshops and a follow-up science and engineering exhibit. Workshop sessions will be conducted by discipline-specific instructors with emphasis on critical thinking and problem-solving skills.

2. Pre-Engineering Cohort (PE-Cohort):
   The purpose of this project is to create a pre-engineering cohort to improve the recruitment and retention of highly motivated minority students. Students will participate in an enrichment program at TAMU during the summer following the end of their first year at TAMIU. This program exposes students to the various engineering fields and emphasizes critical thinking and problem solving skills.

3. Mathematics Education/Physical Science Education Cohort (ME-Cohort):
   This project creates a mathematics education/physical science education cohort to improve the recruitment and retention of highly motivated minority students from area high schools. Students will participate in an enrichment program during the summer following the end of their first year at TAMIU.

4. High School Recruitment:
   For recruitment at the seven local and one private High Schools, TAMIU's Outreach and Retention Specialists will make twice-weekly visits to each campus. For the seven surrounding county high schools, recruiters will visit each campus twice a month. During campus visits, recruiters will be available to meet with prospective students and their parents.

5. Endowment:
   STEM-RRG will establish a $500,000 endowment fund to provide scholarships to students pursuing degrees in STEM programs. The US Department of Education funds are matched by donors solicited through the Office of Institutional Advancement of the University.

<u>Retention projects</u>

1. STEM Research Experiences to Enhance Retention (STEM-REER):
   This project offers real-world learning experiences to outstanding minority students in the STEM majors at TAMIU. The program awards internships and research assistantships to highly qualified students. Interns will be placed in positions at private industries or government agencies. Research assistants will be supervised by faculty members conducting research in computer science, mathematics, biology, physics, or engineering.

2. Mathematics Enrichment Project (MEP):
   This project offers a pre-freshman camp for incoming minority students to help these students make connections between mathematics and science to encourage success in freshman chemistry and physics courses, to develop more sophisticated understanding of their own study skills and strengths, and to develop learning communities of peers.

3. College Algebra Support Project (CASP):
   The main goal of this project is to increase the passing rate in College Algebra. The approach is based on the belief that students learn mathematics by doing it. Homework and laboratory projects will be used to help students understand concepts and build problem solving skills.

4. Professional Development Plan:
   The professional development plan includes offering professional development workshops for faculty in the STEM fields at TAMIU. Our goal is to increase the proportion of students who complete introductory mathematics, engineering, biology and chemistry courses with a grade no lower than a C and return the following year to continue their program of study.

5. Model Transfer Agreement and Student Advising:
   To increase the number of students in STEM disciplines, a TAMIU STEM Academic Advisor(STEM AA) will identify likely candidates through discussions with LCC academic advisors and faculty. The STEM AA will meet with LCC officials to discuss any changes in curriculum as they apply to the STEM students.

6. Counseling Support Services:
   A series of 12 outreach modules will be made available to STEM students. These modules will deal with different ways of overcoming school related anxiety and will teach STEM students a means of using metacognition in learning situations. Fully accredited clinical support and consultation will be available to STEM students to address extreme complications in personal and social identity and adjustment issues. Also, TAMIU counseling staff helps STEM students bridge the gap for transferring students.

Progress to Date

All projects under STEM-RRG are making progressing according to an established schedule of events. At the present, most planning is directed towards summer 2009 activities. Major accomplishments so far include:

- Developing a program web site: http://www.tamiu.edu/~rbachnak/STEMRRG/index3.html[10].
- Assigning leaders for all projects and initiating project activities.
- Advertising all positions available under the program, including research assistants, interns, and student workers.
- Hiring 14 Research Assistants. The remaining positions are being filled.
- Hiring four student assistants to help carry out the program activities.
- Ordering most of the equipment to be purchased from grant funds,
- Forming a Pre-Engineering Cohort. This Cohort's summer 2009 workshop is scheduled from July 20 to 30, 2009.
- Recruitment for the ME-Cohort has been initiated. This Cohort's summer 2009 workshop is scheduled from May 18 to 29, 2009.
- High school recruitment for the summer MEP workshops has been initiated. Three REP workshops have been scheduled between June 1 and 28, 2009.
- Counseling services are taking place as planned
- Planning for the faculty professional development workshops is underway. Four workshops will be offered by the end of March 2009.
- Receiving $50,000 of the $125,000 matching funds needed for the first year endowment. The project Director and personnel from the Institutional

Advancement Office of the University are currently visiting community organizations and clubs to generate more donations.

- Conducting a MEP workshop in January 2009. A second week-long session of MEP workshop is planned for summer 2009 from August 10 to 14, 2009. Details about the January 2009 workshop follow.

MEP Workshops

As described earlier, the purpose of the MEP workshops is to help students make connections between mathematics and science to influence their success in freshman mathematics, chemistry, and physics courses. The workshops also develop more sophisticated understanding of their own study skills and strengths, and develop learning communities of peers.

The first MEP workshop was conducted from January 5 to January 9, 2009. Recruitment of participants was done by emailing all students registered in College Algebra for Spring 2009, as of December 15, 2009. Students were sent an e-mail inviting them to participate and apply. Participants needed to submit an application including an essay describing their career plans and goals for future. All sessions were conducted by experienced TAMIU mathematics faculty with the support of two student assistants. 23 participants completed the workshop. Of which, there were 13 female participants and 96% are Hispanics. Workshop participant received up to $300.00 to cover their daily expenses. Figure 1 shows a group picture taken on the last day of the workshop.

Figure 1. A group picture

Program Activities and Format

Six hours of activities were scheduled each day from January 5 to 9, 2009. This adds to 30 hours of mathematics instruction, equivalent to a two semester credit course at the college level. There were two sessions in the morning, each 1 hour and 25 minutes long separated by a 10 minutes break. Students were dismissed for an hour lunch, and would come back to work for three hours in ALEKS. ALEKS is a web-based, artificial intelligence assessment and learning system[11]. ALEKS uses adaptive questioning to quickly and accurately determine exactly what a student knows and does not know in a

course. All sessions were held in the University's Technology & Enrichment in Mathematics (TEMA) Computer Lab. This laboratory is equipped with 28 personal computers with Internet access.

The first morning session was conducted in a mixed setting. This included an instructional session followed by a list of problems to be completed by the participants. This list of problems determined the type of lessons for the next day, and was determined also by the performance of students in ALEKS in previous sessions. Figure 2 shows that students are progressing well in some selected areas, as also still need to learn from the assigned topics as the workshop progresses. A list of problems based on a review chapter of a standard college algebra textbook similar, to the review chapter of the College Algebra book by Barnett, Ziegler, and Byleen, (2008), was divided equally for five days[12]. Students attempted to solve these problems at the end of the first morning session.

The second morning session was in a lecture format. Participants were involved in the topics throughout discussion and analysis. Students were encouraged to think about basic concepts and procedures that they took for granted from their earlier education, discuss why a method would work, or how could geometrical objects be modeled by mathematical equations. Before the workshop, students had studied mathematics mostly from an algorithmic point of view. In this setting, students discussed why these algorithms worked. This would prepare them to solve more complex equations in their future courses in mathematics.

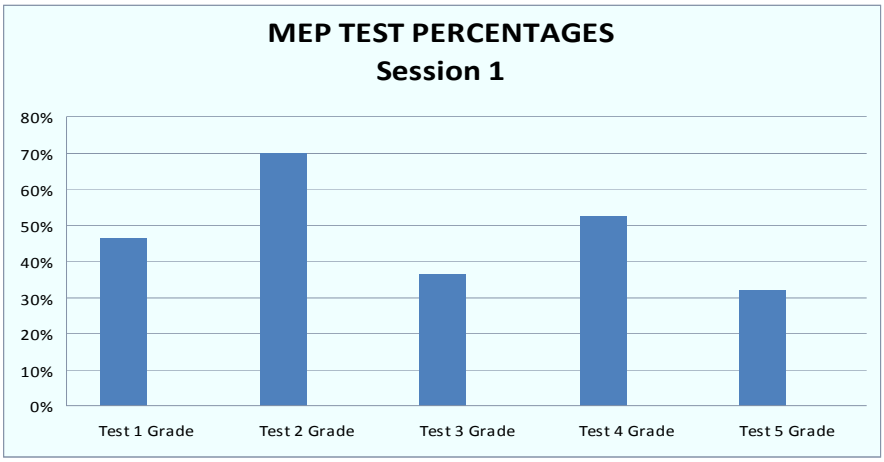

Figure 2. Average scores by tests

During the afternoon session, students worked on ALEKS. In the first meeting, students learned what ALEKS was, registered into ALEKS and completed an initial assessment. In subsequent sessions, students worked in ALEKS in learning mode. As a student works throughout a course, ALEKS periodically reassesses the student to ensure that topics learned are also retained. ALEKS courses are very complete in their topic coverage and avoid multiple choice questions. Several studies have shown that students who show a high level of mastery of an ALEKS course will be successful in the actual course they are taking. ALEKS also provides the advantages of one-on-one instruction, and is available at any time, from a Java-compatible web browser, for a fraction of the cost of a human

tutor[12]. A group of two participants was assigned to a single ALEKS license. Their task was to complete the ALEKS pie consisting of 197 items. Identifying the areas they needed to work in is another task. Workshop facilitators and two students supervised their activities and provided help as needed. The two group members worked on a problem completely and collectively before one of them entered the answer into ALEKS. If students had a problem they could not solve, they could either raise their hands to have a tutor explain the problem to them or they could click on the "Explain" button, which would provide a complete explanation of the problem the student was presented to solve. After having read an explanation in ALEKS, a student would press the "Practice" button to solve a problem of similar difficulty to the one the student had missed.

An interesting characteristic of the group is that it was homogeneous in terms of its strengths and weaknesses. That is, most of them had the same strengths and weaknesses. While students showed that they understood basic properties of the real numbers, they also showed that they had problems with expression containing radicals or with rational expressions as revealed on the first day of sessions. Students were encouraged to work in the topics that they were the weakest in, given that they had available at that time all the help that they needed in order to overcome their problems.

At the end of the last day of the workshop, all participants shared their experiences and expressed their appreciation for the workshop activities and organizers before they received a certificate of completion.

Curriculum

The curriculum is mainly confined to pre-algebra lessons for college students. The number of ALEKS Preparation for College Algebra licenses was adequate to provide this background. The ALEKS software was the main focus for applications, tutorials, and problem solving. Tables 1, 2, and 3 provide the list of items covered in these sessions based on the review chapter of the College Algebra book by Barnett, Ziegler, and Byleen (2008).

Table 1. *Topics for Algebra I: Lesson/Activity (9:00 am – 10:25 am)*
Basic Algebraic Operations
Day 1: Algebra and Real Numbers
Day 2: Exponents and Radicals
Day 3: Polynomials: Basic Operations
Day 4: Polynomials: Factoring
Day 5: Rational Expressions: Basic Operations

Table 2. *Topics for Algebra II: Lesson/Activity (10:35 am – 12:00 noon)*
Equations, Inequalities and Graphs
Day 1: Linear Equations and Applications
Day 2: Linear Inequalities
Day 3: Quadratic Equations and Applications
Day 4: Cartesian Systems and Equation of a Line
Day 5: Distance, Mid Point and the Equation of a Circumference

Table 3. *Topics for ALEKS Mathematics Tutorials (1:00 pm – 4:00 pm)*
Learning with ALEKS
Day 1: Registration, Introduction, Initial Assessment and Learning Mode
Day 2-4: Learning Mode and Assessment
Day 5: Final Assessment

Evaluation of the Workshop

Figure 3 outlines the typical composition based on participants' knowledge as they enter the workshop. Their course mastery is 91 items from a total of 197 topics (46%) as depicted in Figure 2.

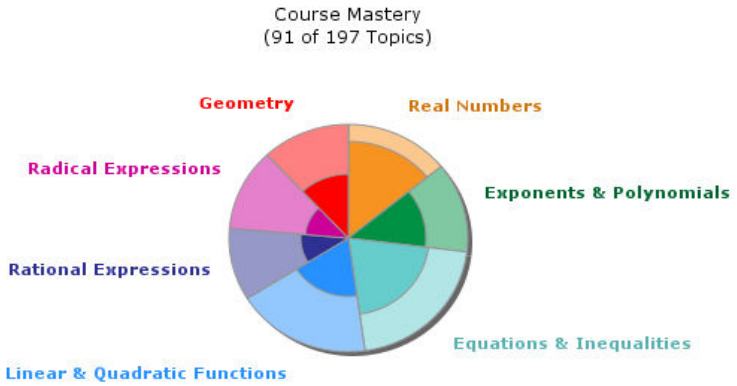

Figure 3. Average composition of a pie after the initial assessment

Figure 4 shows a dramatic improvement in their knowledge base including to some extent recovery of their knowledge from their early years after successful completion of the workshop sessions. It was evident that 68% from the 197 topics assigned to participants throughout the workshop for ALEKS tutorial effectively provided this knowledge transfer.

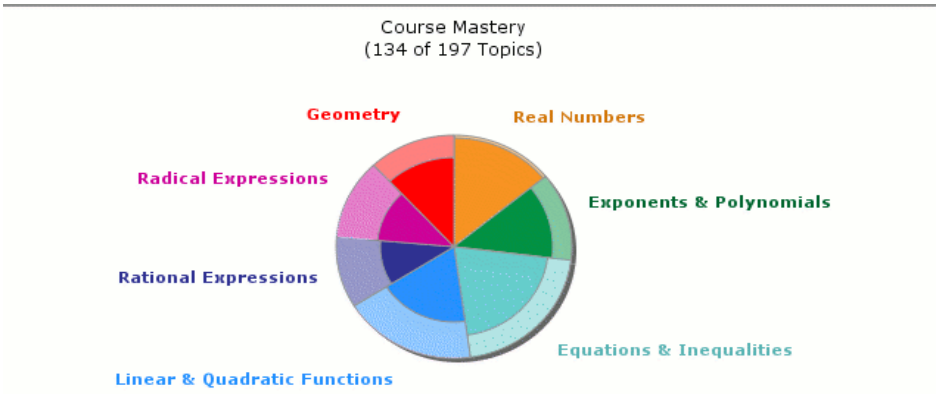

Figure 4. ALEKS pie average items completed by the end of the last

Lessons Learned

In order to determine the success of this workshop, a feedback form was completed by the 23 participants. A scale of: 1 - strongly agree, 2 - agree, 3 - neutral, 4 - disagree, 5 - strongly disagree was used. A summary of the findings is summarized in Figure 5.

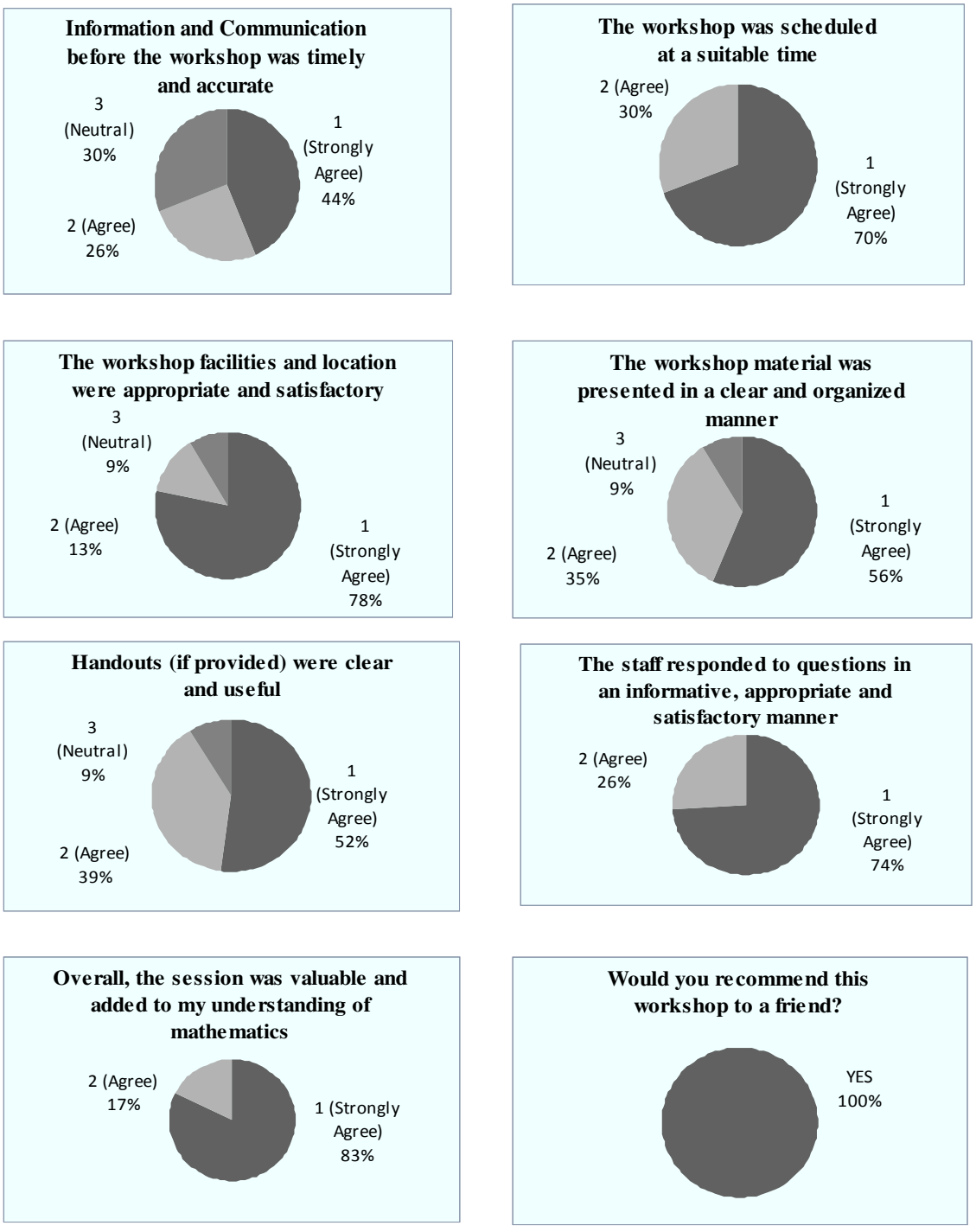

Figure 5. A summary of feedback received from the workshop participants

Workshop participants were highly appreciative about the way the workshop was conducted as is evident from Figure 5.

Conclusion

This paper describes a new program to attract students to pursue science and engineering careers. The first workshop completed under the program, MEP Workshop, January 5-9, 2009, was a major success. Other projects are making proper progress according to a planned schedule of activities. Full implementation of all activities is expected to be completed by the end of July 2009.

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