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Cristina Villalobos

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14. ABSTRACT
The C-STEM grant had five activities. Three of the activities centered around the teaching pedagogy of Challenge-Based Instruction (CBI). Activity 2 focused on the professional development of university faculty on CBI. Activity 1 focused on the development of curricula materials for STEM university classes, while Activity 3 focused on the development of curricula materials for two STEM outreach programs: the Texas Pre-Freshman Engineering Program (TexPREP) which is a program for middle school and high school students; and the South Texas College Dual Enrollment Engineering Academy which is a high school program for students seeking dual enrollment

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Report Title

Final Report: DoD HBCU/MSI ED Center

ABSTRACT

The C-STEM grant had five activities. Three of the activities centered around the teaching pedagogy of Challenge-Based Instruction (CBI). Activity 2 focused on the professional development of university faculty on CBI. Activity 1 focused on the development of curricula materials for STEM university classes, while Activity 3 focused on the development of curricula materials for two STEM outreach programs: the Texas Pre-Freshman Engineering Program (TexPREP) which is a program for middle school and high school students; and the South Texas College Dual Enrollment Engineering Academy which is a high school program for students seeking dual enrollment. Moreover, Activity 4 was a research program for undergraduate STEM students that allowed them to conduct research under the guidance of a faculty mentor with the objective of increasing the number of students pursuing graduate degrees. Finally, Activity 5 focused on the STEM academic, professional, and career development of undergraduate and graduate students and also provided hands-on STEM activities to K-12 students.

Enter List of papers submitted or published that acknowledge ARO support from the start of the project to the date of this printing. List the papers, including journal references, in the following categories:

(a) Papers published in peer-reviewed journals (N/A for none)

Received Paper

TOTAL:

Number of Papers published in peer-reviewed journals:

(b) Papers published in non-peer-reviewed journals (N/A for none)

Received Paper

TOTAL:

Number of Papers published in non peer-reviewed journals:

(c) Presentations

Cristina Villalobos, “Student Resources at the Center of Excellence in STEM Education”, University of Texas System NSF-LSAMP Program, September 16, 2016

Cristina Villalobos, L. Martinez, L. Melara, “Applying to Graduate School”, 2016 SACNAS National Conference, October 13-15, 2016, Long Beach, CA

Number of Presentations: 0.00

Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received	Paper
03/29/2017	36 Emmett Tomai, Luis Lopez. Towards a Model-Learning Approach to Interactive Narrative Intelligence for Opportunistic Storytellling, International Conference on Interactive Digital Storytelling. 15-NOV-16, Los Angeles, CA. : ,
08/11/2014	13 Emmett Tomai, Rosendo Salazar, Roberto Flores. Mimicking Human-like Agent Movement in Open World Games with Path-Relative Recursive Splines, Association for the Advancement of Artificial Intelligence. 14-OCT-13, . : ,
08/11/2014	14 Emmett Tomai, Roberto Flores. Adapting In-Game Agent Behavior by Observation of Players with Learning Behavior Trees, International Conference on the Foundations of Digital Games. 03-APR-14, . : ,
08/30/2016	29 Dumitru I. Caruntu,Reynaldo Oyervides, Valeria Garcia. ROM OF VOLTAGE RESPONSE OF PARAMETRIC RESONANCE OF ELECTROSTATICALLY ACTUATED MEMS PLATES, ASME 2015 International Mechanical Engineering Congress & Exposition. 13-NOV-15, Houston, Texas. : ,
TOTAL:	**4**

Number of Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received		Paper
08/16/2013	7.00	Horacio Vasquez, Arturo A. Fuentes. Integration of Sensors and Low-Cost Microcontrollers into the Undergraduate Mechanical Engineering Design Sequence, American Society for Engineering Education. 23-JUN-13, . : ,
08/16/2013	9.00	Emmett Tomai, Rosendo Salazar. Simulating Adaptive Quests for Increased Player Impact in MMORPGs, AAAI Conference on Artificial Intelligence and Interactive Digital Entertainment. 08-OCT-12, . : ,
08/16/2013	8.00	Emmett Tomai, Rosendo Salazar, Roberto Flores. Simulating Aggregate Player Behavior With Learning Behavior Trees, Behavior Representation in Modeling and Simulation. 11-JUL-13, . : ,
08/19/2013	10.00	Ben R. Jurewicz. Prototyping Systems Thinking Curriculum Development for Pre-college Students, Third International Conference on Complex Systems Design & Management. 12-DEC-12, . Berlin, Heidelberg: Springer Berlin Heidelberg, Springer Berlin Heidelberg
08/24/2015	17.00	Dumitru I. Caruntu, Christian Reyes. Voltage Response of MEMS Resonators Under Simultaneous Resonances, Proceedings of International Mechanical Engineering Congress and Exposition 2014. 14-NOV-14, . : ,
08/24/2015	21.00	Stephen W. Crown, Ana Alanis, Jose Luis Chavez Jr, Joel Guadalupe Montemayor, Haidy Enid Soto. Texas Pre-freshman Engineering Program Challenged Based Instruction Curriculum Development and Implementation, 122nd American Society for Engineering Education. 14-JUN-15, . : ,
08/24/2015	20.00	Dumitru I. Caruntu, Christian Reyes. Simultaneous Resonances of Electrostatically Actuated MEMS Resonators, ASME 2014 Proceedings of International Design Engineering Technical Conferences & Computers and Information in Engineering Conference,. 17-AUG-14, . : ,
08/24/2015	19.00	Dumitru I. Caruntu, Christian Reyes. Simultaneous Resonance of Soft AC Doubly Actuated MEMS Resonators, Proceedings of 2014 Dynamic Systems & Control Conference. 22-OCT-14, . : ,
08/24/2015	18.00	Dumitru I. Caruntu, Christian Reyes. ROM of Electrostatically Actuated MEMS Resonators under Simultaneous Resonances, Proceedings of International Mechanical Engineering Congress and Exposition 2014. 14-NOV-14, . : ,
08/25/2012	1.00	Arturo A. Fuentes, Robert A. Freeman, Stephen W. Crown. Pedagogy for Pedagogy: Using Wiki to Promote the Adoption, Development, and Implementation of Challenge-Based Instruction in STEM Education, 2012 American Society for Engineering Education . 10-JUN-12, . : ,
08/25/2012	2.00	Emmett Tomai, Rosendo Salazar, Dave Salinas. Adaptive Quests for Dynamic World Change in MMORPGs, International Conference on the Foundations of Digital Games. 29-MAY-12, . : ,
08/25/2012	3.00	Emmett Tomai, Rosendo Salazar, Dave Salinas. A MMORPG Prototype for Investigating Adaptive Quest Narratives and Player Behavior, Workshop on Research Prototyping in Games. 29-MAY-12, . : ,

08/25/2012 4.00 Stephen W. Crown. Preparing and Inspiring Middle and High School Students with a Pre-Freshman Engineering Program,
American Society for Engineering Education. 10-JUN-12, . : ,

08/27/2012 5.00 Alex Martinez, Juan F. Lopez, Zhijun Qiao, Yufeng Cao. A Mathematical Model for MIMO Imaging,
SPIE Conference. 01-MAY-12, . : ,

TOTAL: **14**

Number of Peer-Reviewed Conference Proceeding publications (other than abstracts):

(d) Manuscripts

Received Paper

08/11/2014 12.00 Teresa N. Nguyen, Rohitha Goonatilake, Rafic A. Bachnak, Miguel San Miguel, Aida C. Garza. All for the Success of College Algebra,
The Mathematics Teaching-Research Journal Online (04 2013)

08/24/2015 15.00 Dorothy Owens, Aijie Han, Luyi Sun, Yuanbing Mao. Synthesis of VTMS(X)-HMS-3 mesoporous ordered silica for hydrogen storage,
International Journal of Hydrogen Energy (12 2014)

08/24/2015 16.00 Edna Garcia, Qiang Li, Xing Sun, Karen Lozano, Yuanbing Mao. TiO2 Fibers: Tunable Polymorphic Phase Transformation and Electrochemical Properties,
Journal of Nanoscience and Nanotechnology (01 2014)

TOTAL: **3**

Number of Manuscripts:

Books

Received Book

TOTAL:

Received	Book Chapter

TOTAL:

Patents Submitted

Patents Awarded

Awards

Dr. Cristina Villalobos, Recognized by the American Mathematical Society during Hispanic Heritage Month. Lathisms.org

Graduate Students

NAME	PERCENT_SUPPORTED	Discipline
Arnold Amador	0.30	
Carlos Flores	0.03	
Fernando Flor	0.12	
FTE Equivalent:	**0.45**	
Total Number:	**3**	

Names of Post Doctorates

NAME	PERCENT_SUPPORTED
FTE Equivalent:	
Total Number:	

Names of Faculty Supported

NAME	PERCENT_SUPPORTED	National Academy Member
Horacio Vasquez	0.08	
FTE Equivalent:	**0.08**	
Total Number:	**1**	

Names of Under Graduate students supported

NAME	PERCENT_SUPPORTED	Discipline
Alejandra Benitez	0.38	Environmental Science
Bilkis Martinez	0.43	Civil Engineering
Anahi Esquivel	0.38	Other-Art
Brenda Hernandez Barron	0.43	Other-Biology
Christian Julian	0.38	Other-Business Administration
Christian Manuel Duarte	0.43	Other-Computer Science
Daniel Acevedo	0.45	Other-Computer Science
Domingo Javier Villarreal	0.30	Mechanical Engineering
Isadora Luna	0.38	Other-Biology
Joel Montemayor	0.26	Mechanical Engineering
LIsa Gonzales	0.76	Other-Criminal Justice
Luis Alberto Lopez	0.33	Other-Computer Science
Luis Alvarez	0.26	Other-Business Administration
Mario Capetillo	0.38	Other-Biology
Mark Ortiz	0.26	Mechanical Engineering
Miguel Angel Palacios	0.14	Mechanical Engineering
FTE Equivalent:	**5.95**	
Total Number:	**16**	

Student Metrics

This section only applies to graduating undergraduates supported by this agreement in this reporting period

The number of undergraduates funded by this agreement who graduated during this period: 8.00

The number of undergraduates funded by this agreement who graduated during this period with a degree in science, mathematics, engineering, or technology fields:..... 7.00

The number of undergraduates funded by your agreement who graduated during this period and will continue to pursue a graduate or Ph.D. degree in science, mathematics, engineering, or technology fields:..... 0.00

Number of graduating undergraduates who achieved a 3.5 GPA to 4.0 (4.0 max scale):..... 4.00

Number of graduating undergraduates funded by a DoD funded Center of Excellence grant for Education, Research and Engineering:..... 8.00

The number of undergraduates funded by your agreement who graduated during this period and intend to work for the Department of Defense 0.00

The number of undergraduates funded by your agreement who graduated during this period and will receive scholarships or fellowships for further studies in science, mathematics, engineering or technology fields:..... 0.00

Names of Personnel receiving masters degrees

NAME
Total Number:

Names of personnel receiving PHDs

NAME
Total Number:

Names of other research staff

NAME	PERCENT_SUPPORTED
Idalia Mejia	1.00
Martha Salazar	1.00
FTE Equivalent:	**2.00**
Total Number:	**2**

Sub Contractors (DD882)

Inventions (DD882)

Scientific Progress

See Attachment

Technology Transfer

The Center of Excellence in STEM Education
The University of Texas Rio Grande Valley

Scientific Progress and Accomplishments
February 2011- December 31, 2016

Table of Contents

This section briefly describes the projects and the measurable outcomes in the five activities during the period 2011- December 31, 2016 and also summarizes the information altogether:

Activity 1: **Curriculum Reform**--supports the implementation of Challenge-Based Instruction (CBI) in selected STEM courses with DoD applications,

Activity 2: **Faculty Development Program** --supports the professional development of STEM faculty in CBI curriculum incorporating DoD applications,

Activity 3: **Student Recruitment and Outreach Activities**--supports the development of CBI curricular materials in the K-12 programs of the Texas Pre-freshmen Engineering Program and Dual-Enrollment Engineering Academy,

Activity 4: **Student Research**--supports student STEM research in DoD areas, and

Activity 5: **STEM Student and Faculty Resource Program**--creates a STEM resource program for the academic and professional development of students and faculty.

Mission of the Center of Excellence in STEM Education

The Center of Excellence in STEM Education at The University of Texas-Rio Grande Valley (UTRGV) was one of three centers funded by the U. S. Department of Defense over a period of five years from April 2011-December 2016. It was the only Hispanic Serving Institution to receive this prestigious award and recognition.

The goals of the Center are focused on *strengthening STEM academic programs and increasing the number of STEM graduates*, particularly those from underrepresented groups. As the lead institution of the grant, UTRGV collaborated with South Texas institutions: South Texas College, Texas A&M International University-Laredo, the former University of Texas-Brownsville, and the University of Texas-San Antonio. At UTRGV, the Center works closely with faculty in the College of Engineering and Computer Science and the College of Sciences.

The Center of Excellence in STEM Education builds a community of faculty, who are leaders in the teaching pedagogy of Challenge-Based Instruction, and student programs in the Science, Technology, Engineering, and Mathematics (STEM) fields. The Center supports five activities focusing on faculty professional development in Challenge-Based Instruction (CBI), the development and implementation of CBI curricular materials in pre-college student outreach activities (TexPREP and the South Texas College Dual Enrollment Engineering Academy) and undergraduate STEM curricula, undergraduate research, and the establishment of a student-faculty resource program. Furthermore, the Center of Excellence in STEM Education continues to build communities to *identify and address specific needs* to increase rates in recruitment/student outreach, enrollment, retention, and graduation in STEM fields across South Texas. In fact, the Center is rapidly growing to incorporate additional *synergistic* initiatives including STEM student scholarship programs for academically talented students, partnering with STEM university faculty and the local community in organizing STEM education symposia and seminars, and collaborating with student support units and faculty in grant proposals to better mentor students in their research and academic careers.

Impact

To date over 18,000 faculty, students and K-12 students and teachers have visited the center. The table below shows the specific breakdown in the demographics of the population as of Fall 2015.

Total number of Faculty visits	1462
Total number of UG visits	4983
Total number of K-12 Teacher visits	750
Total number of K-12 student visits	9222
Total	16,417 as of Fall 2015

Dissemination of Work

Due to our efforts, we published a total of 23 refereed papers which consisted of 5 journal papers and 18 conference proceedings all associated with STEM research and/or STEM education. Additionally, over 30 presentations were given at the national-level at professional conferences or professional meetings, and over 35 presentations were given by students at UTPA/UTRGV-affiliated conferences.

Journal Papers	5
Conference Proceedings	18
External national-level presentations	over 30
Presentations at UTPA/UTRGV-affiliated conferences	over 35

Activities

Activity I - Curriculum Reform - Dr. Robert Freeman

This activity aims to introduce the teaching pedagogy of Challenge-Based Instruction (CBI) into the STEM curriculum incorporating DoD applications to enhance student learning by providing opportunities for students to see the relevance of studies to the real world and to develop adaptive expertise.

Activity II - Faculty Development - Dr. Arturo Fuentes

The Faculty Development Program focuses on the professional development of faculty in the teaching pedagogy of Challenge-Based Instruction. This plan includes a series of training workshops and mentoring workdays for STEM faculty that will bring the latest research in effective educational methods to a large number of Hispanic and low-income students in South Texas, therefore delivering course content successfully.

Activity III - Recruitment & Outreach- Drs. Steve Crown and Horacio Vasquez

This activity focuses its efforts on the Texas Pre-freshmen Engineering Program (TexPREP) and the Dual-Enrollment Engineering Academy (DEEA). It created and developed the fourth-year TexPREP curriculum that delivers STEM content in a Challenge-Based Instruction (CBI) framework with challenges that impact DoD areas of interest. The courses have been disseminated to the collaborators as well as other programs across the state. The DEEA academy has also infused its program through the development of CBI courses.

Activity IV - Student Research – Dr. Richard Fowler

The C-STEM Student Research Program at UTRGV provides opportunities for students and faculty to conduct research together in areas of interest to the U.S. Dept. of Defense (DoD) with the goals of retaining students in STEM, increasing the number of students receiving bachelor's degrees in STEM, and increasing the number of students who enter STEM graduate programs.

Activity V - STEM Student and Faculty Resource Program – Drs. Olga Ramirez and Cristina Villalobos, and Ms. Martha Salazar

The Center of Excellence in STEM Education is a resource for UTRGV students and faculty in the Science, Technology, Engineering and Mathematics disciplines, along with K-12 students. The purpose of K-12 community outreach is to promote and encourage students in exploring careers in STEM fields and to strengthen their understanding of STEM disciplines. Students and faculty can

reserve the C-STEM and take advantage of software and equipment for use in enhancing their teaching and studies. Additionally, the Center provides workshops such as "Applying to Graduate School", "Applying for Summer Research Programs", and "Applying for Fellowships" for the professional and academic development of students.

Visit us at: www.utrgv.edu/cstem

Faculty & Staff Involved in the Center

1. Drs. Cristina Villalobos, Olga Ramirez, Sophie Wang, UTRGV School of Mathematical & Statistical Sciences
2. Drs. Robert Freeman, Arturo Fuentes, Steve Crown, Horacio Vasquez, UTRGV Dept of Mechanical Eng
3. Drs. Richard Fowler, UTRGV Department of Computer Science
4. Ms. Idalia Mejia, Administrative Coordinator
5. Ms. Martha Salazar, Project Coordinator (50% with C-STEM and 50% with HHMI)
6. Approximately 10 undergraduate students

External Collaborators

1. Dr. Rudy Reyna, Director of the TexPREP Program, UT-San Antonio
2. Dr. Rohita Goonatilake, Texas A&M International University (TAMIU) at Laredo
3. Dr. Mahmood Fathelden, South Texas College
4. Dr. Jerzy Mogilski, University of Texas-Brownsville but now with UTRGV

Some Community-Engagement Activities

1. International Museum of Arts and Science
2. McAllen Mini-Maker Faire
3. Palmfest McAllen
4. Hispanic Engineering Science and Technolgy Conference (HESTEC) Community Day and HESTEC Middle School Challenge at UTPA/UTRGV
5. Providing 30 hours of professional development to PSJA teachers (Fall 2015)
6. Providing 4 professional development workshops to local area teachers (Summer 2016)
7. Interviewed by Fox Good Day Valley regarding C-STEM and STEM Education, 2014 and 2015
8. Annual multiple UTPA/UTRGV events for faculty and students to inform them of the services at the C-STEM
9. Fossil loan from Dr. John Gerling

International Collaborations

1. In February 2015, C-STEM provided a one-week 20-hour professional development training to 10 high school teachers from Uruguay. The workshop was delivered in Spanish. C-STEM was contacted by the Texas International Educational Consortium (TIEC) in Austin, TX to deliver the workshop due to our efforts in STEM Education. In spring 2017, the Uruguayan teachers delivered a presentation to their government regarding the Challenge-Based Instruction workshop that C-STEM delivered.

Honors and Awards

National-Level

1. 2012 HENAAC Luminary Award from the Great Minds in STEM, *Cristina Villalobos*
2. Hispanics On the Move, *Hispanic Outlook*, 2013, *Cristina Villalobos*
3. 2013 Society for the Advancement of Chicanos & Native Americans in Science (SACNAS) Distinguished Undergraduate Institution Mentor Award, *Cristina Villalobos*
4. 2016 Outstanding Faculty Member in Teaching and Service Award, *American Association of Hispanics in Higher Education, Cristina Villalobos*
5. Recognized by the American Mathematical Society (AMS) during 2016 Hispanic Heritage Month, *Cristina Villalobos*. www.lathisms.org The AMS is the largest professional mathematics organization. Posters can be ordered from the AMS featuring 2016 Hispanic Heritage scientists.

University/Regional/State-Level

1. 2011 University of Texas Regents' Outstanding Teaching Award, *Robert Freeman*
2. 2011 UTPA University Faculty Excellence Award in Service, *Cristina Villalobos*
3. 2011 UTPA College of Science & Mathematics Faculty Excellence Award in Service, *Cristina Villalobos*
4. 2011 UTPA College of Engineering & Computer Science Faculty Excellence Award in Service, *Arturo Fuentes*
5. Outstanding Mentor Award, Department of Mathematics, University of TX-Arlington, 4/2011, *Cristina Villalobos*
6. 2012 University of Texas Regents' Outstanding Teaching Award, *Arturo Fuentes*
7. Outstanding Mentor Award, Department of Mathematics, University of TX-Arlington, 3/2013, *Cristina Villalobos*
8. 2013 University of Texas Regents' Outstanding Teaching Award, *Cristina Villalobos*
9. 2014 Innovation in Online Learning COLTTie Award, UTPA, Andres Padilla-Oviedo (UTPA Math)
10. 2014 UTPA College of Engineering & Computer Science Faculty Excellence Award in Teaching, *Horacio Vasquez*
11. The Senator Judith Zaffirini Award for Leadership, Service, and Scholarship at the 2013 Freshman Convocation, Texas A&M International University, Laredo, Texas, *R. Goonatilake*
12. Presidential Endowed Professorship, 2014-2016, *Cristina Villalobos*
13. 2015 University of Texas Regents' Outstanding Teaching Award, *Horacio Vasquez*
14. 2015 University of Texas Regents' Outstanding Teaching Award, Emmett Tomai (UTRGV Comp Sci)
15. 2016 University of Texas Regents' Outstanding Teaching Award, *Steve Crown*

In summary, 5 of the faculty who co-founded the C-STEM and were PI/CoPIs were awarded the University of Texas Regents' Outstanding Teaching Award.

Endowment

The Center of Excellence in STEM Education helped procure $125K from Mr. Lee Aaranson (Lack's Furniture Stores) for an endowed position in STEM Education.

Activity 1: Curriculum Reform

Objective 1: By July 2011, increase the number of fully developed Multidisciplinary CBI modules.

1. Outcome
Complete CBI Module on Power Swim Challenge (Reduction of CBI budget resulted in reduced scope. The second module per year was removed from the final proposal)

Status of Outcome (Explanation of Progress)
Power Swim Module evolving into a series/sequence of interrelated modules beginning with the "Humpback Whale" Module. **a. Four of nine modules / challenges** (ultimately comprising an entire undergraduate **Fluid Mechanics** course and based on the Humpback Whale) **completed.** **b. Eight biologically motivated challenges** (to be utilized in fall 2012 in courses in BIOL 2402 Comparative Vertebrate Anatomy and BIOL 6307 Animal Bioenergetics) **under development.**

Objective 2: By July 2012, increase the number of fully implemented Multidisciplinary LC CBI modules

2.a. Outcome
Implement CBI Module on Power Swim Challenge (Power Swim Module evolving into a series/sequence of interrelated modules beginning with the "Humpback Whale" Module.)
2.b. Outcome
Complete one new module (Power Swim Module evolving into a series/sequence of interrelated modules beginning with the "Humpback Whale" Module)

Status of Outcomes (Explanation of Progress)
2.a.1 Four Humpback Whale / Power Swim challenges implemented in a Fluid Mechanics course in spring 2012. Modest comparative assessment underway involving a control group in a second section of Fluid Mechanics taught in spring 2012. The two sections of Fluids were MECE 3315 – 01 (Experimental group with Choutapalli) and 02 (control group with Tarawneh). The experimental group had a pass rate of only 56% with a class GPA of 1.65 while the control group had a pass rate of 84% with a class GPA of 2.89. Comparative assessment of common exam problems forth coming. The biologically motivated challenges will be implemented in in fall

2012 in courses in BIOL 2402 Comparative Vertebrate Anatomy and BIOL 6307 Animal Bioenergetics. In addition, a Senior Design project investigating the effect of non-smooth leading edges on airfoil aerodynamics will be undertaken in fall 2012 and spring 2013.

2.a.2 Instead of developing a distinct second module the proposed first year "module" based on DARPA's Power Swim program assistive swimming device is evolving into a series of interrelated modules that will involve topical content including fluid mechanics, adaptive anatomy, bioenergetics, biomechanics, and mechanism synthesis and design. Current plans are to offer a new technical elective course in spring 2014. This will include selected challenges from the biology and fluids modules and to be developed curricular modules involving human biomechanics and bioenergetics, and the kinematic synthesis of an assistive swimming device incorporating non-smooth "air" foils. In addition, we will be soliciting proposals for a new DoD CBI module from faculty who have completed the CBI training of activity 2

Objective 3: By July 2013, increase retention and transition of students into graduate school and increase quality of student learning.

3.a. Outcome
Increase the number of students retained and entering graduate school by 10%.
3.b. Outcome
Complete one new implementation (continuation of the power swim suite of modules)
3.c. Outcome
Complete one new module.

Status of Outcome (Explanation of Progress)
3.a.1 The impact of CBI is also evident from the number of undergraduate students in the fluid mechanics class who expressed interest in aerodynamics research. More than 6 out of 22 (~30%) students in the CBI fluids section contacted the instructor requesting to be considered as undergraduate research assistants in his research lab (which focusses on aerodynamics and propulsion). Because of space constraints in the lab, the instructor was only able to assure four students that they could work with him as undergraduate research assistants. However, the impact of CBI in inciting interest and curiosity of the students towards aerodynamics research was vivid. 3.a.2 The Senior Design project (see 3.b.4 below) and the fluid mechanical concepts involved made a **deep impression on the group so much so that three out of the four students in the group (Jean Calzada, Oscar Hernandez, and David Cano) decided to continue with the master's program** in fluid mechanics in the mechanical engineering department. 3.a.3 Jean Calzada, Oscar Hernandez, and David Cano are continuing in the master's program and are expected to graduate in May or August 2015. John Thomas is continuing to pursue his experimental Master's Thesis dealing with the development and testing of a non-smooth leading

edge power swim foil. He is expected to graduate in August or December 2014.

3.a.4 John Thomas graduated with Thesis (Low Speed Water Tunnel Testing) in December 2014. Oscar Hernandez graduated with Thesis (Aerodynamic Flow Field Characterization of Airfoils with and without Leading Edge Modifications) in May 2015. David Cano graduated with Thesis (Wind Tunnel Flow Characterization) in August 2015. Jean Calzada is scheduled to graduate with Thesis in December 2015.

3.a.5 Jean Calzada graduated with Thesis (Pressure Field Estimation using Particle Image Velocimetry) in December 2015.

3.b.1 A set of **four new challenges** for module – applications of Navier-Stokes equations - was developed. The challenges are: 1. Coca-Cola on a roller coaster (covering fluid statics); 2. Coasting of a humpback whale (Viscosity); 3. Table-tennis ball in a funnel (for Bernoulli's equation); 4. The bumblebee and the humpback (drag and lift). These challenges were presented to the students after teaching some of the related fundamental concepts. Challenges 2, 3 and 4 were developed towards the end of the spring 2013 semester and were not implemented fully.

3.b.2 D**evelopment of a website outlining these modules / challenges is underway** and is expected to be completed by Fall 2013. The website will provide a source of reference for fluid mechanics to mechanical engineering students as well as students from other disciplines.

3.b.3 In Spring 2013, a **comparative assessment of common exam questions** was carried out between two sections of the fluid mechanics course, one with CBI and the other without. In the section with CBI, 81% (average) of the students answered the common exam problems correctly and the overall course pass rate was 95%. Results from control class to be determined.

3.b.4 In addition to implementing Fluid Mechanics CBI in the class room, a **senior design project based on the humpback whale module was completed** by group of four students. The goal of this project was to apply the concepts the students learnt in fluid mechanics to build and analyze a model pectoral fin of the humpback whale. The senior design group focused on properties such as drag, lift, and stall angle for fins that were designed with and without the leading edge bumps. A flow visualization study of the fins was conducted in the low-speed wind tunnel of the mechanical engineering department. The senior design group found that the presence of these leading edge modifications altered the fluid flow over the wing dramatically as compared to the smooth wing.

3.b.5 A Master's degree student in Mechanical Engineering is pursuing a Thesis on the experimental design and testing of the effects of non-smooth leading edge air-foils/fins on a facsimile of the power-swim device in a water tunnel.

3.b.6 The developer of the Humpback Whale fluid mechanics challenges (Dr. Isaac Choutapalli) was awarded an Air Force Research Laboratory (AFRL) summer faculty fellowship for his proposal "Vortex Dynamics and Aerodynamic Characterization of High Lift Low Drag Airfoils with Surface Modifications. The idea for the proposal was a direct offshoot of the CBI work for the fluid mechanics course.

3.b.7 The Bullet Proof Vest design module was implemented in Probability and Statistics courses (MATH 2330 – UTPA [20 students], MATH 1442 – STC [18 students]) and Organic Chemistry courses (CHEM 2303 – UTPA [37 students], CHEM 2425 – STC [23 students]) in fall 2013 at UTPA and in spring 2014 at STC. This first implementation(s) has served as a learning experience for planned implementation in fall 2014. In fall 2014 the implementation will specifically address the three main shortcomings previously experienced; a stronger collaboration commitment by the instructors to ensure interaction among the Math and Chemistry students at both UTPA and STC, a more structured research assignment process to keep the various student groups on point, and a stronger emphasis on continuous collaboration between student groups via electronic means (Blackboard).

3.b.8 The Bullet Proof Vest Module was implemented again at UTPA in two sections of Math 2330 Elementary Probability and Statistics, one face to face with 31 students and one online with 55 students. It was also implemented again at STC and involved 45 students in Organic Chemistry and 60 in statistics.

3.b.9 The Sociopolitical Infrastructure Sustainability module was pilot tested in spring 2015 in one section of a UTPA university core course POLS 2314 (US and Texas Government and Political Science) with around 40 students.

3.b.10. The Bullet Proof Vest Module was implemented again at STC. Involvement to date includes 77 students in Organic Chemistry and 83 students in Elementary Probability and Statistics.

3.b.11. Initial implementation of the Engineering Analysis challenges in summer 2016 involved 6 students.

3.b.12. The new Cyber Security CBI modules will begin implementation this fall 2106 and will involve at least 30 students.

3.c.1 A new module concerning Bullet Proof Vest design has been initiated. The current challenge statement is; "The Department of Defense has approached you and asked that you use what you learned in your Chemistry courses to design a lighter, tougher bulletproof vest that can be used by law enforcement and my the military in combat missions. Currently, bulletproof vest are bulky and heavy which can be problematic for users of the vests to perform their missions effectively. Research ways you can design and produce bulletproof vests that are lighter, yet strong enough to perform the function of stopping bullets or other projectiles." The broad learning objectives for the module include polymer chemistry and statistics. The development team is comprised of Chemistry faculty (Dr. Javier Macossay – UTPA and Dr. Oscar Rodriquez – STC) and Math faculty (Mr. Andres Padilla Oviedo – UTPA and Mr. John Garcia – STC). The module and its associated challenges will be implemented (as appropriate) in the following three courses; Organic Chemistry, Polymer Chemistry and Statistics.

3.c.2 A new module dealing with Sociopolitical Infrastructure Sustainability is under development. Three faculty, one from Computer Science, one from Civil Engineering, and one from Political Science, and their three students are developing an interactive game dealing with how we as a society determine how to expend our resources to impact and or mitigate manmade or natural disasters. The associated module will be pilot tested in fall 2014 in POLS 2314, US and Texas Government and Politics, one of the university's core courses required of all students. It is expected that this module will eventually be adopted by all sections of this course and hence will impact all students at the university.

3.c.3. Development of the Sociopolitical Infrastructure Sustainability module continued development. Discussions with new leadership in the Political Science Department are beginning with the aim to implement the SocioPolitical CBI Game module in more sections of POLS 2314. More detail concerning this module: As a CBI challenge introducing the interplay between engineering and policy issues in a federalist system, we developed a prototype in-class game. The students competed in groups to complete a bridge construction approval process. In each phase of game play, the students discussed and voted on a set of *proposal cards* to include or omit from their bridge project proposal. Each student was given a secret *interest group* to represent. The students had to try and maximize meeting the goals of their own interest group, while successfully agreeing as a group on a valid proposal. This required that they pass at least a minimum number of required elements, such as the construction material and the sources of funding, and that the funding was sufficient to complete the project. Different proposal cards helped or hurt various interest groups, and also placed constraints on each other, such as requiring more funds, being mutually exclusive with other proposal cards, or requiring other proposal cards. In this way, the game sought to represent the conflicts and alliances possible between local, regional and state entities.

This *paper prototype* of what ultimately would be designed as a digital game allowed us to begin to explore the effectiveness of the simulation. Three of the four groups completed a valid proposal, with clear winners in terms of advancing the agendas of their interest groups. Discussion in those groups was lively and in some cases even heated, as the quality of life in poor communities was pitted against broader economic interests. However, it was also difficult in the paper format for the students to manage the large flow of information. A next step paper prototype would have to simplify the game further in order to get at the heart of the debates. An eventual digital version could re-expand information delivered on-demand on mobile devices.

3.c.4. A new suite of challenges concerning content normally covered in Calculus III and Linear Algebra is being developed by a team consisting of a math and mechanical engineering faculty for a course MECE 3449, Mechanical Engineering Analysis I.

3.c.5. A new module concerning Biomechanics is being developed by a team consisting of one faculty member, two graduate students, and one undergraduate student. The initial challenge is "would you recommend the wall squat as a rehabilitation exercise after ACL and/or PCL surgery?" This challenge will involve the integrated use of a state of the art motion analysis system, force plate, and EMG measurement. It is planned to implement this module once a year to around 30 interdisciplinary students pursuing a bioengineering minor within the college of engineering and computer science starting fall 2017.

3.c.6. As cyber security has become a major societal issue at the intersection of technology, economy, politics and ethics a new suite of CBI modules focused on Cyber Security is being developed for implementation in the (multi-disciplinary) two course introductory Computer Science sequence CS 1 & 2 using the Python programming language (instead of C++). As an example of a summary challenge, students will be given a large binary dump of (simulated) everyday internet traffic and challenged to determine what information is vulnerable to automated attack, and what security measures could be employed to protect it. Along the way they will learn the science and technology behind digital networks, encoding and encryption. They will also become familiar with the current legal and ethical landscape through research and discussion.

The suite of challenges for CS I & CS II expanded beyond the initial cyber-security challenge.

The pilot CS I course in Fall 2016 used Challenge-Based Instruction with an alternative programming language (Python instead of C++) to emphasize engagement with real-world problems. Introductory programming courses often "lose the forest for the trees" due to the large amount of basic skills that have to be learned prior to engaging with significant problems. Using CBI helped our students engage with big problems, decompose them down to critical questions and from there motivate the learning of specific concepts and skills. The Python language allowed them to focus on computational thinking and problem solving at a higher level of abstraction. Through the CS I section, challenges included entrepreneurship (the Roomba vacuum robot, data visualization for product pricing), cyber-security (spies sending encoded and encrypted data, surveillance packet sniffing), artificial intelligence (game playing and finding hiking paths) and multimedia (digital image processing, procedural image generation and music playback). We are collecting data on motivation and performance for the students from that CS I class at the CS II level and beyond. One significant initial finding is that roughly a month into CS II, the CBI/Python students are just as good at C++ as the students who took a traditional C++ CS I course. This means that at the very least, the CBI/Python approach exposed them to bigger problems and another programming language without in any way disadvantaging them in traditional C++ work at the next level.

Activity 2: Faculty Development Program

Objective 1: To provide STEM faculty in South Texas with training in CBI instructional methods that positively impact the delivery of course content to STEM majors.

Objective 2: To provide a structured mentoring environment for STEM faculty where best practices and resources in CBI are shared for course development.

Objective 3: To encourage and support widespread faculty development of STEM course content (based on the use of DoD relevant applications) through activity participant stipends and access to development resources and activities.

Objective 4: To encourage and support widespread faculty development of STEM course content through activity participant stipends and access to development resources and activities.

1. Outcome
By March 2014, 40 more STEM faculty from UTPA, STC, UTB, and TSTC will have attended the first and second of a total of eight two-day CBI workshops.

Status of Outcome (Explanation of Progress)
Twenty and twenty four STEM faculty members attended the faculty development workshops at UTPA and UTB in the Fall 2013 and Spring 2014 semesters respectively. While the STEM areas represented in the UTPA Fall 2013 faculty development workshop were Biology (1 faculty), Mathematics (8 faculty), Engineering (2 faculty), Chemistry (5 faculty), Education (2 faculty), Political Science (1 faculty) and Physics (1 faculty); the STEM areas represented in the UTB Spring 2014 semester workshop were Mathematics (14 faculty), Engineering (4 faculty), Chemistry (1 faculty), Biology (1 faculty), and Computer Science (4 faculty). The faculty members' names and disciplines are provided in the table of Academic Year 2013-2014 faculty supported through workshops; see Appendix.

2. Outcome

By March 2015, 40 more STEM faculty from Laredo CC, Texas A&M International-Laredo, Texas A&M-Kingsville, and Texas A&M-Corpus Christi will have attended the third and fourth of a total of eight two-day CBI workshops.

Status of Outcome (Explanation of Progress)

Twenty seven and nineteen STEM faculty members attended the faculty development at Texas A&M International University (TAMIU) and Texas A&M Corpus Christi (TAMUCC) in the Fall 2014 and Spring 2015 respectively. In addition to the two scheduled workshops for academic year 2014-15, the Center of Excellence in STEM Education (C-STEM) sponsored an additional UTB and UTPA workshop about Inquiry based learning during the summer 2015. This workshop targeted UTPA and UTB faculty who have will now work together under the University of Texas-Rio Grande Valley. Fourteen UTPA faculty and nine UTB faculty from science, mathematics and engineering attended and benefited from this additional workshop.

The Challenge based Instruction faculty development pre-workshop, workshop, and workday at Laredo, TX took place in TAMIU on Oct. 24th, November 7-8th and December 5th respectively. Eighteen TAMIU and nine Laredo Community College (LCC) faculty members attended the workshop. The STEM areas represented in the TAMIU workshop were Biology (2 faculty), Mathematics (17 faculty), Engineering (3 faculty), Chemistry (3 faculty), and Physics (2 faculty). The faculty members' names and disciplines are provided in the table of faculty supported through workshops; see Appendix.

The Challenge based Instruction faculty development pre-workshop, workshop, and workday at Corpus Christi, TX took place in Texas A&M Corpus Christi (TAMUCC) on March 13th, March 19-20th and May 8th respectively. As previously mentioned, nineteen TAMUCC faculty members attended the workshop. The STEM areas represented in the workshop were Mathematics (2 faculty), Engineering (6 faculty), Chemistry (2 faculty), Biology (2 faculty), Computer Science (3 faculty), and other Life Science and Physical Sciences (4 faculty). The faculty members' names and disciplines are provided in the table of faculty supported through workshops; see Appendix.

In terms of assessment and evaluation, our continuous quality improvement efforts that include different participants' surveys indicated the CBI workshops are effective.

3. Outcome

By March 2013, the "Teaching Toolbox" online resource will be updated to include a variety of CBI support tools and at least five examples of best practices implemented.

Status of Outcome (Explanation of Progress)

The teaching toolbox has been updated with examples developed by the participants of the first workshop. So far, the examples below have been highlighted as exemplars of CBI course content at *http://en.wikiversity.org/wiki/UTPA_STEM/CBI_Courses*:

- Thermal_Systems_Design_and_Optimization/Economics
- Manufacturing_Processes_Lab
- Introduction to STEM
- Foundations of Life Sciences
- Statistics

The first two examples were chosen because they are good examples to show first time implementation of CBI for beginners that are not threatening to faculty and students. The scope and complexity of these challenges fit within the context of a single lecture and would demonstrate typical cost and learning outcomes of CBI. The third exemplar illustrates the success of the wiki environment where a user goes beyond the expectations by posting multiple challenges on the STEM CBI wiki website. The fourth and fifth challenges are examples challenges from our latest faculty development workshops.

The methods used to develop and promote the teaching toolbox site and the significant materials and templates developed were disseminated at the American Society for Engineering Education Annual Conference in San Antonio, Texas on June 2012 (see reference below). Furthermore, a novel example of challenge based instruction developed at UTPA was presented this summer in the American Society for Engineering Education Annual Conference in Atlanta, Georgia on June 2013 (see reference below)

Crown, S., *Fuentes, A.A.*, and Freeman, R.,A, "Pedagogy for Pedagogy: Using a Wiki to promote the adoption, development, and implementation of Challenge Based Instruction in STEM education", Proceedings of the 2012 ASEE Annual Conference and Exposition, San Antonio, Texas, June 10-13, 2012.

Vasquez, H.; Fuentes, A.A., "Integration of Sensors and Low-Cost Microcontrollers into the Undergraduate Mechanical Engineering Design Sequence", Proceedings of the ASEE Annual Conference and Exposition, Atlanta, Georgia, June 23-26, 2013.

A short video about CBI implementation and additional information about the challenges faced and successes experienced in adoption of the CBI pedagogy has been uploaded to the C-STEM website (www.utrgv.edu/cstem) .

4. Outcome

In order to further encourage and support widespread faculty development of STEM course content through activity participant stipends and access to development resources and activities:

By May 2016, a regional CBI conference will be held at UTRGV to facilitate the permeation of CBI through short introductory presentations from 20 STEM faculty (previous workshop participants).
By December 2016, 20 more STEM faculty from UTRGV and STC will have attended a final CBI workshop.

Status of Outcome (Explanation of Progress)

Twenty two STEM faculty presenters attended the faculty development CBI conference at UTRGV Spring 2016 semester. The STEM areas represented in the UTRGV CBI conference were Biology (2 faculty), Mathematics (8 faculty), Engineering (10 faculty), Chemistry (1 faculty), and Physics (1 faculty) The faculty members' names and disciplines are provided in the table of Academic Year 2015-2016 faculty supported through workshops; see Appendix.

The CBI final workshop took place at UTRGV for STEM faculty from UTRGV (UTPA, UTB) in the Fall 2016 semester. Specifically, the Challenge based Instruction faculty development pre-workshop, workshop, and workday at Edinburg, TX took place in UTRGV on Oct. 21st, October 28-29th and December 2th, respectively. Nineteen UTRGV STEM faculty members attended the workshop. The STEM areas represented in the UTRGV workshop were Biology (1 faculty), Computer Science (2 faculty), Mathematics (4 faculty), Engineering (8 faculty), Chemistry (3 faculty), and Physics (1 faculty). The faculty members' names and disciplines are provided in the table of faculty supported through workshops; see Appendix.

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The Center of Excellence in STEM Education
The University of Texas- Rio Grande Valley

Academic Year 2016-2017
Faculty Participants in the Challenge-Based Instruction
Professional Development Workshops

The faculty members below were supported through a stipend by the funding agreement during the reporting period August 1, 2016 - December 31, 2016 for attending professional development workshops on the pedagogy of Challenge-Based Instruction (CBI).

The University of Texas Rio Grande Valley (UTRGV) CBI Workshop

Challenge Based Instruction Faculty Development Pre-workshop	Oct. 21, 2016
Challenge Based Instruction Faculty Development Workshop	Oct. 28-29, 2016
Challenge Based Instruction Faculty Development Workday	Dec. 2, 2016

Faculty Name	Institution	Discipline
Thanh Vu	UTRGV	Civil Engineering
Aaron Greenwood	UTRGV	Civil Engineering
Vesselin Vatchev	UTRGV	Mathematics
Javier Macossay	UTRGV	Chemistry
Noe Vargas H	UTRGV	Mechanical Engr.
Jose Ponce	UTRGV	Mathematics
Zaena Zamora	UTRGV	Mathematics
Kristina Vatcheva	UTRGV	Mathematics
Isaac Choutapalli	UTRGV	Mechanical Engr.
Jorge Luis Canchola	UTRGV	Biology
Ruben Ortega	UTRGV	Physics
Nazmul Islam	UTRGV	Electrical Engr.
Megan Strait	UTRGV	Computer Science
Andrew Winslow	UTRGV	Computer Science
Ben Xu	UTRGV	Mechanical Engr.
Jazmin Ley	UTRGV	Mechanical Engr.
Tulay Atesin	UTRGV	Chemistry
Abdurranhman Atesin	UTRGV	Chemistry
Thang Pham	UTRGV	Civil Engineering

Activity 3: Student Recruitment and Outreach Activities

Objective 6: Offer 4th year TexPREP program at the three South Texas sites

6.a. Outcome
20 students will participate in the 4th year TexPREP program using the developed materials.
6.b. Outcome
Assessment data collected.

Status of Outcomes (Explanation of Progress)
6.a. With the DoD grant, the 4th year curriculum for the Tex-PREP program was developed which consisted of a cyber security course, an Introduction to Engineering course, career development, and a computer science coding class, for example. The 4th year curriculum was used at 8 PREP sites (five sites in addition to UTPA/UTRGV, UTSA and TAMIU). The 4th year curriculum was improved and expanded throughout the year in preparation for the 2016 summer program. The developed materials were made available to all of the TexPREP sites (approx. 35 sites) through an E-Community on the internet dedicated to TexPREP and through training workshops offered early in the summer. A total of 13 sites (UTPA/UTRGV, TAMIU, and UTSA plus 10 others) across the state of Texas offered the 4th year TexPREP program due to the initial efforts of the U.S. DoD grant. From Summer 2012-Summer 2016, a total of 1,019 4th year TexPREP students participated. The 4th year program has been approved by the Texas Education Agency (TEA) as a high school science elective credit. 6b. Students using the 4th year CBI curriculum developed under the grant were given pre and post course surveys. The assessments were administered to 4th year students at UTPA and at Texas Tech. IRB approval for the surveys was obtained and permission forms from parents and students were collected for UTPA students. Survey results will be presented under the evaluation plan.

Objective 7: Disseminate 4th year curriculum to all sites.

7. Outcome
All 35 TexPREP sites have access to the 4th year curriculum at the fall director's meeting.

Status of Outcomes (Explanation of Progress)
7. The 4th year program has been approved by the Texas Education Agency (TEA) as a high school science elective credit.

Activity 3: Dual Enrollment Engineering Academy

Objective 6: By July 2015, continue offering the "Introduction to STEM" course at the Dual Enrollment Engineering Academy (DEEA) program at two campuses of South Texas College.

4.a. Outcome
Acquire equipment and components for hands-on activities in electronics, renewable energy, statics, dynamics, and chemistry for the DEEA program.
4.b. Outcome
60 new students will be enrolled in the course each year.

Status of Outcome (Explanation of Progress)

4.a. Equipment such as breadboards and electronic components like resistors, motors, switches, Arduinos, LEDs, color wires, and similar, to keep plenty of them available for students to complete their work in the "Introduction to STEM" courses, and to replace expendable items. The "Introduction to STEM" course was completed.

4.b. During the grant period, a total of 167 high school students participated in the DEEA program. The breakdown is below:

	Total DEEA	Weslaco Campus	McAllen Pecan Campus
Summer 2012	40	17	23
Summer 2013	31	14	17
Summer 2014	27	14	13
Summer 2015	34	16	18
Summer 2016	35	11	24
Total	**167**		

Student participation is limited to 24 students in each group due to the size of the labs and the group structure of having 8 groups of 3 students each working on the hands-on activities. Therefore, we expected to get at most 48 new students per year involved in the DEEA program taking the "Introduction to STEM" course during the summers. It was difficult have 48 students in the DEEA program because some students potentially accepted to DEEA decided not to take classes in the summer because of numerous reasons.

Below is a list of the topics and timeline of the "Introduction to STEM" course covered in the DEEA summer program.

Besides the CBI activities, the "Introduction to STEM" course consisted of activities to study other fundamental STEM topics such as engineering professions and responsibilities, scientific method, and engineering design process, units and unit conversions, problem solving techniques, and graphing and data presentation. The following table presents the topics and timeline of the course which is simultaneously taught at two campuses. The class met for 4 hours/day during 15 days.

Topics and timeline of the Introduction to STEM course at DEEA

Green—classes taught by Dr. H. Vasquez; Yellow—classes taught by STC Faculty

Date	TOPIC at Pecan Campus	TOPIC at Mid-Valley Campus
1 W 7/13	What is STEM? Bridge Failure Challenge (Statics CBI)	Engineering Professions. Scientific Method. Engineering Design. Data Presentation and Graphing Experiment.
2 R 7/14	Teamwork Skills. Bridge Failure Challenge (Statics CBI)	Dimensions, Units, and Conversions. Problem Solving.
3 F 7/15	Funding your Education. Mindstorm Racer Challenge (Gears and Torque and the engineering design process)	CBI: Basic Electronics.
4 M 7/16	Mindstrom Shuttle Race Challenge (Programming mindstroms, motors, and predicting system performance via testing).	CBI: Engineering Economics. Data Presentation and Graphing Lab.
5 T 7/17	STEM Job Functions and Major Fields Mindstorm Shuttle Race with Sensors challenge. (Programming mindstroms, using flow charts in programming, sensors, programming loops and logic).	CBI: Energy and Power.
6 W 7/20	Work Experience, PE Registration, professional organizations. Mindstorm Shuttle Race with Sensors challenge. (Programming mindstroms, using flow charts in programming, sensors, programming loops and logic).	CBI: Solar Energy.
7 R 7/21	Engineering Professions. Scientific Method. Engineering Design. Data Presentation and Graphing Experiment.	What is STEM? Bridge Failure Challenge (Stati CBI)
8 F 7/22	Dimensions, Units, and Conversions. Problem Solving.	Teamwork Skills. Bridge Failure Challenge (Statics CBI)
9 M 7/23	CBI: Basic Electronics.	Funding your Education. Mindstorm Racer Challenge (Gears and Torque and the engineerir design process)
10 T 7/24	CBI: Engineering Economics. Data Presentation, and Graphing Lab.	Funding your Education. Mindstorm Racer Challenge (Gears and Torque and the engineerir design process)
11 W 7/27	CBI: Energy and Power.	Mindstrom Shuttle Race Challenge (Programming mindstroms, motors, and predicting system performance via testing).
12 R 7/28	CBI: Solar Energy.	STEM Job Functions and Major Fields Mindstorm Shuttle Race with Sensors challenge. (Programming mindstroms, using flow charts in programming, sensors, programming loops and logic).

Five activities in CBI were completed at each campus. One was about basic electronics, another about electronics with integrated circuits, another about engineering economics; the next one was about trusses and bridges, and the last one about programming Mindstorms systems. All of them involving most of the following steps or activities:

a) A pretest
b) A handout with background information and instructions for a hands-on activity, and also with generate ideas, measurements, conclusions, and go public sections.
c) A lecture
d) A hands-on activity or experiment
e) An in class or computer lab assignment to analyze the experimental results and to test theoretical knowledge.
f) Reporting results by turning the handout with solutions and conclusions
g) A post-test

Following are a description of one of the challenges developed for and implemented in the course.

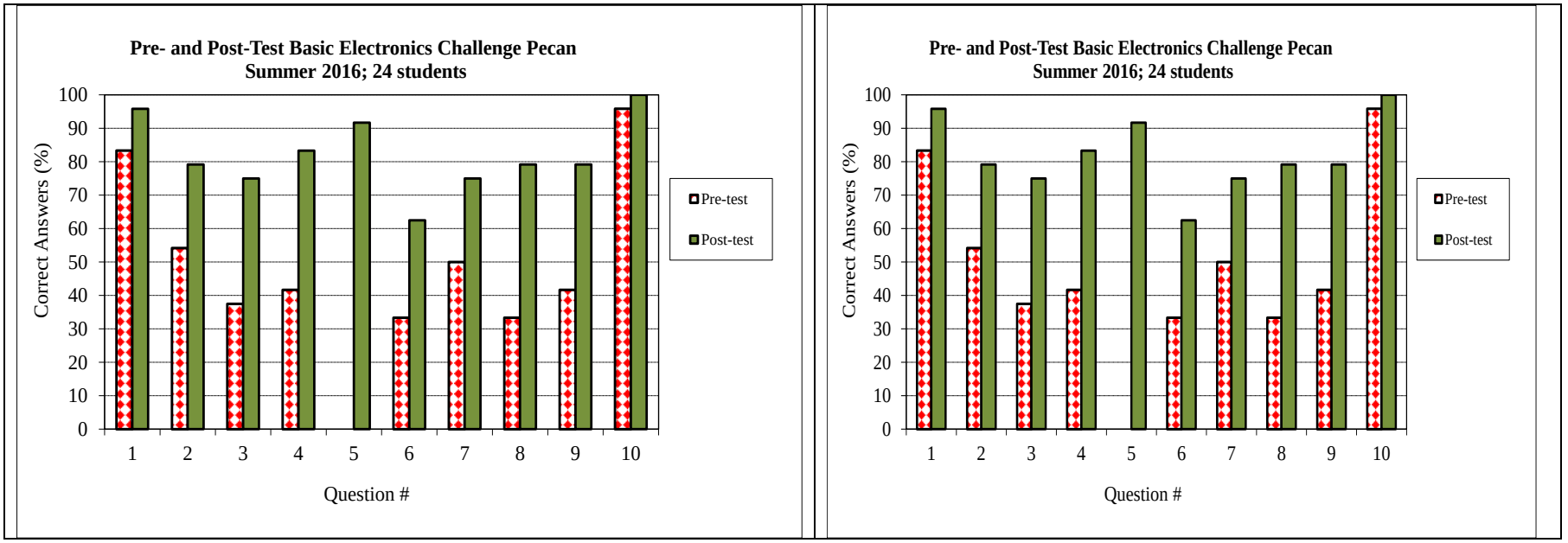
Challenge 1: Video Game System

You are an electromechanical engineer working for a company that is planning to release a new video game system in two weeks. You supervisor asked you to inspect LED circuits that are malfunctioning. It is your job to get the LED circuits inspected and running in order to meet the deadline to release the system. The company is planning to sell millions of video game systems and your future job depends on executing such plan at perfection. Below are the results for the latest summer 2016 DEEA cohort.

Pre-test results (24 students at Pecan): 47.1%; Post-test: 82.1%
Pre-test results (11 students at Weslaco): 28.2%; Post-test: 69.1%

A great improvement was obtained from pre-test to post-test, in particular with the STC Pecan group. It was noticed that for the pre-test that the results were low as an indication that most of the students were just guessing the answers. Also, the assessment consisted of the following 10 questions. Students not only have to understand the concepts, but also identify or remember the correct relationship among parameters to find the correct equation needed to compute the results. More practice and time might be required for all the students to be able to solve this type of problems.

The specific results of the pre- and post-test assessments of this basic electronics challenge performed by 35 students in Introduction to STEM are presented in the following graphs.



It can be noticed that there is improvement in knowledge in all of the 10 questions. The results of the pre-tests were in general low because these are topics that very few of the new DEEA students have previously studied. Therefore, the challenges have been useful activities that make good contributions to learn these new concepts. It is also important to mention that students at the two different campuses obtained similar results.

In summary, handouts, pre-tests, post-tests, lectures, hands-on activities, equipment and instrumentation setups form part of the CBI activities performed in the "Introduction to STEM" course at DEEA-STC.

Activity 4: Student Research

The following provides a summary of 1. Objectives and 2. Publications and Presentations during the 2011-2016 period of funding.

1. Objectives

Objective 1: Increase retention and timely graduation of students participating in undergraduate research.

1a. Outcome
Participant retention will exceed university-wide STEM retention by 20%.
1b. Outcome
80% of participants will graduate in less time than university average

Status of Outcome
1a. 100% of program participants were retained or graduated during the reporting period, exceeding the university-wide STEM retention by well over 20%. Note: Funding was provided for eight participants for a full academic year (fall, spring, and summer semesters). Some participants received funding for only part of the year for a variety of reasons, e.g., conducting research at other institutions during the summer, illness. When a participant was not available for a semester, the funding for that participant was utilized for a replacement. This results in more than eight individual students, including replacements, receiving support and participating in the program's activities. Outcome assessment is reported in terms of the eight participants who participated two or more semesters in an academic year. 1b. During the project, 31 participants graduated, and of those graduating 74% graduated in less time than the university average. Four participants from the project's final year continue in their undergraduate studies.

Objective 2: Train students in preparation of research results reports.

2a. Outcome
80% of participants will display posters in HESTEC undergraduate research competition
2b. Outcome
80% of participants will make presentations at program's annual research conference

Status of Outcome
2a. 100% of participants displayed posters in the HESTEC undergraduate research competition. 2b. 100% of participants made presentations at the program's annual research conference. The presentations were made to faculty mentors and STEM faculty generally, Center activity directors, and other students.

Objective 3: Increase student participation in summer research experiences at other institutions and research facilities.

3a. Outcome
50% of program participants will engage in research programs at other institutions, DoD, and research facilities

Status of Outcome
For participants who did not graduate prior to the summer, 18% participated in summer research experiences outside the region and 52% traveled to participate in conference research experiences. The larger goal for this objective was to expose students to disciplinary activities outside their regional experience. In practice the attendance of research conferences served to be a more effective means to accomplish this goal.

Objective 4: Increase the number of STEM students seeking graduate degrees.

4a. Outcome
30% of program participants will enroll in graduate programs within two years of graduation.

Status of Outcome (Explanation of Progress)
74% (23/31) of participants who have graduated have enrolled in graduate programs in the STEM disciplines, and 10 have received Master's degrees. Student research and the program supplied activities proved very successful in motivating undergraduate students and providing the skills for continuation to graduate studies.

2. Publications and Presentations

The list is grouped by program year.

2011-2012

Helen Vanderpool, Rene Solano, Jesse Rivera, Robert Dearth. Exposure to Low-level Arsenic (As) During Pubertal Development Suppresses Circulating Insulin-like Growth Factor-1 (IGF-1) and Delays Mammary Gland Differentiation in Female Rats. Other Institutions of Higher Education (OIHE) – Minority Serving Institutions (MSI) Symposium, Edinburg, Texas. Feb 20-21st .

Tomai, E., Salazar, R. and Salinas, D. 2012. Adaptive Quests for Dynamic World Change in MMORPGs. In Proceedings of the International Conference on the Foundations of Digital Games 2012.

Tomai, E., Salazar, R. and Salinas, D. 2012. A MMORPG Prototype for Investigating Adaptive Quest Narratives and Player Behavior. In Proceedings of the Workshop on Research Prototyping in Games 2012.

Tomai, E. and Salazar, R. 2012. Simulating Adaptive Quests for Increased Player Impact in MMORPGs. In Proceedings of the Eight International Conference on Artificial Intelligence and Interactive Digital Entertainment.

V. Valle and H. Leo. "Applications of Convex Optimization to Weighted Generalized Fermat-Torricelli and Heron Problems." Emerging Researchers National. Atlanta, GA. 24 Feb. 2012. Poster presentation.

V. Valle and H. Leo. " Applications of Convex Optimization to Weighted Generalized Fermat-Torricelli and Heron Problems. " OIHE-MSI Symposium. Edinburg, TX. 21 Feb. 2012. Poster presentation.

Cloning and Characterization of EF-Tu and EF-Ts from *Pseudomonas aeruginosa,* Stephanie Palmer, Alexis Tran, Albert Montalvo, Edna Rangel, James M. Bullard, Department of Chemistry, The University of Texas-Pan American.

Garcia, Edna, "Metal oxide nanofibers produced by a ForceSpinning method for battery electrodes", poster to be presented at the 244th American Chemical Society National Meeting,Philadelphia, PA, August 19-23, 2012.

Yufeng Cao, Juan F. Lopez, Jr., Alex Martinez and Zhijun Qiao, "A mathematical model for MIMO imaging", Proc. SPIE 8393, 839308 (2012);http://dx.doi.org/10.1117/12.918920

2012-2013

Tomai, E., Salazar, R. and Flores, R. (2013). Simulating Aggregate Player Behavior With Learning Behavior Trees. In B. Kennedy, D. Reitter, R. St. Amant (Eds.), Proceedings of the 22nd Annual Conference on Behavior Representation in Modeling and Simulation. Ottawa, Canada: BRIMS Society. pp 56-63. https://cc.ist.psu.edu/BRIMS2013/archives/2013/BRIMS2013-119.pdf

Tomai, E. and Salazar, R. (2012). Simulating Adaptive Quests for Increased Player Impact

in MMORPGs. In Proceedings of the Eight AAAI Conference on Artificial Intelligence and Interactive Digital Entertainment. pp 185-190.
http://www.aaai.org/ocs/index.php/AIIDE/AIIDE12/paper/view/5471

Tomai, E., Salazar, R. and Flores, R. (in press, October, 2013). Mimicking Human-like Agent Movement in Open World Games with Path-Relative Recursive Splines. To appear in Proceedings of the Ninth AAAI Conference on Artificial Intelligence and Interactive Digital Entertainment.

S. O. Palmer, E. Y. Rangel, A. T. Tran, Y. Hu and J. M. Bullard, "Two Homologous EF-G Proteins from *Pseudomonas aeruginosa* Exhibit Distinct Functions" (2013), *Biochemistry*.

S.O. Palmer, E.Y. Rangel, A.E. Montalvo, A.T. Tran, K.C. Ferguson, J.M. Bullard, "Cloning and Characterization of EF-Tu and EF-Ts from *Pseudomonas aeruginosa*" (2013), *Biomed Research International*.

Edna Garcia, Qiang Li, Xing Sun, Karen Lozano, and Yuanbing Mao, "Large-scale ForceSpinning synthesis of TiO2 nanofibers with electrochemical enhancement through tunable polymorphic phase transformations", (manuscript in preparation).

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Activity 5: STEM Student and Faculty Resource Program

January 1, 2012 through December 31, 2016

Objective 1
The SFRP (Student & Faculty Resource Program) will utilize the 2D display wall at least 20 times annually, with steady increases in subsequent years.

Status of Outcome:

1a. Outcomes: The SFRP (Student & Faculty Resource Program) utilized the 2D wall numerous times and it was used 386 times for special presentations in the duration of the grant. This number of presentations does not include attendants to other 2D wall presentations conducted for other listed objectives.

	IPR Number of Events	**IPR Number of Attendees**	**Date**	**Objective**
Total	386	4,640	1/1/2012-12/31/2016	1a

Objective 1b
The SFRP will offer at least 10 STEM recruitment and orientation sessions annually given to high school student programs and entering freshmen.

Status of Outcome:

1b. Outcomes: The SFRP offered 328 recruitment and orientation sessions to high school students and entering freshmen impacting a minimum of 20,270 attendants. In addition to high school students, the SFRP also provided STEM recruitment presentations to K-8 students. In the list of outcomes below, presentations were done by the C-STEM faculty directors and staff, unless otherwise indicated.

	IPR Number of Events	**IPR Number of Attendees**	**Date**	**Objective**
Total	328	20,270	1/1/2012-12/31/2016	1b

Objective 2a
The SFRP will offer 6 focused workshops on STEM career development and graduate school per year.

Status of Outcome:

2a. Outcomes: The SFRP (Student & Faculty Resource Program) offered 175 STEM career development and graduate school presentations impacting a minimum of 4,655 attendants. In the list of outcomes below, presentations on STEM career development and graduate school presentations were done by the C-STEM faculty directors and staff, unless otherwise indicated.

	IPR Number of Events	**IPR Number of Attendees**	**Date**	**Objective**
Total	175	4,655	1/1/2012-12/31/2016	2a

Activity 5: STEM Student and Faculty Resource Program

Objective 2b
The SFRP will increase the number of students attending STEM summer research programs by 5% with steady increases in subsequent years.

Status of Outcome:

2b. Outcomes: The SFRP (Student & Faculty Resource Program) offered 63 STEM summer research program presentations impacting a minimum of 795 attendants. This has resulted in encouraging students to attend STEM summer research programs. In the list of outcomes below, presentations to assist in increasing STEM summer research programs were done by the C-STEM faculty directors and staff, unless otherwise indicated.

	IPR Number of Events	**IPR Number of Attendees**	**Date**	**Objective**
Total	63	795	1/1/2012-12/31/2016	2b