AC 2010-2102: MEASUREMENT OF SUCCESS: AN OVERVIEW OF THE IMPACT OF SUMMER RESEARCH OPPORTUNITIES FOR COMMUNITY COLLEGE STUDENTS

Sheryl Custer, Texas A&M University, Kingsville

Harriet Lamm, Texas A&M University-Kingsville

David Ramirez, Texas A&M University

Kuruvilla John, University of North Texas

Measurement of Success: An Overview of the Impact of Summer Research Opportunities for Community College Students

Sheryl Custer, Texas A&M University-Kingsville
Harriet Lamm, Texas Engineering Experiment Station
David Ramirez, Texas A&M University-Kingsville
Kuruvilla John, University of North Texas

Abstract

With the rise in the number of engineering positions in the workforce, and the decrease of graduates to fill those positions, institutions of higher education have to rethink their recruiting efforts to attract top notched students within the science, technology, engineering and mathematics (STEM) disciplines. In 2005, the National Science Foundation awarded the Frank H. Dotterweich College of Engineering at Texas A&M University-Kingsville a STEM Talent Expansion Program (STEP) grant to engage students in STEM disciplines. A key focus of this grant is to provide summer research opportunities (May-mester) for community college students partnering with faculty and graduate students at Texas A&M University-Kingsville (TAMUK). To date, 129 students have participated in this summer research program with 42 students having successfully transferred to TAMUK to pursue undergraduate degrees in STEM fields. More students are expected to transfer in the next couple of years as they graduate from community colleges. This paper highlights successes and challenges of this program. The May-mester research experience impacts favorably the students' decision to become an engineering, a science, or a math major, increases students' confidence and motivation to pursue higher academic degrees, and gives students opportunities for leadership roles in professional organizations. The TAMUK-STEP model for student success and persistence can be used as a base for similar initiatives at any higher education institution.

Background

With the high demand for jobs in science, technology, engineering, and math (STEM), and not enough skilled men and women to fill these jobs especially in Texas[4], it is easy to ascertain that there is a great need for universities and other institutions of higher education to take a more proactive stance in ensuring that there is an abundant number of graduates to meet these demands. Almost 13 million workers have found the need for bachelor degree-level knowledge in the areas of science and/or engineering although only about a third of the workers were actually employed in science and/or engineering occupations[4]. According to the 2008 Department of Labor report[5], jobs in the STEM disciplines will potentially increase by approximately 51%; however, over 6 million of these jobs will remain unfilled because there are not enough graduates completing their degrees to fill these positions. In addition, there is an even larger shortage of minorities and women in these fields which raises even greater concerns for not only universities, but for employers as well[10]. Because of the need to recruit and retain more students into the STEM disciplines, many universities are taking a more proactive stance in the recruiting and retention of students. The Frank H. Dotterweich College of Engineering and

the College of Arts & Sciences at Texas A&M University-Kingsville (TAMUK) along with the National Science Foundation (NSF) have taken the first step in addressing this issue through the NSF grant award of the STEM Talent Expansion Program (STEP).

In October 2005, the Frank H. Dotterweich College of Engineering in partnership with the College of Arts & Sciences at TAMUK was awarded a 5-year one million dollar STEP grant by the NSF. The purpose of this program is to increase the quantity of students pursuing degrees in the STEM disciplines and the quality of students being placed into the engineering workforce. While the program targets students of all ethnic backgrounds, it is especially interested in building a diverse population of students in these fields by focusing on the recruitment and retention of both minority and female students which will also increase the diversity of future engineering graduates. In short, the STEP program provides better access and more research opportunities within the STEM disciplines.

Partnering Institutions

There are six community colleges that participate in the STEP program: Del Mar College, Palo Alto College, Texas State Technical College – Harlingen, St. Philips's College, Coastal Bend College, and the Victoria College. These institutions are all located within South Texas, from San Antonio on the northern edge to McAllen in the extreme south. Prior to the award of the grant, a memorandum of understanding was obtained from each institution acknowledging their participation in the TAMUK's STEP project. The project's internal evaluator collects and processes the TAMUK transfer data for the partnering institutions, assesses project data, and prepares reports for the project's sponsor and for dissemination.

Purpose

There are three main objectives that the STEP program addresses. *Objective 1* targets the number of community college SEM transfers. *Objective 2* focuses on the enhancement of student success. *Objective 3* concentrates on improving persistence to degree completion for the predominantly first generation and Hispanic students of South Texas. While all three objectives are vital to the project, this paper discusses only the May-mester Summer Research Program which is a culmination of strategies that fall mainly within the first and third objectives. In addition, this paper highlights some of the key successes that the STEP project team and the internal and external advisory boards have identified as true measures of success.

Description of the May-mester Research Program

The May-mester Summer Research Program is a one- to two-week undergraduate research opportunity that brings 20 to 60 partner community college students to the main campus at TAMUK. These students are possible future TAMUK transfer students. May-mester provides a hands-on learning opportunity for these undergraduate community college participants and is a vital part of the STEP program. In most cases, community college students are not privy to an undergraduate research experience at their perspective community colleges.

Students who are selected for the May-mester Summer Research Program originally came from the six participating institutions. Due to the success of the program, the invitation to participate has been extended to other area community colleges. The STEP project's Transfer Liaison visits with the counselors at each of the partner campuses to disperse the applications and information sheets on the program. The information sheet and application are also posted on the web site which was developed specifically for the STEP project. Students who visit the web site have an opportunity to review the potential research topics. This allows students who are applying to better prepare for their possible project should they be selected to participate. Selection criteria require the student to have completed at least 16 semester credit hours and have a cumulative grade point average of 2.5 or higher. The inclusion of some participants in the 2009 experience who were not yet high school graduates or 18 year of age or older resulted in the requirements for participation being changed due to the obstacles and unexpected expenses resulting from the participation of minors. Counselors at each of the community colleges must verify their students' qualifications.

Research Topics

Research topics vary from year to year and come from a wide array of backgrounds as indicated in Table 1. The majority of the topics focus on the STEM disciplines, but topics from Agriculture Science, Biological Science, and Pharmacy are included if there is sufficient student interest.

Table 1: Past Years' May-mester Research Topics

Content Area	Topic
Architectural Engineering	Sustainable Design Topics; Models and the Design Process
Civil Engineering	Civil Engineering – A Real Experience; Transportation Design; Concrete Materials
Chemical Engineering	Biofuels; Rheology of Polymer Fluids Used in Completion and Fracturing Wells; Investigations of Catalysts for Making Bio-fuels from Citrus Waste
Chemistry	Investigation of Sol-Gel Derived Nanostructured La1-xSrxCo1-yFeyO3 applied for green energy source - Solid Oxide Fuel Cell; Modeling Electronic Energy Levels; Fuel Cell Vehicles
Computer Science	Speech Processing
Electrical Engineering	Computer Analysis and Simulation of Switch-mode DC-DC Power Converters; Electric Machinery; Design and Validation of a Novel Circuit for Fast Scalar Inversion
Environmental Engineering	In-cabin Particle Deposition form Vehicular Emissions; Waste-derived Adsorbents for Atmospheric Pollution Control
Mathematics	Optimization Project; Bioinformatics; Computational Approaches to Solve Difference Equations
Mechanical Engineering	Design of Fuel Cells For Cars; Design/Programming of a Mobile Robot Wheeled or Legged; Programming a Mobile Robot for Navigation
Physics/Geosciences	Solar Energy; Cosmic Ray Telescope; 3-D Campus Model and animation of TAMU-Kingsville; Development of Spherical

	Harmonic Power Spectra Techniques for High Energy Astrophysics

Research Activities

At the beginning of this one- to two-week experience, the students are assigned a research project along with a discipline faculty mentor. This faculty mentor provides instruction and supervision while the participants perform specific research-related tasks throughout the duration of the May-mester program. The faculty mentors understand that students who participate in the May-mester program may have no prior background or knowledge in their assigned topic. The students are given internet and library access to research their topic before they begin on the actual projects. The students are generally given time to research their topic and obtain adequate background on their assigned project. The projects are assigned based upon student interest and the availability of faculty mentors. The STEP project team generally assigns topics that students list as their number one priority; however, if faculty are unavailable, the second choice is assigned.

During the two-week research experience, the majority of the students stay on campus in assigned dormitory rooms although a few may commute daily. The students are given a $1,000 stipend which helps cover the costs of gas, housing, and meals. They receive half of this stipend on their first day, and the remaining portion is distributed at the end of the two-week period. A final presentation is scheduled for the last day, and the students are given the opportunity to showcase their work to their fellow participants. Students prepare power point presentations or posters, display models of their projects, or use other representations to illustrate what they have learned working on their projects during the previous two weeks. In order to provide additional incentives for student transfer to TAMUK, scholarships valid only at TAMUK are awarded to the top presentation team when they transfer to TAMUK and major in engineering.

May-mester Data

Participant demographics by year in the May-mester program is provided in Table 2. This enables an examination of the demographic characteristics of the participants which have varied from 50% to 59% Hispanic.

May-mester 2006 had 8 participants transfer to TAMUK after participating in the event with five majoring in engineering, one in computer science, one in agricultural science, and one in another field. Of those 8 transfers, six are still enrolled and the other two had not yet enrolled for the spring 2009 semester at TAMUK when this data was collected. Two of the 2006 group had been enrolled at TAMUK prior to their May-mester experience but enrollment was not indicated for them after the experience. 2007 provided 16 transfers to TAMUK as a result of participation. Fifteen of these participants majored in an engineering discipline while one majored in chemistry. Eleven of the 2007 participants were enrolled for spring 2009. May-mester 2008 yielded 9 participants who transferred after the event and all are continuing their work at TAMUK. Seven of the 9 participants are engineering majors, one is a computer science major, and one participant is majoring in physics. Four of the 2009 participants (three engineering and one biology) transferred in fall 2009 with one other having attended prior to the

experience but has not matriculated. Several of the past participants were planning to transfer as soon as they completed the core curriculum at their community college due to the differences in expenses.

Table 2: May-mester Participant Demographics by Year

	Year 1 2005 - 2006			Year 2 2006 - 2007				Year 3 2007 - 2008				Year 4 2008 - 2009		
Demographics	Female	Male	Total	Female	Male	NR *	Total	Female	Male	NR *	Total	Female	Male	Total
Alaskan / American Indian	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Asian	0	0	0	0	1	0	1	0	0	0	0	0	1	1
Hispanic	4	6	10	2	13	1	16	3	10	0	13	13	22	35
White	3	7	10	1	1	1	3	3	4	0	7	8	8	16
Other	0	0	0	0	0	1	1	0	1	0	1	0	0	0
Not Reported	0	0	0	0	5	1	6	0	0	2	2	3	3	6
Total	7	13	20	3	20	4	27	6	15	2	23	24	35	59

* Data not reported on initial application

After four years of the May-mester Summer Research Program, a total of 129 community college students have participated with 42 having transferred after participation as of fall 2009. Current data yields a 33% success rate for transfers to TAMUK from this activity. Prior to the 2009 experience the success rate was 47%. The reason for the decline in the percent of successful transfers immediately after the experience results from the doubling of the number of participants for 2009 and the fact that several of the participants were not ready to transfer in the following semester. This success rate should increase as previous participants transfer after completing the core curriculum at their current two-year institution. Efforts to contact all non-transferred past participants are ongoing to determine if they transferred to another institution and are they majoring in a STEM discipline.

Benefits of the Program and Student Successes

Putting aside the obvious benefit of increasing the number of student transfers within the STEM disciplines, there are several other benefits that have evolved from May-mester. Writing research papers and submitting for publication, increased interest in research, and opportunities for student leadership within student professional organizations are among the other benefits emerging from participation.

Not all of the May-mester participants transfer to TAMUK to complete the baccalaureate degree. According to a recent follow-up survey given to former May-mester participants, many of these students have already transferred to TAMUK and several plan to transfer in upcoming terms. This same survey estimated that when these additional students transfer, they will major in one of the STEM disciplines at TAMUK. Most of the survey responses indicated that

transfers will take place upon completion of their general education requirements and/or the Associate Degree program.

Data are collected on all incoming transfers (May-mester participants and non-participants) into the targeted disciplines of chemistry, engineering, mathematics, and physics. The data are examined for overall trends from all sources (two-year and four-year institutions) as well as those coming from the partnering institutions. Table 3 provides the actual number of transfers from the participating community colleges with a note that the partners changed in Years 3 and 4. The increase in Year 3 numbers in Table 3 are in part due to the change in partner community colleges.

Table 3: TAMUK STEP Partner* Transfers for the Fall Semester

Major	Baseline 2003-04	Year 1 2005-06	Year 2 2006-07	Year 3* 2007-08	Year 4* 2008-09	Total to date
Engineering	32	22	28	45	22	149
Chemistry	1	0	1	1	0	3
Mathematics	3	0	3	2	3	11
Physics	0	1	1	1	2	5
Total	36	23	33	49	27	168

* Partners changed in Years 3 and 4 so data reflects different partners

Table 4 provides data for all other sources of transfers which includes other community colleges and four-year universities. As in Table 3, the data for Year 3 varies due to the change in partners. One of the previous partners who was providing several transfers became a bachelor degree granting institution. As a result, this partner was replaced since partners were to be only two-year institutions.

Table 4: TAMUK STEP Non-Partner* Transfers for the Fall Semester

Major	Baseline 2003-04	Year 1 2005-06	Year 2 2006-07	Year 3* 2007-08	Year 4* 2008-09	Total to date
Engineering	35	34	46	45	36	196
Chemistry	0	2	3	1	0	6
Mathematics	3	2	3	2	3	13
Physics	2	0	2	1	3	8
Total	40	38	54	49	42	223

* Partners changed in Years 3 and 4 so data reflects different partners

Increase in publications and/or research opportunities at the undergraduate level

One of the greatest successes that any academic collegian can obtain is to have his/her work published in a refereed publication. This feat is considered even more successful when an undergraduate student has his/her work published in this manner. In 2008, two recent May-

mester participants were able to accomplish this through their continued work on the assigned May-mester project under the supervision of their May-mester faculty mentor. Participant Daniel Clancy and his mentor Dr. Jingbo Liu wrote the paper entitled "Facile Route to Prepare Silver Nanoparticles" [1] discussing the results of the research project. The paper was published in the *Journal of Undergraduate Chemistry Research*. Mr. Clancy also presented his research work in poster format at the TAMUS Pathways Conference at Tarleton State University, Stephenville, TX[2] and at the 4th International Conference on Environmental Science and Technology in Houston, TX[3]. Robert Salinas, the second participant, and his mentor Dr. Yifang Zhu had the results of his May-mester research project "Roadside Measurement of Ultrafine Particles at a busy Urban Intersection" published in the *Journal of the Air & Waste Management Association*[6].

Student Leadership Opportunities

The May-mester experience also prepares transfer students to serve in leadership roles at TAMUK. Students who participate in the May-mester experience find it easier to join student professional chapters and they feel more comfortable in serving as officers in these organizations. Students are encouraged to be more active in other campus and scholarly activities such as tutoring, student organization officer positions, and in developing and writing research reports for publications and presentations. Students are able to take these experiences with them to their jobs upon graduation making the May-mester experience even more valuable to the students.

Student Success Stories

In order to gain a more holistic view of what the students were getting out of their May-mester experiences, an open-ended survey was distributed to each of the participants. When asked how the May-mester experience benefited them, most saw it as a way to get to know the campus before actually transferring to TAMUK. They noted that the experience also enabled them to have a better understanding of what their degree program involved as well as providing an opportunity to get to know some of the other students in the program. One of the key successes that the project team has identified is the success of the students in publishing and/or presenting their research projects in professional journals and/or at professional conferences. When asked how the program benefited them, Robert Salinas, May-mester 2006 participant, stated

> One of the many benefits that I still recognize is the people I met. I worked for a graduate student by the name of Jessica Ruiz. Till this day she and I have remained friends and I have met more people because of her. As a result, my circle of friends has grown and my transition in 2006 was much easier and welcoming. Another benefit is that May-mester opened the door so that I could work for CREST; under the advisement of Dr. Zhu. Working in this field has allowed me to network with graduate students as well as professors. Since I have worked for Dr. Zhu for almost two years, I have gained a vast amount of research experience. Also, my assistance has been recognized because we have a research paper that is to be published in the 2008 *Journal of the Air & Waste Management Association.*

Students were also asked if they had an opportunity to share their experiences with

others, and all stated that they had talked with their peers about the experience. In most cases, they were able to eliminate the "nerdy" image that most students have of engineers, mathematicians, and scientists. Students shared what they did in their projects and how this experience will help them after they graduate. May-mester 2008 participant Alejandra Solis Caceras stated

> I did have the opportunity to share the research experience and still have; this experience change my life in a good way and I am never going to stop giving thanks. I always share with my friends this experience. Right now in this semester I had been sharing with my students' colleagues everything about it and how great was it. Mostly I share it with the architectural engineering students that I have in my engineering class and when we go to the lab the Heliodon that I built is there so I show it to them, how it works and what is for. I always encourage the students to go and do internships because it let you experience what you are going to do in your future when you graduate.

Challenges of the Program

As with all programs, the STEP project team has identified several challenges that have affected the overall success of the May-mester Summer Research Program. Some of these challenges were noted during the first year and have been address by the project team. Other issues continue to remain ongoing obstacles. One of the ongoing challenges pertains to the students' lack of prior knowledge in the research subject area. The majority of the students have little to no background in the research topics that they are assigned, and many of the students have completed less than 30 semester credit hours. Because most of the STEM research subject areas require a strong background in both math and science, some students are less prepared for the research experience. Faculty mentors typically provide the students with the additional information to bring them up to speed, but students still state in their final focus group session that more time is needed to prepare for the projects. Several of the faculty have graduate assistants who are able to provide additional tutoring outside of working on the project as needed.

Another of the ongoing challenges that the STEP project team encounters is the internal issue of using and/or the availability of campus facilities during the project session. To avoid interfering with regular campus activities, the May-mester Summer Research Program is held during the intersession period between the spring term and the first summer session. In the past, this has caused a hardship for students participating in the program because all student-centered areas, such as the cafeteria, bookstore, gym, etc. are closed for maintenance and cleaning. The dormitories also close with the exception of the one used to house the May-mester participants. Usually this dormitory has not been readied for the summer session which produces some issues for the participants.

An uncontrollable challenge faced by the May-mester project is the lack of city activities. Kingsville, Texas is a small town and does not have the attractions that larger cities have. Many students noted this as a negative concern if they were to transfer. While the university is collaboratively working with the city officials to help bring in more attractions to the city, the likelihood of new businesses and attractions being in place before the end of the project are slim.

Efforts to correct these issues are ongoing and are producing some results. As noted in the external evaluator's last Focus Group Report[8], the dorm situation and the lack of activities during the intersession have resulted in some students not transferring to TAMUK. However, each year the STEP project team works closely with housing, student activities, and student affairs to ensure that campus offices, other than the colleges, are open for business during the intersession period.

Program Sustainability

Program sustainability is also a major concern for the STEP project team. The May-mester Research experience has been well-received by most, if not all of the students who participated, despite the challenges. All of the funding for the STEP project has come from the NSF; however, the project is funded for only five years. The project is now in Year Five which means May-mester 2010 will be the last event (or activity) funded by the project. The program began its final year on October 1, 2009. As a result of the successes from May-mester, the STEP project team is currently researching ways to continue the program through private and/or university-based resources.

Summary

It is anticipated that the May-mester Summer Research Program will continue to receive positive feedback from participating students as well as the internal and external advisory boards. The May-mester Summer Research Program increases the participants' self-esteem and self-confidence by providing the encouragement they need to obtain their baccalaureate degree as it develops research-based knowledge. Many of the participating students acknowledged a certain level of apprehension when contemplating the transfer process to a four-year institution[8]. Based upon the feedback obtained from the participants, the May-mester research experience appears to be a tool that helps students overcome these fears. Former May-mester 2007 participant Andy Vigstol stated

> I feel exceptionally lucky to have been chosen for the May-mester research program. The projects were complex to say the least and I still haven't figured out how everyone finished on time. I left with a keener sense of direction towards my degree in civil engineering and a greater respect for all the sciences.

Based on this and other similar comments, the project team feels that students who participate in the May-mester experience leave with a broader perspective of what STEM disciplines encompass.

The program also assists those students wanting to transfer with the actual transfer process. The process can often seen as tedious, time-consuming and challenging for students wanting to transfer from a community college setting into a four-year institution[7]. The STEP program helps to make the transition less stressful. E.G. Elizondo, II, May-mester 2006 participant stated regarding his transfer experience

> I am thankful for the May-mester research experience I had that was funded by STEP. It gave me the chance to live and work at the college making the transfer a lot easier.

May-mester 2009 also produced positive feedback from students with some of these comments including statements such as having an opportunity to work with both faculty and graduate assistants[9]. Kelly also notes in her report that students really appreciated the opportunity to "be away from home and focus just on school" (p. 17), and be able to work within a small group setting as opposed to a large, impersonal classroom. In short, however, the common theme in the focus group activity among the 2009 May-mester participants was that May-mester provided "an opportunity to see if you like a field, to decide if you want to do this, and to talk to professors in the field and get their advice" (p. 17) as well as providing a small glimpse of what "graduate school might be like" (p. 17).

Comments such as these enable the STEP project team to consider the May-mester program to be successful. Not only does the data reveal this with the increase in the numbers of transfer students to TAMUK, but also through the participants themselves. These students return to their community colleges where they share their May-mester experiences with others who may also be apprehensive about pursing a career in one of the STEM disciplines.

Acknowledgement

The authors would like to thank the STEP project team Dr. John Chisholm, Dr. Greg Moehring, Dr. Ali Pilehvari, Dr. Larry Lee, Martie De La Paz, Rose Rodriguez, Idolina Cortez, and Laura Parr for their support in the May-mester Research Program. This paper is based on work supported by the National Science Foundation under DUE grant No. 0525496. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the sponsor.

References Cited

1. Clancy, D. & Liu, J. L. (2008). "Facile Route to Prepare Silver Nanoparticles," *Journal of Undergraduate Chemistry Research, 7*(2), 66-71.
2. Clancy, D. & Liu, J. L. (2007, October). *Parameter Optimization of Fabricating Nano- structured TiO2-Ag Catalyst to Remove Multi-contaminants.* Poster session presented at the annual TAMUS Pathways Conference, Tarleton State University, Stephenville, TX.
3. Clancy D. & Liu, J. L. (2008, July). *Parameter Optimization of Fabricating Nano-structured TiO2-Ag Catalyst to Remove Multi-contaminants.* Poster session presented at the 4th International Conference on Environmental Science and Technology, Houston, TX.
4. Perryman, M. Ray. (2007, February). *The Potential Impact of an Initiative to Increase the Pool of Engineering and Computer Science Graduates on Business Activity in Texas.* Waco, TX: Perryman Group.
5. U.S. Department of Labor Report (2008). Retrieved February 1, 2009 from http://www.dol.gov/esa/olms/regs/compliance/rrlo/lmrda.htm.
6. Wang, Y., Zhu, Y., Salinas, R., Karnae, S., Ramirez, D., & John, K. (2008). Roadside measurements of ultrafine particles at a busy urban intersection, *Journal of Air and Waste Management Association,* 58:1449–1457.
7. West Texas Office of Evaluation and Research (WTER) & Kelley, J. (2007). May-mester focus group report. Internal document produced by external evaluator.
8. West Texas Office of Evaluation and Research (WTER) & Kelley, J. (2008). May-mester focus group report. Internal document produced by external evaluator.
9. West Texas Office of Evaluation and Research (WTER) & Kelley, J. (2009). May-mester focus group report.

Internal document produced by external evaluator.
10. Yurtseven, H. O. (2002). How does the image of engineering affect student recruitment and retention? A perspective from the USA. *Global Journal of Engineering Education, 6*(1), pp. 17-23.