

## **Benefits of Summer Enrichment Workshops for Incoming College Students in STEM Disciplines**

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### **Abstract**

It has been discovered that incoming college students need enrichment, support, and guidance in order to overcome the academic challenges ahead of them. Summer enrichment workshops certainly attempt to impact positively these students who plan to pursue programs in Science, Technology, Engineering, and Mathematics (STEM) disciplines. This eventually benefits their ability to complete the programs, timely graduation, and as a result, colleges will also be able to maintain higher retention rates to accommodate growing need of skilled STEM workforce to meet the current demand of the country. This paper summarizes the details of one enrichment workshop series conducted past three summers holding three carefully planned workshops at Texas A&M International University (TAMIU), Laredo, Texas, thanks to the US Department of Education grant to increase recruitment, retention, and graduation of a number of Hispanic and other minority students pursuing degrees in STEM fields at TAMIU.

**Keywords:** STEM disciplines, enrichment workshops, minority students, participants

## Introduction

The grant program, STEM Recruitment, Retention, and Graduation (STEM-RRG), received from the US Department of Education for the academic years 2008-2011 is designed to help Texas A&M International University (TAMIU) establish an innovative recruitment and retention program that increase the number of Hispanic and other minority students pursuing degrees in STEM fields at TAMIU. STEM-RRG consists of several projects that implement a number of activities, including enrichment workshops, scholarships, internships, research experience, mentoring and tutoring, advising and career counseling, experiential training, recruitment of high-potential students, and faculty professional development. To implement these activities, STEM Recruitment and Enrichment Project (STEM-REP) has been established and is expected to accomplish the goals, in particular, to improve the recruitment, enrichment, and preparation of Hispanic and other minority students through participation in summer workshops and a follow-up science and engineering exhibit. The workshop sessions were conducted by discipline-specific instructors, experts, and professionals locally available with a strong emphasis on enhancing critical thinking and problem-solving skills among incoming high school students.

Incoming college students in STEM disciplines have many challenges. These challenges include: adapting to college life, getting used to college courses, coping with professors' individual teaching styles, and lack of experiences in preparation of laboratory assignments. Accordingly, students face a daunting task in deciding whether to stay focus on college courses or to give up everything altogether amidst of these challenges. These carefully planned two-week long workshops will certainly help retention, in which enrichment is fortified to enhance their ability to succeed in college programs. In a society like the United States, there can be no definite model design for student learning that serves all students and all disciplines. Learning abilities and styles of students are different and unique. These characterize US higher education and remain a source of vitality and strength by itself. Yet all educational institutions and all fields of studies also share this obligation to prepare their graduates to the fullest extent possible for the real-world demands of work, citizenship, and life in a complex and fast-changing world. In this setting, there is great value in a broadly defined educational preparation and objectives of incoming college students who are willing to embark in this important task that provides both a shared obligation, sense of determination, and strong emphasis on effective practices that help students achieve successes in STEM disciplines. To highlight these shared responsibilities, this workshop series has been carefully crafted to impact these young minds as they prepare to meet these college challenges.

### **Demand for Enrichment Activities**

Hispanics comprise a growing segment of population in the United States and a major concern is the shortage of Hispanic students who are pursuing STEM degree programs. The summer enrichment workshops would lead to the recruitment, retention, and graduation of Hispanic students for these programs. Benefit of enrichment activities are essential for incoming college students to succeed in STEM disciplines and degree programs and lead to research and learning potentials

High school students in the US are expected to have completed a rigorous high-school curriculum, if they receive a diploma, completed a State-designated program or met a similar set of course requirements, or earned at least some achievements in Advanced Placement (AP) courses. Students who complete this coursework either as outlined by their state or under the Education Agency in the state and who seek college admission will be given the opportunities, such as scholarships (Waters, 2006). The pace at which science and mathematics education proceeds in the US has been slow. As such, the U.S. Department of Education requested an appraisal of the scientific knowledge base on human aspects of learning and their application in the current high school education. Research suggests that all of these topics lead to providing all students with inside and outside experience in order to gain the fundamental knowledge base for understanding and implementing necessary changes in student education (Bransford, Brown, and Cocking, 1999). Subsequent enrichment programs can further enhance this knowledge base as they begin to take college courses.

The National Leadership Council for Liberal Education and America's Promise (LEAP) strongly recommended aligning the essential goals and guiding principles for higher education in today's dynamic global economy. They also emphasize the importance of providing students with the necessary knowledge and skills but also experience putting those knowledge and skills to practical use. All individuals must master these skills and knowledge in order to be successful and to contribute to today's global economy with some intervention (Hart, 2004).

Colleges have become a gateway to many opportunities in the scientifically inclined society. The proposed activities must strengthen higher education in the United States, especially the academy's commitment to inclusion and excellence in advancing innovative solutions to important problems. Working together, with determination, creativity, and a larger sense of shared responsibility, the students in high schools can fulfill the promise of a liberating college education to sustain America's future through additional enrichment intervention (ABET, 2000). Our nation still has the strongest scientific and technological enterprise and the best research facilities in the world.

However, the recent trend in the country which is occurring in mathematics and science education needs to be rapidly corrected so as not to fall behind of the rest of the world who prospers in this arena (Augustine, 2005).

Students are to be thinking in terms of the professions and more real-world applications in the liberal arts and sciences setting. The other great systemic impediment to educational reform is the ever-changing marketplace and its diversity. When an institution of higher education independently raises its entrance requirements, or holds students to more rigorous graduation standards in science, mathematics, linguistics, or global learning, students remain entirely free to go to another institution that has set less academic standards. For all these reasons, administrators shall work collectively across institutional boundaries as well as within themselves to create conducive environment for the marketplace to flourish and educational excellence is achieved from all. Support and reward for collaborative work must be in place to achieve them (Adelman, 2004).

### **Extent and Planning of Sessions**

It is advocated that small group sessions are favorable for students' learning and to promote more interaction among the participants. Each of the three workshops was limited to 20 participants to assure extensive interaction between the participants and instructions. In each day, two sessions were conducted from 9:00 am to 4:00 pm MTWRF with a dismissal for lunch from 12:00 pm to 1:00 pm for two weeks in a lecture room equipped with computers totaling 20 sessions of 60 hours of lessons for each workshop under direct supervision of the session leader who is assigned to deliver the enrichment sessions in his/her expertise (see the appendix for session themes). Each session was a complement to other sessions in order to provide a broad range of coverage of subject and discipline matters. In some cases, a split session was held to accommodate an expert in the field. Attendance was taken just before the session started and just before it was over. Alternative sessions were planned to address absences by the participants (1.37%) thus, allowing them to make up hours in emergencies. These workshops have been planned a week apart so that the presence of session leaders can be curtailed to three weeks. This session model that limited the duration of the workshops to four weeks as in Figure 1 was considered important. This allowed the span of any session leader's engagement only to three weeks unless they chose to conduct two different sessions for the entire workshop series. This format only uses minimum university facilities at any given time. Session topics ranged from mathematics, biology, environmental issues, physics, statistics, business models, geology, computer science, and engineering, to robotics.



**Figure 1.** The model that limits the entire duration of the workshops to four weeks

The participants contributed to these subject topics by either willing to pursue degree programs in them or choosing minors in these specific fields. Different delivery formats such as lectures, laboratory experiments, library sessions, and planetarium shows were used to accommodate the sessions in groups and individually in an actual college setting. The participants were very curious to learn how to interact with college professors as many of the sessions have been conducted by them. They had access to the campus cafeteria, student center, gymnasium, game room (pool tables etc.), recreational center (exercise equipment, table tennis etc.), bookstore, and library. The lunch break was certainly a valuable experience for many as they completed one session and got prepared for another one. This paved the way to promote collegiality among participants and make new friends among them. Some took the opportunity to explore the University facilities during this time. The last day of activities consisted of presentation of participants' experience (7-10 minutes of each either oral or PowerPoint self-presentation by the individual or group participants), completion of workshop feedback form by the participants, award of certificates, group photo, and concluding remarks by the Program Director, Dr. Rafic A. Bachnak during the afternoon session. At the end of each presentation, there was a time for Q&A and comments relevant to their talks. Some participants took the opportunity to inquire the STEM degree programs and relevant coursework offered by TAMIU.

One feature of the workshops was to promote presentation skills among participants. This was certainly achieved, as was evident from their brief final day presentations describing their experience during the two-week period. Some chose to have PowerPoint presentations and others used video presentations to deliver their extents of experience. There were many group presentations as well.

### Recruitment and Selection of Participants

About one-hundred fifty application packages were distributed to area high school counselors through the University's the Office of High School Recruitment. Each application package contained of a program flyer, program benefits, schedule of sessions (see, appendix 1), and an application each year. Another 100 application packages were sent to area high school through students working for the programs. Some freshman students in the University were encouraged to recruit seniors and juniors at local area high schools. About 100 applications have been received. Selections were done thereafter. All twelfth graders wanted to pursue STEM disciplines were given a priority. Eleventh graders were selected from the applications received who indicated strong interests to pursue programs leading to STEM disciplines at TAMIU. Criteria for selection are the strength of the students' essays and interests in STEM disciplines. Their high school GPA was certainly a factor in the decision-making process. Selected students were communicated using e-mails and phone calls. Some instances, students were contacted to clarify items in the applications including e-mail addresses and missing information, if any, and to provide another preference for a workshop. Final acceptance letters were issued to the selected students close to the actual workshop.

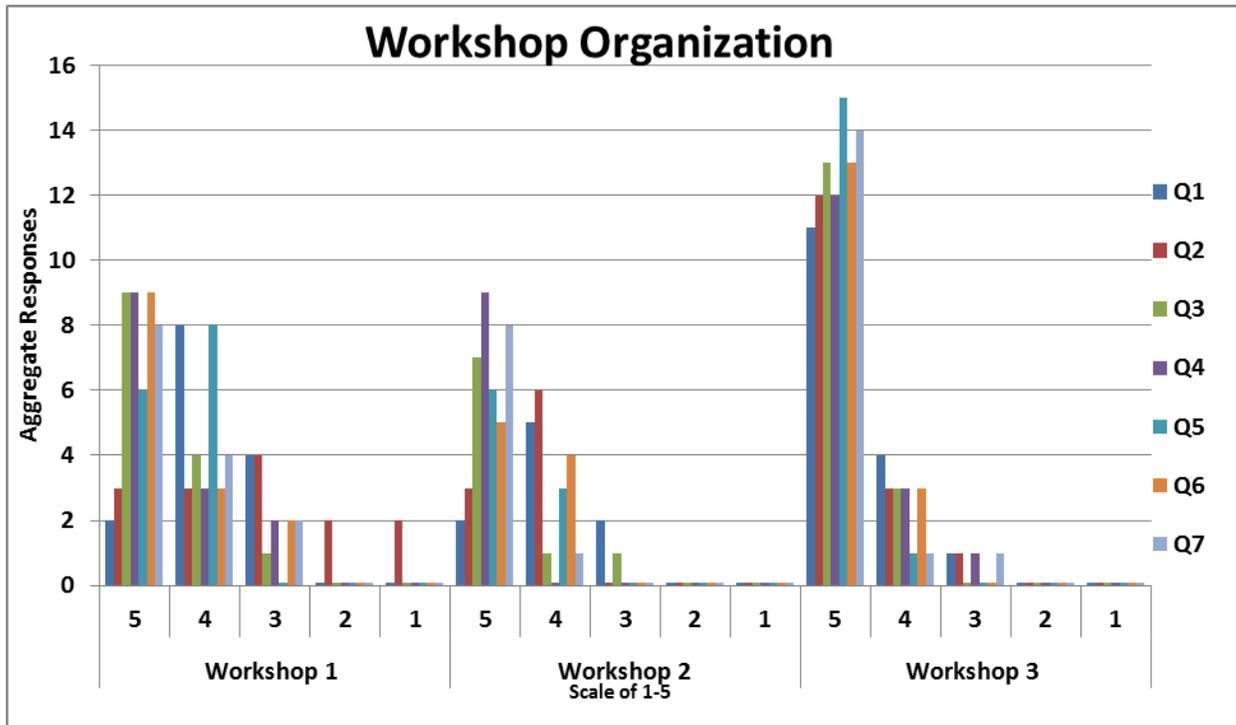
### Analyses and Extent of Achievements

Table 1 provides the breakdown of the 51 workshop participants attended the workshop series held in summer of 2009 on the basis of the workshop they attended, the grade level, and gender. Most of them are either incoming college freshman or juniors at area high schools taking concurrent courses at TAMIU. For the remaining two workshop series, 67 students attended in the summer of 2010 and 39 attended in 2011 totaling 157 high school students.

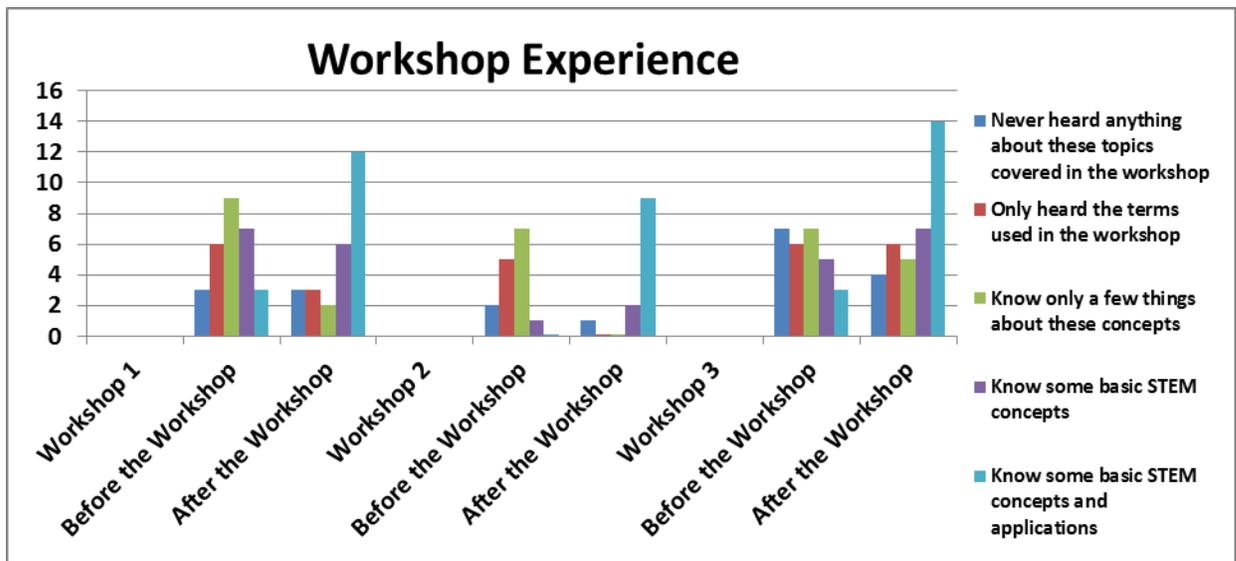
**Table 1.** Participant breakdown: workshop/grade level/gender

	Workshop 1: June 1-12, 2009			Workshop 2: June 8-19, 2009			Workshop 3: June 15-26, 2009		
	Male	Female		Male	Female		Male	Female	
12 <sup>th</sup> Graders	10	3	13	4	1	5	2	3	5
11 <sup>th</sup> Graders	4	4	8	12	1	13	5	2	7
	14	7	21	16	2	18	7	5	12

All participants have been requested to comment on their experience by answering a set of eleven questions in a feedback form (appendix 2 provides the form used in 2009) at the end of their last day of the respective workshops. Figures 2a-d depicts the aggregate of these responses gathered using the feedback forms from the workshops 1, 2, and 3 for questions 1-7 for the years, 2009, 2010, and 2011, respectively. In addition, all participants from the workshops 1, 2, and 3 indicated (questionnaire 9) that they would overwhelm recommend this workshop to a friend.



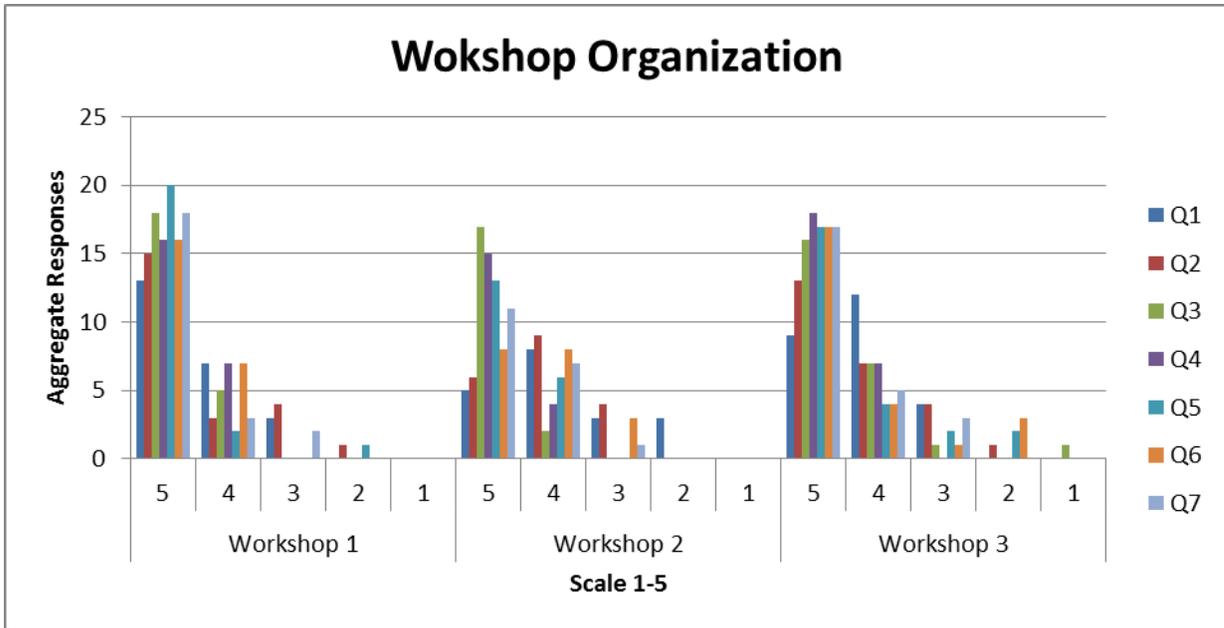
**Figure 2a.** Aggregates of the responses for questions 1-7 received from the participants who attended workshops 1, 2, 3, overall for the workshops held in 2011



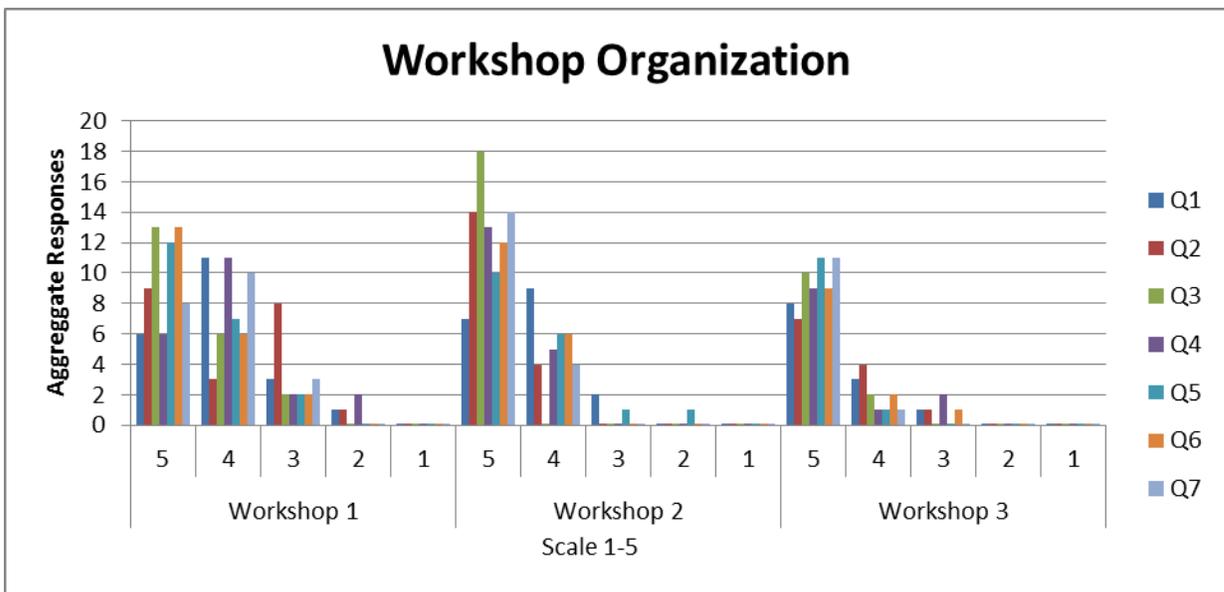
**Figure 2b.** Achievement of STEM experience following workshops held in 2011



For the workshop held in 2011, an additional set of questionnaires has been included as advised by the project external evaluator. Figure 2b depicts the aggregate results to show that the students have achieved wide range of STEM experience following the workshops.



**Figure 2c.** Aggregates of the responses for questions 1-7 received from the participants who attended workshops 1, 2, 3, overall for the workshops held in 2010



**Figure 2d.** Aggregates of the responses for questions 1-7 received from the participants who attended workshops 1, 2, 3, overall for the workshops held in 2009

For the three open-ended questions (8, 10, and 11) in the feedback form, Table 2 summarizes the responses received in 2009 as to how the majority of them responded using top six responses received (two responses for each workshop). Similar responses were received in 2010 and 2011. These responses will be certainly taken into consideration when planning similar workshops in the future.

**Table 2.** Top six responses received for questions 8, 10, and 11, respectively

Workshop 1: June 1-12, 2009	Workshop 2: June 8-19, 2009	Workshop 3: June 15-26, 2009
8. In what ways could this workshop have been improved to better suit your needs?		
Provide lunch	More hands-on activities	Shorter hours
Three-week workshop	Extended lunch break	More labs or projects
10. Please comment on how sessions helped you grasp mathematical and science concepts		
Helped to remember old materials	Students got to understand and learn new concepts	Uses of concepts in multiple ways
Students got to understand and learn new concepts	Helped to remember old materials	Good lectures by experienced professors
11. Please comment on your overall experience during these workshop sessions		
Enjoyed the program	Excellent educational experience	Enjoyed topics of the program
Great experience	Very interesting	Learned new materials

### Participants' Experience in their Own Words

All participants echoed their experiences and benefits received from this two-week workshop during the final session just before the awarding of certificates and group photos. Some have remarked about particular sessions, session leaders, and an activity stemmed from a session or two. The following is the summary of these brief presentations as our student assistants were able to witness, gather, and take notes. Some remarks were paraphrased and corrected for inclusion in the paper.

The workshops allowed them to meet new people from the area who share the same passion and desire to succeed in mathematics and science. Students were made more aware of the role of mathematics in the world today; “mathematicians are becoming the global elite” as one said. In relation to the role of mathematics in scientific fields, one student remarked that he learned “mathematics is the language of science.” A majority of students acknowledged that, not having taken a mathematics course within the past semester, the sessions which concentrated on the practice of algebra helped to greatly

“refresh their mind.” The session dealing with the application of statistics in the world of criminal justice helped students make a connection between mathematics and social behavior. Students learned about the pressing environmental issues right here in Laredo, most notably the “plastic bag problem.” Along with a trip to the planetarium, students enjoyed learning about the study of astronomy and the methods of mathematics that were used by scholars as early as Galileo to determine the dimensions of the universe. Coming back to Earth, many students made mention of the hands-on-lab session focusing on rocks and minerals in which they were challenged to differentiate and identify rocks from an array of samples. Most students admitted that although they hadn’t really considered geology before, the lab was fun and interesting. The overall message from the students was, “we learned how to apply mathematics in real life applications” and “I enjoyed and benefited from the experience.” Suggestions for more physical activities, shorter session periods, supply of food, and more advanced mathematics material were among those mentioned by some participants.

Probably the most appreciated session was that of algebraic principles such as polynomials and trigonometry. The Lego Robotics session gave students the chance to design their own unique robots and taught them about the use of a variety of different sensors in the field of engineering. The students all enjoyed this hands-on session. Aside from the robotics session, the lessons held using the AutoCAD and Geometer’s Sketchpad software helped aspiring engineers and architects gain insight into the inner workings of the profession. The session dealing with the practice and applications of mathematics seemed to really help the students to refresh their skills and even learn new ways to solve quadratic equations and use matrices. Participants really enjoyed the session on genetics and learned about the importance of gene study and how unique we all are. They mentioned on several occasions that they enjoyed session leader’s style of teaching and felt confident in his ability to answer their questions; students planning to major in biology were encouraged by these remarks. Regardless of whichever academic path these students may have had in mind when they began the workshop, they all left with a greater understanding and appreciation for mathematics; “mathematics is the leading principle of life which brings people together as a unit.” Some students even decided to switch their major to mathematics because of the positive experiences provided by the sessions and professors. Students credited the effectiveness of the sessions to the “high quality of the professors.”

Students learned about the issues involving water treatment and processing and were inspired to take a more active role in community efforts to make Laredo a cleaner place. They expressed deep gratitude for the opportunity to learn from such knowledgeable and interesting professors and seemed to have retained most of what they learned during the two weeks. Students made group oral and video presentations; one of which included a jeopardy style question and answer section at the end. The enthusiasm with which these

participants spoke and presented is a strong indicator that these workshops achieved their goals to inspire and motivate young minds to excel in the fields of STEM.

### **Conclusions**

This workshop series was a great success as a total of 157 high school students were able to benefit from three two-week summer workshops consecutively held from 2009 to 2011. The attendance has been enforced to its fullest extent. As a result, the program administrators were able to achieve a high rate of attendance throughout all sessions of three workshops by the participants. The participants echoed the positive impact of the workshop on them to make their college life successful. The feedback received from the workshops 1, 2, and 3 for each year of the program will be used in planning the similar future workshops of this type. This paper provides a model of summer enrichment workshops that can be used to prepare incoming college students to succeed in STEM education. This also provides development of new enrichment activities to increase preparedness of Hispanic students for STEM education together with adequate added benefits to incoming Hispanic college students to successfully complete STEM degrees on time.

### **Acknowledgements**

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**Appendix 1. STEM Recruitment and Enrichment Project (STEM-REP) Schedule for Speakers and Session Themes Schedule for the 2008-2009 Academic Year**

	Workshop 1: June 1 – 12, 2009		Workshop 2: June 8 – 19, 2009		Workshop 3: June 15 – 26, 2009		
	9:00 am – 12:00 pm	1:00 pm – 4:00 pm	9:00 am – 12:00 pm	1:00 pm – 4:00 pm	9:00 am – 12:00 pm	1:00 pm – 4:00 pm	
Week 1	M	Welcome & Introduction Introduction to computer hardware Dr. Roberto R Heredia	A primer on genetics Dr. David L. Beck	Welcome & Introduction Introduction to computer hardware Dr. Roberto R Heredia	A primer on genetics Dr. David L. Beck	Welcome & Introduction Introduction to computer hardware Dr. Roberto R Heredia	A primer on genetics Dr. David L. Beck
	T	Robotics with legos Dr. Fethi Belkhouche	Local Environmental Issues Mr. Gerardo Pinzon	Robotics with legos Dr. Fethi Belkhouche	Local Environmental Issues Mr. Gerardo Pinzon	Robotics with legos Dr. Fethi Belkhouche	Local Environmental Issues Mr. Gerardo Pinzon
	W	Decision support in operations management using Microsoft Excel Dr. Balaji Janamanchi	Practical uses for matrices Prof. Miguel San Miguel	Decision support in operations management using Microsoft Excel Dr. Balaji Janamanchi	Practical uses for matrices Prof. Miguel San Miguel	Decision support in operations management using Microsoft Excel Dr. Balaji Janamanchi	Practical uses for matrices Prof. Miguel San Miguel
	R	Applying statistical techniques to real-world problems Prof. Dae-Hoon Kwak	Several methods for solving quadratic equations Prof. Alma V. Jasso	Applying statistical techniques to real-world problems Prof. Dae-Hoon Kwak	Several methods for solving quadratic equations Prof. Alma V. Jasso	Surface Water Treatment Mr. Gerardo Pinzon	Several methods for solving quadratic equations Prof. Alma V. Jasso
	F	Exploring the universe Dr. Juan H Hinojosa	Computers, people, and programming Dr. Fuming Wu	Exploring the universe Dr. Juan H Hinojosa	Computers, people, and programming Dr. Fuming Wu	Exploring the universe Dr. Juan H Hinojosa	Computers, people, and programming Dr. Fuming Wu
Week 2	M	A deeper understanding of mathematics through mathematical puzzles Dr. Firooz Khosraviyani	Vanilla UNIX Mr. Timothy E. Bogue	A deeper understanding of mathematics through mathematical puzzles Dr. Firooz Khosraviyani	Vanilla UNIX Mr. Timothy E. Bogue	A deeper understanding of mathematics through mathematical puzzles Dr. Firooz Khosraviyani	Vanilla UNIX Mr. Timothy E. Bogue
	T	The role of mathematics and science in the business world Mr. Mario E. Moreno	Drawing with AutoCAD Prof. Miguel San Miguel	The role of mathematics and science in the business world Mr. Mario E. Moreno	Drawing with AutoCAD Prof. Miguel San Miguel	The role of mathematics and science in the business world Mr. Mario E. Moreno	Drawing with AutoCAD Prof. Miguel San Miguel



<b>W</b>	Working with geometer's sketchpad Mr. Pablo David Morales	The rock cycle: how earth materials change with time Dr. Marvin E Bennett	Working with geometer's sketchpad Mr. Pablo David Morales	The rock cycle: how earth materials change with time Dr. Marvin E Bennett	Working with geometer's sketchpad Mr. Pablo David Morales	The rock cycle: how earth materials change with time Dr. Marvin E Bennett
<b>R</b>	Polynomial and rational functions Prof. Alma V. Jasso	Exploring new worlds: the search for extrasolar planets (in Planetarium) Mr. Gerardo A. Perez	Polynomial and rational functions Prof. Alma V. Jasso	Exploring new worlds: the search for extrasolar planets (in Planetarium) Mr. Gerardo A. Perez	Polynomial and rational functions Prof. Alma V. Jasso	Exploring new worlds: the search for extrasolar planets (in Planetarium) Mr. Gerardo A. Perez
<b>F</b>	Contours and gradients Prof. Joe McCarry	Presentation of participants' experience & award of certificates	Contours and gradients Prof. Joe McCarry	Presentation of participants' experience & award of certificates	Applying statistical techniques to real-world problems Prof. Dae-Hoon Kwak	Presentation of participants' experience & award of certificates

For information of this program, visit:

<http://www.tamtu.edu/~rbachnak/STEMRRG/Files/REP%20Mathematics%20Enrichment%20Flier.pdf>

**Appendix 2. Workshop Feedback Form: STEM Recruitment and Enrichment Project (STEM-REP), Summer 2008-2009**

Review Guidelines						
<p><b>Please take a moment to complete this feedback form. Your comments will assist us in improving our future workshops and seminars.</b></p> <p><b>* This information is confidential and will only be used by the project personnel *</b></p>						
Participant Information						
<b>Name (Optional):</b>	Error! Not a valid bookmark self-reference.			<b>Date:</b>		
Evaluation						
<b>Scale:</b>	5- strongly agree;		4 – agree;		3 – neutral;	
	2 –disagree;		1 – strongly disagree			
	5	4	3	2	1	<b>Comments</b>
<b>1. Information and Communication before the workshop was timely and accurate.</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Error! Not a valid bookmark self-reference.
<b>2. The workshop was scheduled at a suitable time.</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Error! Not a valid bookmark self-reference.
<b>3. The workshop facilities and location were appropriate and satisfactory.</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Error! Not a valid bookmark self-reference.
<b>4. The workshop material was presented in a clear and organized manner.</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Error! Not a valid bookmark self-reference.



5. The staff responded to questions in an informative, appropriate and satisfactory manner.	<input type="checkbox"/>	Error! Not a valid bookmark self-reference.				
6. Handouts (if provided) were clear and useful.	<input type="checkbox"/>	Error! Not a valid bookmark self-reference.				
7. Overall, the session was valuable and added to my understanding of mathematics.	<input type="checkbox"/>	Error! Not a valid bookmark self-reference.				
8. In what ways could this workshop have been improved to better suit your needs?						Error! Not a valid bookmark self-reference.
9. Would you recommend this workshop to a friend?	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	Error! Not a valid bookmark self-reference.	
10. Please comment on how sessions helped you grasp mathematical and science concepts						Error! Not a valid bookmark self-reference.
11. Please comment on your overall experience during these sessions						Error! Not a valid bookmark self-reference.