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Engineering Senior Design - Business Collaboration Model

Noe Vargas Hernandez[1], and Sylvia Robles[1]
[1]*University of Texas Rio Grande Valley*

Senior Design and Capstone courses are an opportunity to develop a variety of critical skills in engineering students and prepare them as future innovators. Among other requirements (e.g., environmental consciousness, leadership, teamwork), innovation requires an entrepreneurial mindset. For this reason, having a collaboration with Business makes sense, but it can be truly challenging to initiate. The objective of this paper is to present an Engineering Senior Design – Business (E-B) collaboration model that can potentially serve as a blueprint to kickstart a collaboration between an engineering senior design or capstone design course and a business course such as new venture creation, intro to entrepreneurship, or similar. The paper presents a balance between the theory of the model and its practical implementation at the University of Texas Rio Grande Valley (UTRGV), a Minority Serving Institution (MSI) with an incipient emerging I&E (Innovation & Entrepreneurship) ecosystem. The model was developed using the PARE (Preparation, Action, Reflection and Evaluation) approach and 5 years of collaboration experience by the authors (professors from Engineering and Business).

Keywords: Entrepreneurship, Multidisciplinary Collaboration, Innovation

Corresponding Author: Noe Vargas Hernandez, noe.vargas@utrgv.edu

E-B Collaboration Model Development

This model is descriptive as it incorporates our experiences collaborating for the last 5 years, and it is also prescriptive as it follows the PARE[1,2] model in its development. Among the different existing collaboration models (Science of Teams[3], RASPPA[4], etc.), the PARE model offers a structured approach to high-quality service-learning experiences, which include the key components of Preparation, Action, Reflection, and Evaluation:

- Preparation: Prepare before embarking on a project (logistics, projects, broader issues, etc.).
- Action: Project deployment (needs, location, time, teams, work, materials, supplies, etc.).
- Reflection: Discuss the experience to improve in the future.
- Evaluation: Measures of success, achieving goals and learning objectives.

The PARE model focuses on Service Learning (SL) experiences [5-13], we can easily adapt this model to our E-B Collaboration since (1) most of our projects have SL components, (2) promotes collaboration across disciplines, and (3) it is a simple and flexible model that has been previously validated. This paper presents a first iteration of the PARE approach to generate the E-B Collaboration Model. This is a summary of the model as shown in Fig. 1.

Preparation

It is important to prepare the students from Senior Design I (SDI) and from New Venture Creation (NVC) courses to increase the likelihood of positive project outcomes. Based on these considerations and the experience from previous iterations of the E-B Collaboration (2018-2022) we have developed practical Logistics guidelines for participating students which are included in the syllabi of each course. The students learn about the Project Content form the engineering students' project proposal. During the E-B Collaboration kick-off meeting with the instructors and students, the Broader Issues, Expectations, and Assumptions are discussed.

Action

Once the Engineering and Business students have been prepared, the project experience starts. Although the teams follow different syllabi with different tasks, deadlines, deliverables, etc., these are some key common elements: (1) Unity & Identity: we are "one team" working on one project, (2) Communication: teams receive detailed communication protocols, (3) Solidarity: if teams support each other, the outcome will be better, (4) Motivation: the main purpose is to learn, and (5) Recognition: teams must acknowledge each other during their presentations and reports. For Engineering and

Business teams to successfully execute the projects, a well aligned institutional context must be in place, here are some initial actions:

- Departmental Level: Collaborating departments must be aware and supportive of this collaboration, the faculty advisors must be onboard with the collaboration.
- College Level: Typically, colleges encourage this type of collaboration, for this reason we recommend keeping the respective Deans up to date with the collaboration.
- University Level: Some projects may represent the institution at prestigious competitions; it is always a good idea to notify other areas such as student success, institutional advancement, and the president's office.

Reflection

Through reflection[14], students can become aware of their learning: why things did or didn't work, how to improve in the future, what skills were developed, etc. At every iteration of the E-B Collaboration, participating students go through a debriefing session with the instructors. Students are asked to think critically about their experience through the semester. From these reflections, the instructors have made important discoveries to improve the Collaboration model, for example: Students feel proud when they are acknowledged by the other team during presentations, among other findings. At the end of each collaborative semester, the instructors go through a debriefing session to identify issues and opportunities of improvement. There were many issues during early collaboration iterations, such as inefficient communication. The improvements can now be seen in this continuously improving model of collaboration.

Evaluation

Both instructors (Dr. Vargas and Dr. Robles) are trained in the Course Blueprinting process, and their corresponding courses have been independently blueprinted (SD and NVC). This E-B Collaboration model follows the PARE approach which has similarities with the Blueprinting process. This means that the Learning Objectives are aligned to the Learning Activities and to the Assessment. In the case of the E-B Collaboration Model, we have defined an inventory of skills for the participant students that includes Teamwork, Communication, among others, all these in a multidisciplinary context. These skills are transformed into specific Learning Objectives. Following the Blueprinting approach, participating students must complete assessment surveys that align with the Learning Objectives and measure the success of the collaboration. Results so far indicate that the collaboration has been effective in achieving the Learning Objectives and that the students develop specific useful skills.

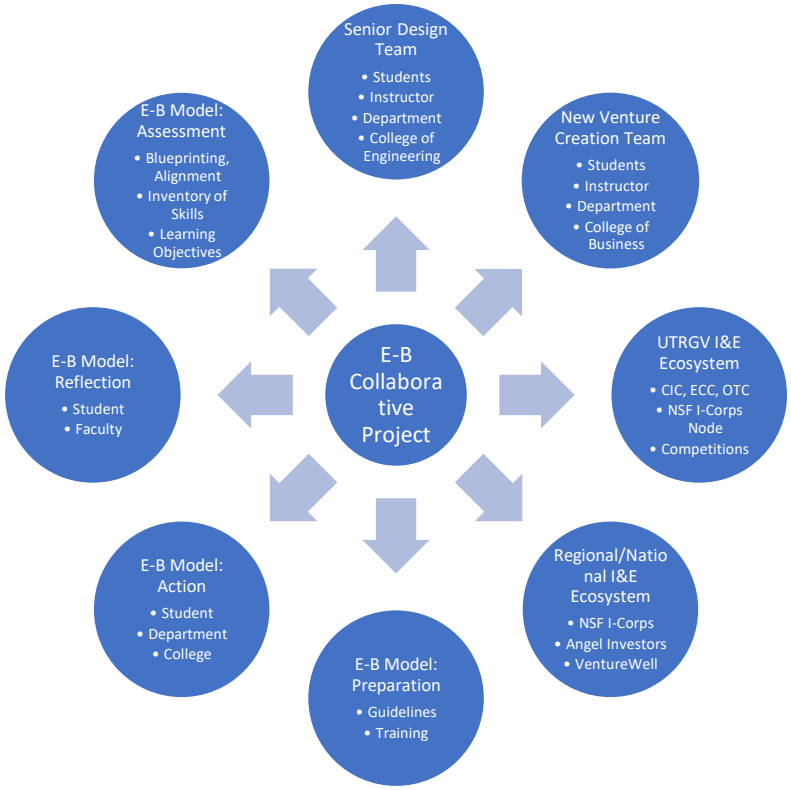

Figure 1. E-B Collaborative Model.

Rules of Engagement

When two teams of students initiate multidisciplinary collaboration, it is natural to have uncertainty and a feeling of apprehension. Based on the authors' experience, defining the "rules of engagement" is of the utmost importance. These rules reflect our experience:

- Immediately arrange for a Kickoff Meeting this Week with both teams, and include Dr. Robles, and Dr. Vargas. Team Leaders, consult with your team and reply with your availability.
- SDI and NVC immediately assign one student as a point contact (POC) to represent the team and reply to emails.
- SDI Team share your project information and keep them updated with the latest developments.
- CC Dr. Robles and Dr. Vargas in every email communication between the teams.
- The main objective for this collaboration is mutual support, and the flow of information is crucial. Contact the course instructors immediately if you have any questions or issues.
- Both sides must understand that information may not be readily available since both teams are developing their model/design. Share information when you have it, if you don't have the information, you can help by providing an idea or concept whenever possible, if not, you can clearly state that you don't have the information. Contact your course instructor if in doubt.
- Address emails to the POC. POCs must acknowledge and reply all emails in less than 24 hours and provide an answer as soon as possible.
- When SDI or NVC present their work in their respective course or events, they can use each other's shared information by (1) getting clearance from the SDI team to avoid IP disclosure issues and (2) giving proper credit to the other team generating the information.
- The SDI team retains every IP right in this collaboration.
- This collaboration is an important learning opportunity, resulting in mutual benefit and a stronger project. Although it requires an additional effort, it should not become an unsustainable burden. If you find yourself in this situation, immediately contact your course instructor.

How to Start

Initiating a collaboration between Engineering and Business faculty requires certain steps:

- Start with one faculty from Engineering and one from Business, convinced of the need to make a change.
- Identify the courses to collaborate, for example Senior Design and New Venture Creation.
- Start with small changes, do not overburden the students, focus on student skills development.
- Simultaneously convey the message to the Departments and Colleges of the value of this collaboration.
- Advertise your achievements.

Struggles and Opportunities

The authors have faced multiple struggles in this collaboration, and we have managed to transform these into opportunities:

- Students lack entrepreneurship role models: but there is a rich history on how underrepresented minorities are resilient, innovative, and entrepreneurial.
- Hit & miss historical collaboration between Engineering and Business Colleges: we started with a clean slate; mutually acknowledging our contributions.
- The Rio Grande Valley (RGV) region is not Silicon Valley: our innovation and entrepreneurship ecosystem are starting, and this is a great opportunity to be a stakeholder; UTRGV is already a part of the NSF I-Corp hub.
- Already busy curricula and course syllabus: we need to be careful with the added work; explain to the teams how collaboration enriches everyone and improves the project.
- Entrepreneurship can distract faculty from their Tenure plans: we must be careful and respectful of faculty involvement but having translational research can enrich traditional research work.
- Our graduating students already get pretty good job offers we can demonstrate that having an entrepreneurial mindset can help with your professional goals.

Our Achievements

Although we have much to learn and grow, we are proud of our achievements so far:

- Our Engineering-Business teams have participated at National NSF I-Corps cohorts and the Hispanic Serving Institution (HSI) Battle of the Brains (2020 Champions).
- We have refined our collaboration and communication model.
- Students develop critical multidisciplinary skills.
- We foster an emerging UTRGV and RGV Entrepreneurship Ecosystem.

Conclusions

This paper summarizes the development of an Engineering-Business Collaboration Model based on the work done by Dr. Vargas Hernandez and Dr. Robles with their corresponding courses in the last 5 years. This experience has been formalized into a PARE model that can be easier to understand and transfer to other institutions with similar contexts and challenges. The E-B model represents the current understanding, as it is updated at each iteration. Preliminary results indicate a great benefit to students' skill development, and other achievements. Important challenges remain, for example: lack of effective assessment tools of interdisciplinary collaboration, some team members cannot participate in I-Corps, Business Plan Competitions, Kauffman programs, etc., among other challenges.

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