STEM Pathways Growth and Support for College Dual-Enrollment Programs

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Abstract

This paper describes support activities for science, technology, engineering, and math (STEM) pathways in college dual-enrollment programs. In particular, it presents information about one of the first steps in this initiative consisting of a new Introduction to STEM course currently being developed for dual-enrollment college students at South Texas College (STC). This new course is being prepared in collaboration between STEM faculty members at the University of Texas-Pan American (UTPA) and STC in order to create, support, and strengthen STEM pathways for students in the Dual-Enrollment Engineering Academy (DEEA) and other dual-enrollment programs. Students in the DEEA program at STC will be the first ones to take this new course in summer 2009, and for most of them, it is going to be one of their first college courses. DEEA students take an accelerated college career path while still in high school and graduate with associate degrees in Engineering by the end of their senior high school year. Introduction to STEM will be an early career course that involves challenge-based instruction with hands-on multidisciplinary activities to increase student interest and motivation to pursue careers in STEM fields. Also, this course is going to provide students with information and learning experiences to allow them to make informed decisions to choose a profession and to determine whether or not to stay in a STEM field. After developing the course, teaching it, and assessing its outcomes, it will be revised and offered to other students interested in STEM fields, not necessarily in the DEEA program. Additionally, the materials, experiments, equipment, and assessment tools developed for the new course will be modified and adapted in other engineering courses at both UTPA and STC to increase and improve educational challenges and hands-on activities in the curricula. In summary, this paper presents the rationale and design criteria of activities that are currently being developed for STEM pathways growth and support between STC and UTPA, and it specifically presents information about a new challenge-based instruction hands-on Introduction to STEM early career course.

1. Background

This section describes the background information about the STEM Pathways Growth and Support initiative including the profile of the institutions involved. Section 2 describes the purpose of dual-enrollment programs including the needs for hands-on activities, qualified tutors in advanced courses, faculty and curriculum development, and higher student retention rates. Section 3 briefly describes the rationale for using challenge based instruction (CBI) and an

example of a challenge in reverse engineering. Finally, section 4 describes the Introduction to STEM course and others supporting STEM pathways activities that are being implemented.

The University of Texas-Pan American (UTPA) is a 78-year old academic institution which is part of the University of Texas system. UTPA serves approximately 17,000 students of which about 86% are Hispanics. South Texas College (STC) was created in 1993 to serve Hidalgo and Starr counties, which are located in deep south Texas. More than 95% of over 20,000 students at STC are Hispanics, about 60% of them are female, and 75% are first generation students [1]. The dual enrollment programs at STC allow eligible high school students to enroll in college courses while attending high school. These courses are taken in place of, or in addition to, the normal high school course load. All high school students admitted to the program must meet the same requirements as any other college student [2]. STC has created two dual enrollment academies, the Dual Enrollment Engineering Academy (DEEA) started in 2006 and the Dual Enrollment Medical Science Academy (DEMSA) started in 2005; each Academy consists of a two-year program of college courses and internship opportunities for qualified junior and senior high school students. Consequently, these students take an accelerated career path to accomplish a college degree while still in high school. By the end of their senior year of high school, students graduate from these academies with associate degrees in Engineering or Science and Biology. In the first cohort, 33 students out of 49 (67%) who were admitted in 2006, graduated from the DEEA program in spring 2008. Six out of these 33 students have been accepted to continue their education at UTPA. In the spring of 2007, as part of the first cohort in the DEMSA program, 16 students graduated. In 2007, 54 students started the DEEA program, of which 49 (91%) remain in the program. Most recently, in 2008, 278 students have submitted complete application packages to the DEEA program, but only 55 (20%) will be accepted. This shows that there is great student interest to enter the DEEA program and to pursue a career in a STEM field. Out of these new 55 DEEA students, 37 participated in Math, Physics, and orientation sessions during a summer camp held June 9-13, 2008. The purpose of this camp was to guide and start the preparation of first year DEEA students who started the program in the fall 2008 semester. In addition to the academies, STC has other dual enrollment programs for college students who are still juniors and seniors in high school: for example, the Precision Manufacturing Technology (PMT) program under the dual-enrollment Youth Career Pathway program and the Express College program.

A new early career Introduction to STEM course is being developed with emphasis in challenge-based instruction and multidisciplinary hands-on activities as a way to inform, motivate, and encourage dual-enrollment students at STC to stay in college and pursue STEM careers. For first year DEEA students, the Introduction to STEM course will be the first, or one of the first, college courses they are going to take; through teamwork challenging hands-on activities, they will be exposed early in their career to what STEM professions are. The new course will cover the majority of the topics in the Introduction to Engineering courses at UTPA and STC; however, the information in those courses is being complemented to include other STEM fields. Besides those topics and during the first time the STEM course will be offered, students will participate in experimental practices and challenges in mechatronics, statics, dynamics, chemistry, renewable energy, economy, and reverse engineering. It is also expected that some of the components, equipment, materials, and other developments obtained from this new course will be useful in other courses in which similar topics are covered in more depth. Therefore, once

students have passed the Introduction to STEM course, they will have a basic understanding of multidisciplinary STEM concepts, and as a result, comprehension of related new material might become more meaningful, interesting, and practical because of the experience acquired in this early career course. In addition, students will receive information to get a better understanding of opportunities and responsibilities of STEM professionals in order to decide pursuing a career in a STEM field.

2. Needs of the DEEA and other Dual-Enrollment Programs at STC

At the beginning of this project, several student needs in the DEEA program at STC were identified and they will be addressed as a way of supporting and improving dual-enrollment or similar STEM programs at STC. Some of these needs actually exist not only at STC but also at UTPA, and probably at other universities and colleges; consequently, these collaborative efforts seek to have a positive impact on students at several institutions. These needs are presented and described next.

2.1 Hands-on and Challenge Based Activities

One important need and opportunity to support the DEEA program, as well as, other similar programs at STC, and UTPA, consists of developing hands-on and challenge based activities for students to integrate and develop better understanding of multidisciplinary concepts through modern instruction methods and experimentation. It has been determined that hands-on activities are required to promote STEM interest as a career path and to allow students to develop abilities to apply concepts and principles to a wide range of problems [3]. Engineers and Scientists need knowledge and skills in areas such as hardware interfacing, sensors and actuators, electronics, data acquisition, controls, programming, and modeling and analysis of static and dynamic systems [4, 5]. They require adequate preparation to work on and design systems which are becoming increasingly electromechanical. Mechatronics is a combination of technologies and disciplines in engineering, electronics, intelligent control systems, and computer science, which together can contribute to design better and smarter products and processes [6, 7]. Modern industry and new technology have a high and increasing demand for skillful graduates with multidisciplinary experience [8, 9]. For example, at the University of Detroit Mercy, Yost et al. [10, 11] developed an “Introduction to Engineering Design” course and a “Pre-college Course in Mechatronics Applications” to engage students in multidisciplinary topics early in their career to increase their preparation and motivation for lifelong learning. Also, at Wright State University a “Model for Engineering Mathematics” was developed to increase retention, motivation, and success in Engineering, and a significant part of their activities consists of hands-on and experimental practices [12].

Among some recent trends in engineering education, relevant results were obtained with eight challenge-based learning modules developed to teach an entire “Biomechanics of Human Movement” undergraduate mechanical engineering course [13]. Their results indicate that challenge-based instruction is an efficient way of engaging modern engineering students to improve the learning process [13]. In such course, assessment was performed using the following instruments: course pre-test and post-test; pre-affect and post-affect surveys were carried out to estimate students' attitudes toward learning in each module; surveys were used before, at midterm, and after the course to determine how successfully the program outcomes were accomplished; and a matrix of information was developed with results from a final survey that

determined which ones of the eight challenges students felt addressed each of 28 topics in biomechanics. Additionally, methods for assessment of challenge-based instruction have been presented by McKenna et al. [14], who mentioned that questionnaires, student presentations, interviews, and thought questions (critical thinking questions) were used to gather feedback about revised challenge-based course materials. Other thought questions were used to determine what student do and do not know about a specific subject. Also, exams, homework and other common assessment methods were used to evaluate knowledge and to provide grades to the students.

2.2 Qualified Tutors for Advanced DEEA Courses

There is an important need for qualified tutors to help students enrolled in courses of the DEEA programs at STC. Senior or graduate students from UTPA could be ideal tutors for the Academy programs. UTPA undergraduate or graduate students who have taken subsequent courses to the ones needed to be tutored at STC could do an excellent job not only helping the Academy students but also mentoring them. Tutors usually work on Friday afternoons and Saturday mornings helping the Academy students. In addition, the tutors can become key informants for evaluation and assessment purposes.

2.3 Faculty and Curriculum Development

There is always a need in academia to improve the learning process by implementing new teaching methods and activities that faculty members could learn by participating in workshops designed to promote modern pedagogical approaches. To implement challenged-based instruction (CBI) methods, faculty need to participate in workshops to become familiar and comfortable developing and using materials, equipment, and experiments to develop and implement educational challenges. Through finding solutions to solve these challenging problems, students are expected to succeed understanding STEM concepts. Faculty would also participate in the same challenges, hands-on activities, and experiments prior to implementing them in their courses. Training in software tools, like LabVIEW and Matlab, is also required in order to incorporate them in courses.

2.4 Increase Retention Rate

An important concern the STC DEEA program administration has is increasing the retention rate of 67%, which was achieved with the first cohort of students who graduated with an associate degree in Engineering in May 2008. This is particularly important for DEEA because students that are selected for DEEA have shown superior interest in STEM fields; therefore, the quality of the DEEA education and the retention rate is aimed to be as high as possible. There is a need to improve this retention rate, which is mainly affected because of three reasons: students who belong to migrant worker families, time management issues, and low GPA. Migrant worker families move from one place to another to work mainly in different activities in agriculture throughout the year. Students who belong to migrant worker families usually travel with them because of the difficulty of living alone and the need to support the rest of the family in such endeavors. Therefore, there have been a few students who dropped out of the DEEA program because of their participation in migrant work. Other students have dropped out due to time management problems in not being able to keep up with the strict schedule of the DEEA program. DEEA students attend high school in the mornings starting at 7:30 a.m. and travel at noon to the STC DEEA for afternoons classes until 5:30 p.m. every weekday except Fridays.

Friday afternoons are dedicated to orientation sessions and the completion of assignments. On Saturdays, they have the option to attend STC for tutoring. Therefore, it is a demanding schedule that requires hard work and discipline.

In the first cohort of DEEA students who started in 2006, 16 dropped out of the program: 8 due to time management issues, 2 due to migrant work, and 6 as a result of a low GPA. In the second cohort who started in 2007, 5 students have dropped out: 2 because of time management issues, 2 due to a changed major from engineering, and 1 because of a low GPA.

Additional efforts by the administration of the DEEA program have been taken place to increase the retention rate with help from retention specialists working in the program to improve student selection, engagement, and the transition process to college. Examples of the efforts retention specialists are doing in the DEEA program are:

a. Develop and implement academic and personal workshop activities, tutorials, and related undertakings for the program.
b. Build a network with community professionals and universities to invite to deliver presentations at DEEA workshops.
c. Provide outreach to DEEA students that will cover information about articulated programs, career exploration, and degree planning.
d. Develop and implement academic advising processes for DEEA student enrolling at the college and be visible and available to students throughout the year.
e. Assist DEEA students with financial aid programs, college admission requirements, ACT and SAT registration.
f. Meet on a weekly basis with students to conduct scheduled workshops and case management.
g. Track and monitor students progress and attendance through several reporting methods
h. Register all DEEA students in their perspective classes.
i. Create and maintains files with student academic degree plans.
j. Conduct process of advisement which includes: course selection, degree planning information on transferring STC credits to other colleges and universities.
k. Develop the creation of partnerships with area school districts, colleges and universities, employers, community leaders and service providers.
l. Promote and recruits students to the DEEA program by conducting presentations at the high schools and other academic events.
m. Assist with the selection process to admit students to the DEEA program.
n. Represent the College at local, state and national conferences, and other events.

Therefore, these efforts made by the DEEA administration are not only to have a great quality program but also to increase the retention rate of selected students that have shown superior interest in STEM fields.

3. Challenge-Based Instruction

Challenge-Based Instruction (CBI) is a research proven method to provide students with an interactive approach in learning and understanding new concepts. Different studies [13-20] have been performed in recent years and data have been gathered on how challenges should be used in

order to appeal to students and, at the same time, enrich them by acquiring and retaining knowledge and understanding of the concepts involved in the challenges. As a common generalized practice, professors spend most of the class period lecturing about new subjects. While this trend has been around for a long time and has proven to work in some cases, the need for high quality graduates in STEM careers is ever growing and new methods of teaching students need to be implemented in order to ensure continued interest in these subjects, increase the enrollment for these majors, and, consequently, increase the number of graduates and the quality of education in these areas. It is expected that in this project, most students will acquire and retain knowledge by going through the process of searching for solutions to challenging problems that require hands-on activities in which they may use and develop their abilities to work in teams and learn on their own.

One of the key findings in the book *How People Learn* (HPL) [18] is that most effective learning environments are those in which knowledge, assessment, learner, and community centered versus the traditional methods are implemented. Traditional methods provide an environment that is largely knowledge centered with some or little summative assessment and no attention to formative assessment. Summative assessment is a form of evaluation (quiz or test) that reviews what the students should have learned over a period of time. This assessment can also identify weaknesses and the instructor and student could continue working to accomplish better results using formative assessment. Formative assessment is a self-reflective process that intends to promote student attainments.

In order to successfully implement CBI, several fundamental requirements must be met to ensure that challenges are educationally effective. Student centered instruction is used to determine student current capabilities; knowledge centered instruction is a form of traditional lectures focused on teaching to achieve mastery of a subject; assessment centered instruction is used to build opportunities for students and teachers to get feedback on the learning progress; and community centered instruction builds a community that promotes learning in an appropriate community context [17,18]. To start implementing CBI, numerous questions arise about group size, students willing to work together, individualized grading procedures, and how to measure student success in collaborative learning environments. Laporte [15] indicated that a group smaller than 3 students might not contain enough diversity and be divergent to provide different thinking styles, while a group of 4 students seems to be ideal, diverse enough, and without excessive participants, allowing all of them to participate in the challenges. An approach to CBI is provided by the Star Legacy Cycle [20] and it presents an appropriate method of the structure and how CBI should be executed. There are a variety of challenges and some extend beyond the classroom, requiring several days of work until the instructor deems that the allotted time has been sufficient to complete the assignment.

Following the Star Legacy Cycle [21], initially a challenge must be identified so that students encounter a realistic and novel problem which is neither too trivial nor impossible for them to solve. Once the students are organized in groups, which could be self assigned or instructor assigned, they begin to generate ideas on how to solve the challenge, discuss, and interact with to exchange thoughts and learn from each other. Having exchanged information and having viewed the problem in different perspectives, each group continues to explore various views on important aspects of the challenge [16]. Afterwards, they must revise their ideas to make sure

they are on the right track. For example, revising consists of performing research and completing homework assignments related to the challenge to ensure that the group is learning and progressing without falling behind. During these tasks, students do most of their formative learning from reading textbooks and articles, looking up information, and asking others for help in order to complete the assignments. Following this phase, students go through formative assessment on the subjects of interest to determine their progress. Finally, students go public with their findings by presenting and defending their solutions to the challenge and, at the same time, get feedback from their peers and instructor. These presentations also allow each student to see various solutions to the same problem and, at this stage, students could identify that there are multiple ways to solve a problem [16].

Challenges will be developed for students in the new Introduction to STEM course following the Star Legacy Cycle so that they will confront situations for which they need to team-up, discuss ideas, learn, and perform hands-on activities in order to determine a solution to the challenge, instead of just following traditional lectures and handout instructions to accomplish a desired result. The challenges with hands-on lab activities for the first offering of this new course are going to be in the following areas: mechatronics, chemistry, engineering mechanics, renewable energy, and reverse engineering. Other challenges will be developed for students to work in the classroom or computer room when studying topics such as: systems of units, data presentation and plotting, economics, ethics, and STEM professions and education.

3.1 Student Learning Outcomes of Group Challenges

The following is a list of outcomes expected from the challenges that the students are going to have in the "Introduction to STEM" course. For student teams, each member of the team needs to be able to:

o. Explicitly state the general goals and specifications that need to be met from any challenge.
p. Give implicit evidence of understanding of the general goals and specifications that need to be met.
q. Define a general approach to the proposed challenge.
r. Work and discuss possible solutions within their group.
s. Efficiently and clearly communicate what they need to know about the challenge.
t. Propose a solution, present, and defend their ideas.
u. Retain knowledge attained by participating in various challenges throughout the course.

3.2 Example of Reverse Engineering Challenge

Students are motivated to learn when they understand the connections between the subject matter and their career aspirations and that long term success may depend upon their ability to access and apply what they have learned. One of the proposed challenges that integrates course content across course boundaries and should help students build connections between related concepts and to better understand the interplay between seemingly unrelated concepts is briefly described below. The overall goals for the reverse engineering challenge are:

- To introduce and develop basic understanding of the legacy cycle.

- To develop understanding of the knowledge, skills, and attributes that STEM majors must possess (including communication and teamwork skills).
- To motivate students to take ownership of their education.

Reverse Engineering Challenge: How do cordless power tools (e.g. drills and screw drivers) work and what are the differences between professional grade and regular grade tools?

First, some class time will be spent on introducing students to reverse engineering, planning charts and diagrams, engineering units and conversions, and basic sketching before the challenge is given. After that, a specific battery-powered tool (it could be other objects such as a flash light, gearhead motor, or a mechanical pencil) is handed out by the instructor to four-member student teams. The students will proceed to do the following tasks:

a. **Generate ideas:** Students will be asked individually to write down their initial thoughts about the challenge for about 10 minutes. Ideas will be posted on the board or on a website and additional brainstorming in teams will be performed.
b. **Multiple perspectives:** As previously discussed, the students will receive some information concerning the challenge from "experts" beforehand. At this point, students will have additional opportunities to obtain more information concerning the challenge through a website that contains materials such as papers, power point presentations, and movies.
c. **Research and revise:** Students will then engage in a series of learning activities. The integrated reverse engineering challenge will involve mechanical dissection of professional grade and normal grade cordless power tools. An initial engineering study of the power-tool will be conducted to study the functionality of the power-tool before the dissection process is initiated. At this point, the students will establish its major input-output using a black-box diagram. Then, the teams will disassemble the power tool to study sub-assemblies and individual components. In order to help students organize the dissection process, a fishbone diagram will be presented to show relationships of these sub-assemblies and components. The fishbone diagram will force the students to study each individual component's functionality and call the components by name. In order to aid in visualizing the dissection process, the students will make sketches of the whole assembly and of the key components. Students will be also required to measure the dimensions of each major component and convert them to different unit systems.
d. **Test your mettle:** Formative, interactive instructional events about challenge activities and learning objectives will be presented to the teams. Quizzes will be structured such that incorrect responses to problems direct the students towards specific review materials including problems from other domains. To facilitate the process of assessing each team member, the team will also submit a table stating each team member's contribution to the different parts of the project as a percent of the total effort.
e. **Go public:** The black-box diagram, fishbone diagram, and the sketches will be submitted to the instructor as a team assignment to be presented to the entire class or posted on a website (public forum) for public display and criticism.

Students are going to be encouraged to follow the legacy cycle to work on other challenges.

4. Supporting STEM Pathways

As an option to satisfy the needs mentioned in the previous section of dual-enrollment programs at STC, a new early career Introduction to STEM course has been proposed as the first step to integrate new teaching techniques with hands-on activities and faculty and course developments. The Introduction to STEM course seeks not only to increase the quality of education but also the interest and motivation of students for STEM fields and to increase the retention rate or maintain it high. This new course is being developed with the idea that it will be one of the first college courses DEEA students will take. This course will provide orientation and information about opportunities in different STEM fields, and it will also expose students to several topics in science and engineering as a preview of future work they will be involved with and to understand the requirements to become knowledgeable and responsible STEM professionals.

4.1 Introduction to STEM Course and other Activities for DEEA Students

Creating and offering the new Introduction to STEM course is one of the main actions in this project to promote, support, and enhance STEM pathways for first generation college students that in a majority are Hispanics. This course will intend to expand and strengthen STEM avenues through the implementation of challenge-based instruction using multidisciplinary experiments, lectures, and assessment materials to promote student motivation, preparation, and interest in STEM careers. For instance, it is proposed to use challenge-based instruction (CBI) techniques and hands-on teamwork activities in an early career Introduction to STEM course to engage students, promote real world understanding of STEM challenges, experimentally validate theoretical concepts, and introduce new topics.

4.1.1 Characteristics of the "Introduction to STEM" course and Supporting STEM Pathways Activities

One of the ways the multidisciplinary nature of the needed hands-on activities will be addressed is by developing and implementing some experiments in Mechatronics to integrate STEM concepts. For example, in one of the Mechatronics sessions, students will learn about programming microcontrollers and use them to solve a challenge, like implementing an on/off controller for fans, LEDs, and buzzers based on the state of several inputs. In the process of solving the challenge, students working in teams are expected to learn to create and compile a program, program the microcontroller, connect the microcontroller and power supply to sensors and actuators, acquire troubleshooting experience, and present the results to the rest of the class. Additional experimental sessions that involve data acquisition systems, computer software, sensors, motors, and other mechanical components will be used to introduce students to new concepts in STEM fields and to engage and promote solving challenges using the approach, some tools, and equipment that STEM professionals normally use. The new course to be offered the first time will have challenges during 5 hands-on sessions in the area of electronics, mechatronics and renewable energy; 4 hands-on sessions in chemistry; and 4 hands-on sessions in engineering mechanics (2 in statics and 2 in dynamics), and 1 hands-on session in reverse engineering. Besides that, several other topics in the Introduction to STEM course that will be presented to the students are STEM professions, system of units and conversions, ethics, economics, and data presentation and graphing. The new Introduction to STEM course, and other support activities, will provide the following opportunities to the DEEA and other dual-enrollment programs at STC and UTPA:

a. Hands-on and challenge based activities: Students will receive real world instruction in order to understand concepts using different approaches and techniques. Hands-on and challenge based activities are being developed to involve students in practical and real engineering applications. Hands-on activities will provide a preview, or complement, concepts of topics covered in the classroom. It is the goal of these hands-on activities that students participating in the experiments acquire practical understanding of theoretical concepts and increase their interest for STEM career paths. Experiments in mechatronics, engineering software utilization, programming and data acquisition systems, statics, dynamics, chemistry, and renewable energy, are proposed to be implemented to support this new course and other DEEA courses. As a consequence, it is expected that STEM instruction will be improved and retention will increase at both STC and UTPA. The same or similar hands-on activities could be used in several courses at UTPA and STC; therefore, the equipment and didactic methods obtained and developed in this project will serve multiple purposes.
b. Access to UTPA Facilities: STC DEEA students will participate in STEM challenges some of which will take place at UTPA.
c. Tutoring: Qualified students at UTPA will work as tutors to help students in the DEEA program. Senior or graduate students from UTPA seem to be ideal candidates to be tutors for the Academy programs at STC.
d. Faculty Development: Promote interaction, exchange of ideas, cooperation while sharing teaching methods, techniques and tools between new faculty as well as faculty who have been teaching a topic for several years. Faculty will participate in challenge-based instruction workshops.
e. Curriculum Intervention Activities: These activities will integrate and improve courses, apply new teaching methods, and add challenges. In several courses, more programming software and hardware tools will be included, such as MATLAB, LabVIEW, PicBasic, and PLC programming; and hardware such as sensors, actuators, data acquisition systems, PLC, and microcontrollers.

4.1.2 Goals of the Introduction to STEM Course

The new Introduction to STEM course will focus on the opportunities and challenges in science, technology, engineering, and math and conceptual tools used by scientists and engineers. The professional challenges of ethical decision making, the communication skills, the globalization of the field, and the preparation required to successfully enter the field of science and engineering will be discussed in the course. Students will be able to understand the application of basic concepts in statics, dynamics, physics, chemistry, and electromechanical systems. Students will receive information and acquire hands-on experience from multidisciplinary fields to allow them to have a broader understanding of STEM education and future opportunities in their lives. At the same time, through the different projects and assignments, students will practice effective time management skills, teamwork, challenge-based instruction, and communicating technical information. Some of the most important objectives to be accomplished while developing and offering the new Introduction to STEM course for the first time are:

a. Increase hands-on activities to boost interest, preparation, and motivation of Hispanic students to pursue a career in STEM fields.

b. Contribute to improve the retention rate of the DEEA program at STC.
c. Implement challenge-based instruction methods in the DEEA program.
d. Develop training materials and workshops to better prepare DEEA and UTPA faculty to implement hands-on activities and CBI methods in early STEM career courses.

At the conclusion of this new course, students will be able to:

a. Describe what it takes to be a successful STEM student and keys to success in STEM fields.
b. Explain the different STEM disciplines and the areas of specialization within these disciplines.
c. Describe the professional and educational trends in STEM.
d. Describe the basic STEM approaches and tools used for problem solving and the graphical presentation of data.
e. Apply different unit systems in engineering.
f. Describe what makes successful teamwork.
g. Describe and apply process steps required to solve challenging problems.
h. Identify the characteristics of good oral and written communication.
i. Identify some of the challenges for life long-learning.
j. Explain the codes of ethics.
k. Describe the registration requirements to acquire a professional license for STEM careers.
l. Identify basic software applications and functions.

4.1.3 Measurable Outcomes for this Project
In order to assess the success of this project, the measurable outcomes are:

a. Increase collaboration and STEM career avenues between STC and UTPA.
b. Create a new "Introduction to STEM" course for the DEEA program to increase hands-on activities and to implement CBI as early as possible for new DEEA students. Develop lectures, experiments, assessments, and other didactic materials for this new course in the following scenarios: i) reverse engineering, ii) mathematical modeling and analysis using experimental data and simulations; iii) data acquisition and analysis of results.
c. Adapt and/or develop instrumented multidisciplinary workstations to improve instruction through hands-on activities and increase student motivation and interest in STEM careers.
d. Implement pre-test, post-test, surveys, and observations to measure perception and understanding before and after hands-on activities and challenges.
e. Increase the quality of education, enrollment, and retention rate of Hispanics in STEM careers.

5. Conclusion

This paper presents a description of steps being taken to support STEM pathways at STC and UTPA in collaborative efforts involving both institutions. As one of the initial activities in this

project, a new Introduction to STEM course is being developed and will be offered for the first time during the summer of 2009 to dual-enrollment college students in the dual-enrollment engineering academy (DEEA) program at STC. This new course is being developed in collaboration with STEM faculty members at UTPA and STC to create, support, and strengthen STEM pathways for students in DEEA and other dual-enrollment programs. The new course will have components of the Introduction to Engineering courses previously taught at UTPA and STC and additional challenge-based hands-on multidisciplinary activities will be included in order to increase engagement, interest, and motivation of students to pursue careers in STEM fields. Other efforts such as tutoring sessions, UTPA-STC collaboration, and faculty development are simultaneously being made in order to improve STEM instruction and to support STEM pathways and curricula in these two institutions. The novelty of the initiative presented in this paper is creating an early career Introduction to STEM course with challenge-based instruction and hand-on multidisciplinary activities for dual-enrollment college students; not only to improve the quality of STEM education but also to improve engagement, motivation, understanding, and retention of knowledge; and consequently, increase the retention rate or maintain it high.

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