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Board 263: Enhancing Hispanic Engineering Students' Psychosocial Outcomes and Engineering Persistence Outcomes Through a Combination of Active Learning and Video Projects

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Abstract

The COVID-19 pandemic has caused classrooms to shift to online or virtual learning modes, which has caused dropouts of underrepresented engineering students taking gateway or introduction to engineering classes. In this in-situ interdisciplinary intervention method, so far, we have engaged one of two cohorts of university freshman engineering students (16 students/cohort): one with Active Learning (AL) (with a culture of inclusion through video-based activity/interaction) and the other with AL and creative video projects (CVP) activities in a 2-semester enrichment program. Our intervention investigated a new 100% (AL) method that combines video-based interaction among student-faculty and group CVP (for ex., self-reflective biography of scientists) to inspire, motivate, and improve the retention rate within TAMIU's engineering program, promoting a culture of inclusion. The CVP was created using Echo360 software integrated into a secure course learning management system (Blackboard). This intervention seeks to develop engineering psychosocial outcomes through reflective thinking, internalization (about the challenges of engineering life and the journey to becoming a successful engineer), and collaborative creative work.

This research is ongoing, and the results we present are preliminary. We examined and evaluated, through pre-and post-intervention surveys for the first semester, the impact of the intervention on the engineering students' scholastic outcomes, psychosocial outcomes (PSO) (e.g., engineering sense of belonging, engineering self-efficacy, and engineering self-identity), and engineering persistence outcomes (EPO) (i.e., retention, graduation, and academic performance (i.e., overall GPA, and engineering GPA). We hypothesize that students will build meaningful and supportive relationships and enhanced PSO and EPO/AP that will persist throughout their tenure at the university. We also hypothesize that the level of persistence of the enhanced PSO and EPO will be significantly higher for students in the intervention group (with CVP). We validated and analyzed the data (cleaning and quality control) and performed preliminary/complete inferential analyses using SPSS 29 was completed. We will discuss the implications of improving pedagogy in introductory engineering courses.

KEYWORDS

Engineering Education, Psychosocial, Engineering Persistence, Active Learning, Retention

1. Introduction and Background

The COVID-19 pandemic triggered a seemingly abrupt paradigmatic shift in education from traditional face-to-face, classroom-based teaching to fully remote, virtual teaching environments. Even once the initial cause of this shift is no longer a driving force, the younger generations have expressed a desire for continued virtual learning options and a shift towards a generation of "digital nomads [1-3]." Universities for learning must accommodate this desire for flexibility and instant online learning to remain a desirable and viable option for future generations of students [4-6]. This shift immediately presented institutions of higher learning with challenges relating to student's psychosocial (e.g., weak sense of belonging, low self-efficacy, and shallow sense of identity), persistence (e.g., high attrition and low four-year graduation rates), and performance (low grades and low GPA) outcomes. STEM education is considerably impacted as well, especially in undergraduate engineering programs. Engineering education benefits from frequent, meaningful face-to-face interactions between instructors and students to effectively transmit tacit skills (i.e., technical and scientific), develop collaborative skills, and improve degree-related psychosocial outcomes. This interaction is drastically reduced or lost during a pandemic-related lockdown and social distancing. Thus, maintaining a careful balance in which virtual programs can be successfully implemented while preserving meaningful interactions among students is a critical goal for this study. Our results will address the urgent need for virtual programs or new Active Learning (AL) methods during both the current pandemic and pedagogical changes brought about by the digital age in the long term. The overarching goal of this ongoing project is to improve psychosocial outcomes (PSO, e.g., sense of belonging, self-efficacy, and self-identity), engineering persistence outcomes (EPO, i.e., retention, graduation, and academic performance (AP; e.g., overall GPA, and engineering GPA, especially as it relates to completing introductory and gateway courses required for upper-level study. AL, with a heads-and-hearts approach in this experiment, is created through frequent interaction with the instructor, who provides students with immediate, meaningful feedback through the Echo 360 access point in BlackBoard (TAMIU secure learning management system).

Inspired by research in cognitive psychology and pedagogical practices in the sociology of science, these two forms of team-based creative video projects (CVP) are specifically designed to enhance psychosocial outcomes such as engineering sense of belonging, engineering self-efficacy, and engineering self-identity. In this paper, we present the preliminary results of creative ways of using CVP) in early college engineering courses to improve PSO in the ongoing study. We examined and evaluated, through pre-and post-intervention surveys for the first semester, the impact of the intervention on the engineering students' scholastic outcomes, psychosocial outcomes (PSO) (e.g., engineering sense of belonging, engineering self-efficacy, and engineering self-identity), and engineering persistence outcomes (EPO) (i.e., retention, graduation, and academic performance (i.e., overall GPA, and engineering GPA)). We presented statistical results for validation and analysis of the data (cleaning and quality control) and inferential analyses.

2. Methods

Our study is a randomized controlled trial that involves two consecutive cohorts of first-time freshman TAMIU engineering students. Each cohort will be engaged for a year, with Cohort 1 starting in Fall 2023 and Cohort 2 starting in Fall 2024. We will be conducting the study online, using the Blackboard (BB) learning management system, and will be administering foundations of engineering gateway courses (ENGR 1201 & ENGR 1202) in consecutive semesters and an ordered sequence. Each cohort will be randomly divided into two equally sized comparison groups: Control Group (CG) and Intervention Group (IG). Participation in the study is voluntary, and we obtained consent from those interested in joining, following Institutional Review Board protocol.

We will take three measurements: pre-intervention (M1), post-intervention after ENGR 1201 (M2), and another after ENGR 1202 (M3). The IG group will receive online learning through Blackboard along with ALS (AL with the culture of inclusion through video-based activity/interaction) and Creative Video Project (CVP). The CG group will receive online learning through Blackboard along with ALS. IG participants will be randomly assigned to CVP teams of 3-4 members. These teams will produce two forms of team-based CVPs: 1) A 12-minute critical self-reflective biographical video of an engineer-scientist (e.g., Nikola Tesla, Donna Strickland, etc.). 2) A 6-minute position statement video on an engineering controversy/problem or a hotly debated issue in engineering (e.g., "Should the U.S. Continue with Its Manned Space Exploration? Did human error cause the Chernobyl Nuclear Disaster?").

The 6-minute video will be created for those assigned CVPs using the TAMIU-licensed Echo360 software, subtitled in English. The link for the video will be shared or submitted by all the team members via a BB Turn-It-In-Dropbox. Team members will assume the roles of director, producer, actors, and film editors in preparing this controversial statement video. All team members must appear and be heard on the video product. Through these CVP activities, we aim to build engineering self-efficacy, self-identity, and a sense of belonging through reflective thinking, internalization (about the challenges of engineering life and the journey to becoming a successful engineer), and collaborative creative work.

3. Results and Discussion

This paper presents results from the first (M1; preintervention) and the last measurement occasion (M3). All statistical results are shown below in Table 1. From data collected through our PSO survey at M1 and M3, we calculated five summated PSO indicators, namely: Y1 (Academic Self-Efficacy in Engineering; average of three items), Y2 (Engineering-Task Self-Efficacy; average of four items), Y3 (Engineering Self-Identity; average of four items), Y4 (Sense of Belonging in the Engineering Community; average of 18 items), and Y5 (Intention to Stay in Engineering; average of five items). To compare IG and CG, we calculated the *% change of Yi from M1 to M3* = ((YiM3 - YiM1)/YiM1) x 100%) for all i = 1...5 and used these values in a set of independent samples t-tests. Calculating the *% change of Yi from M1 to M3* provides a measure of directional change (or gain or loss) from M1 to M3. Without these indicators and their associated calculated values, we cannot measure change (net loss/gain) in PSO associated with CG and IG.

Table 1: Group Statistics Summary for IG and CG for Five PSO Indicators.						
	Group	N	Mean	Std. Deviation	Standard Error	p-value
% change Y1	CG	6	-8.89	8.12	3.31	0.043
	IG	9	6.04	18.4	6.13	
% change Y2	CG	6	-5.5	11.84	4.83	0.147
	IG	9	6.3	24.36	8.12	
% change Y3	CG	6	-8.11	18.15	7.41	0.160
	IG	9	1.14	16.17	5.39	
% change Y4	CG	6	4.1	10.65	4.35	0.224
	IG	9	10.15	16.72	5.57	
% change Y5	CG	6	-9.81	4.85	1.98	0.032
	IG	9	8.66	21.81	7.27	

Separated by comparison groups (CG and IG), Figure 1 presents the % change from M1 to M3, with standard error bars, for each of the five PSO indicators. Across the five indicators, IG participants showed an increase (positive *% change*), while CG participants demonstrated a decrease (negative *% change*) line in all indicators except Y4. Statistically significant results are observed for Y1 ($p = 0.043$) and Y5 ($p = 0.032$). PSO indicator Y5, signifying intention to leave, was aptly reverse-coded to mean intention to stay. Intention to stay from M1 to M3 showed an increase (+8.66%) for IG participants, while the opposite was true for CG participants (-9.81%).

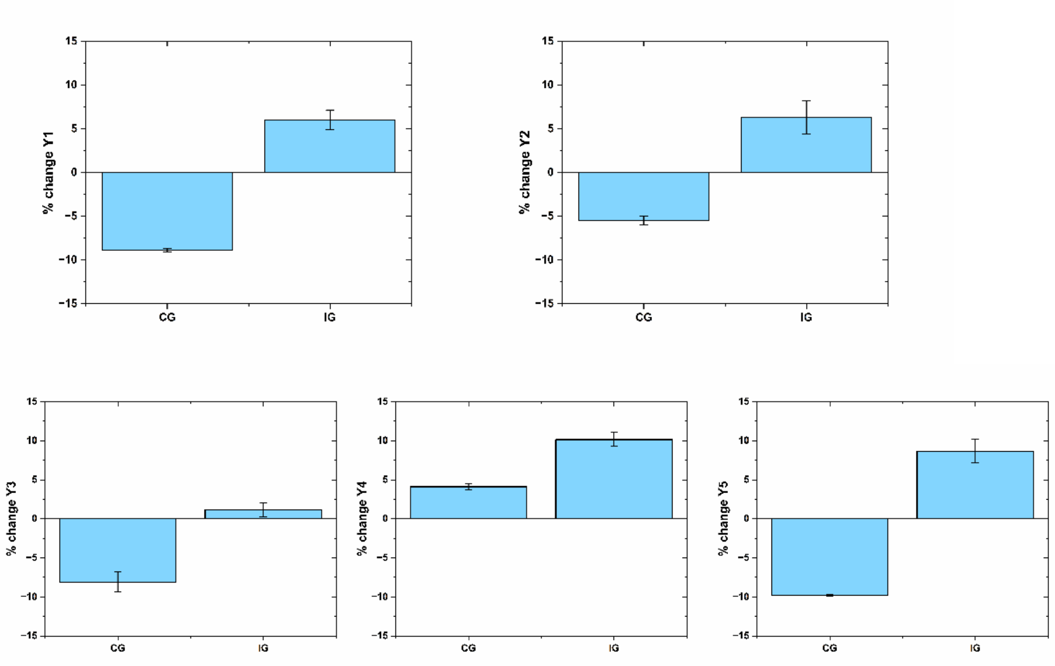

Figure 1 (top and bottom) Compares the % change Y (M1 and M3) for various PSOs for IG and CG.

PSO indicator Y1, indicating academic self-efficacy, also saw an increase (6.04%) for IG participants and a decrease (-8.89%) for CG participants. The assignments given to IG (a video project) and CG (an essay) generally differ in terms of the student's effort. A video project demanding more collaborative efforts from IG participants was likely to spark more personable connections and interactions among peers, which could have potentially increased the morale of students. IG participants, consistently working with others for two consecutive academic semesters, saw statistically significant benefits to such efforts: they were more likely to stay in engineering and had more confidence in their academic abilities. CG participants, only confined to producing an essay, likely had not established the same level of connections and interactions with their peers and thus saw a decline across all but one PSO indicator.

4. Conclusions

Five PSO indicators of interest were compared between the intervention group (IG) and the control group (CG). The results showed that the % change between IG and CG was significantly different for Y1 (Academic Self-Efficacy in Engineering) and Y5 (Intention to Stay in Engineering). However, there were no statistically significant differences in % change between IG and CG for Y2 (Engineering-Task Self-Efficacy), Y3 (Sense of Self-Identity in the Engineering Community), and Y4 (Sense of Belonging in the Engineering Community). It was observed that the PSO indicators that required more internalization and affective connection (Y2, Y3, and Y4) were not readily fostered or impacted by the intervention over two freshman semesters, while Y1 and Y5, which are relatively more surficial, could easily be cultivated and impacted by the intervention. Data collection for Cohort 2 M1 to M3 next year is yet to be completed to obtain definitive, comparable, and generalizable results.

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