

## Promoting International Preparedness in Undergraduate Engineering Projects

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### Abstract

This paper describes the social-cultural elements of the cross-border collaboration between The University of Texas Rio Grande Valley (UTRGV) – College of Engineering and Computer Science (COEC), Department of Manufacturing and Industrial Engineering (MANE) – Engineering Technology program (ENGT), and Tecnológico Nacional de Mexico / Instituto Tecnológico de Matamoros (TecNM/ITM) – Computer Systems Engineering program (CSE).

This initial strategy for cross-border collaboration was technology development by complementing capabilities within different engineering fields, addressing regional priorities.

### Introduction

During the development of the projects, the students were exposed to different teaching and learning methods by being immersed in a constructive cooperation between both higher education institutions. This novel opportunity to train in technical aspects and soft skills, laid an effective platform to experience multi-disciplinary teamwork.

The project was a great opportunity to coordinate future research, taking advantage of our strategic geographic location and identify future research opportunities to contribute to the economic development and social wellness in both sides of the border, due to its distinctive characteristics – economy, culture, language, etc.

In this paper we include a description of the enrolled programs, the general functioning of the project, collaboration lessons learned, communication challenges, and opportunities for growth.

With this undergraduate research in technology development and innovation, both institutions started the cooperative work, leading efforts towards effective and strong cross-border collaboration, sowing the seeds of a global vision with regional impact, through novel teaching and learning strategies.

### Background

The Rio Grande Valley in southeast Texas and the north east of Tamaulipas, Mexico is a region known as one of the fastest growing metropolitan areas of the world, holding a regional population of over 3.5 million people, amongst USA and Mexico, and hosts broadly diverse

manufacturing industries. As a result, faculty from the two most important higher education institutions in the region, the University of Texas Rio Grande Valley and the Tecnológico Nacional de México/Instituto Tecnológico de Matamoros, are working towards the integration of cross-border multidisciplinary collaborative research as a multidisciplinary team. Collaboration with universities across the border provides an opportunity to deliver a better service to the bi-national community in the 150 mile-wide RGV region.

The College of Engineering and Computer Science (CECS) at UTRGV promotes pioneering research with international impact as a path to a better life [1]. With an extensive selection of undergraduate programs in the engineering field, the Department of Manufacturing and Industrial Engineering provides a setting for technology development and applied research in the Engineering Technology (ENGT) program [1].

The Tecnológico Nacional de México/Instituto Tecnológico de Matamoros have registered the CSE program to be committed “to train leading, analytical, critical and creative professionals with strategic visions and broad ethical sense, capable of designing, implementing and managing computational infrastructure to provide innovative solutions for the benefit of society, in a global, multidisciplinary and sustainable context”[2].

The practice of creating multidisciplinary engineering design teams does an important part in engineering problem solving and decision-making and managerial performance [3]. Consequently, the role of a capstone engineering course in engineering education is crucial to support the capability of the students to solve industry challenges. Nevertheless, a more dynamic involvement can provide engineering students with an option to develop a broader understanding of working in international setting, and at the same time gain the skills to successfully interact through diverse cultures [3].

As a bi-national region, we can consider the location as a privileged geographical area, suitable to promote and experience cross-cultural mobility. Therefore, cross-border collaborative learning through capstone engineering projects is developed and presented as a regional, cooperative system to generate collective settings for technology development in undergraduate applied research for students on both sides of the Rio Grande Valley.

### **Undergraduate Research in Capstone Projects as an Opportunity to Promote International Preparedness**

Project-based learning in undergraduate engineering programs is included as a mean to develop the engineering skills required to address real-life technological challenges. In both high education institutions, UTRGV and TecNM/ITM, students who complete their coursework must complete an industry-related, research-based capstone project, which in specific cases involve the design and development of a functional prototype.

As part of the new projects definition, faculty advisors identified the need of including short-term research projects embedded in regular coursework, to enhance the students’ experience not only at the Senior Project I and II, but also as part of the following courses: Solar Energy Technology, and Green Building Design II. With this proposal, the program expanded its capacity, and providing an opportunity to improve the required skills in a multicultural team.

For these cross-border projects, special attention was focused on the following course objectives<sup>1</sup>:

1. Improving in the student's ability to function as a member of a technical team;
2. Ability to apply written, oral, and graphical communications;
3. Ability to identify and use appropriate technical literature, and understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity.

The teams consisted of at least one student representing each of the programs. As shown in Figure 1, the students experienced working not only as small groups, but as a whole cross-border team during presentation rehearsals, experiencing the opportunity to interact with other teams, and learn from different research projects.



Figure 1. Cross-border team: rehearsal meetings, preparing for presentations.

### **Cross-Border Undergraduate Research: Effects on Engineering Learning**

Students actively learned through research and experimentation. Students learned through collaboration on how to apply what they learned in the classroom to a lab size real-scale prototype, gaining knowledge of manufacturing processes, testing and implementation. Both parts have strengthened their critical thinking skills, communication skills, empirical and quantitative skills, teamwork, social responsibility, and personal responsibility.

An example of the above mentioned skills gained by the students were confirmed by a peer-reviewed evaluation and presentation at the 2018 Texas Regional Alliance for Campus Sustainability (TRACS), at Tarleton State University, Stephenville, TX (Figure 2), where students from both institutions participated as a cross-border team presenting their undergraduate research in engineering.



Figure 2. Cross-border students' teams presenting their posters at the 2018 Texas Regional Alliance for Campus Sustainability (TRACS), at Tarleton State University, Stephenville, TX.

Students from both programs developed their projects guided by faculty advisors from the two institutions, joining efforts, sharing knowledge, working to solve a specific engineering project that required innovative and interdisciplinary skills. As an initial step, online communication was encouraged, such as the use of social media groups, in order to open a space for the students to share their thoughts regarding the possibilities of the project. On this phase, the main concern of supervisors and faculty was to shorten external variables that would cause additional communication problems, having in consideration that language diversity is an essential part of our culture.



Figure 3. Cross-border student's team presenting at the 2018 UTRGV Engaged Scholar Symposium (ES2)

We can find diverse examples of global student collaboration, where language diversity is a challenge to overcome, through the Global Virtual Teams (GVTs). The GVT's major concern is to have a fading in the individual performance [4]. Challenge-based instruction, project-based learning, and continuous self-learning were incorporated throughout the project until its completion. The students from both institutions were continuously challenged to search for novel technologies and innovative ideas for implementation to present a viable solution. Another example of this is their participation at the 2018 UTRGV Engaged Scholar Symposium, where

the students presented four undergraduate engineering research projects (Figure 3). The engineering technology students had the opportunity to learn concepts on software design and its applications and the computer systems students learned the engineering design process and product manufacturing fundamentals.

### **Lessons Learned and Opportunities for Growth**

The students have proved their ability for continuous self-learning, and even have proven their marketability: a few of them have received placements from a pool of applicants due to their abilities acquired through this project. This project has shown the students from both higher education institutions the importance of understanding how to address professional responsibilities, with a respect for diversity.

Students' commitment and confidence in their background was essential for the effective accomplishment of the project. Stressful situations and technical difficulties tend to drop the students' concentration, but commitment and interest in being part of an innovative, and revolutionary program kept them on track. From the beginning of the project, the students were well aware of the unforeseeable challenges ahead resulting from participating in a cutting-edge engineering project and the intensive work load.

Promoting a learning-friendly environment is the key factor and challenge to the faculty. To determine the project, define and identify benchmarks to ensure outcomes has strengthened the direction to be followed by the students, who are already wondering if they will be up to the project requirements.

Faculty must prepare to calculate unexpected events, by organizing a list of potential options in advance. It is vital for the teams to work as a multidisciplinary community, not only as a team, where critical thinking will be an important skill since the beginning of the project, connecting diverse backgrounds to improve in the overall team performance[4].

### **Conclusion**

Working as one multicultural and multidisciplinary team, faculty and students from two different countries and two different engineering programs have scientifically tackled a complex engineering problem, to prove cross border collaboration in technology development and innovation.

As part of the continuous efforts on the formulation of novel engineering education strategies for the ever-changing global environment, the undergraduate research experience through cross-border collaboration, promotes an option to improve the graduates' capability to evolve in an international working setting.

The collaboration between both higher education institutions, in technology development and innovation, has proved to be an essential strategic program, planned for the better understanding of a multicultural cross-border region.

## Acknowledgement

The authors would like to thank the UTRGV Dean's office, College of Engineering and Computer Science, and the TecNM/ITM Director, who supported the project since its initial stage. Support from both institutions led the authors to develop the proposal funded by the Innovation Fund grant *Competition #14: Promoting Study in Aeronautics, Agroindustry, Automotive Industry, Energy, and ICT*, sponsored by 100,000 Strong in the Americas, Partners of the Americas and Fundación Televisa, awarded to The University of Texas Rio Grande Valley (UTRGV) in partnership with El Tecnológico Nacional de México (TecNM)/Instituto Tecnológico de Matamoros (ITM), with the proposal: "*Beyond Engineering Education Program - Cross-border multidisciplinary talent: sharing science, technology development and innovation*".

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