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Peer Learning in Introductory Engineering

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Overview

- Overview of the research study
- Review of the literature
- Methods and data collection
- Discussion, conclusions and recommendations

Goals

The goal of our research is to provide a better understanding of the impacts of PLTL on non-traditional groups and promote student’s identity development and commitment within STEM and engineering.

Summary of Research

Our research aim was to understand if PLTL and engagement in problem-based learning activities increase commitment to engineering pathways and academic success.

We used both qualitative and quantitative data collection and analysis to answer our research questions and give recommendations.

The findings show that while there is an overall improvement in grades and commitment to engineering pathways for those involved in PLTL activities, there is still a concern with integration and scalability of PLTL in engineering education.

Research Problem and Analysis

The study examined underrepresented and female students' abilities to translate cognitive knowledge into demonstrable performance-based proficiencies through the engagement in peer-led, team learning activities in post-secondary, undergraduate introductory engineering courses.

Observed Characteristics in targeted non-traditional student population:

- Low retention
- Low grades
- Low participation
- Low confidence in mathematical and problem-solving abilities

Research Question

Does participation in PLTL activities support underrepresented and female students' performance in introductory engineering courses and retention in engineering pathways?

Research Design

- 518 students enrolled in four introductory engineering courses and the recitation lab.
- Proficiencies assessed included evaluation, analysis, synthesis, and reasoning in the contexts of engineering education problem-based activities.
- The study population was undergraduate engineering students at a multi-campus, federally-designated Hispanic-serving, public, two-year college in the southeastern U.S.

Research Design

The data collected was from May 2018-May 2020.

Pre-Post Survey Responses were Collected

Institutional Data was collected on Pass/Fail Rates and Major Choice

Qualitative Data was collected through Classroom Observations and Focus Group Activities

Literature Review

A literature review provides evidence that active learning and problem-based learning strategies introduced through peer-led learning activities had positive outcomes on a student's academic performance (Drane et al., 2014; Loui et al., 2013).

Furthermore, the data collected throughout multiple studies shows that small group discussions with integrated learning strategies increased levels of self-efficacy in non-traditional students (Bumann & Younkin, 2012; Chan & Bauer, 2015; Gosser, 2011)

PLTL Activities and Training

Peer Leaders are Successful Former Students

Peer leaders completed two trainings to improve their teaching capability

- Active Learning Strategies Training
- Peer Leader Academic Training

Faculty members teaching the courses completed training on Active Learning Strategies

PLTL activities are designed/created in collaboration between all the faculty members teaching the course

Peer Leaders implemented the PLTL activities in collaboration with the faculty teaching the course

PLTL Activities and Training

Active Learning strategies Training

- Two hours training – one hour online, one hour Face-to-Face
- Online part contains training on different types of active learning strategies
- Face-to-Face included practice of the active-learning strategies

Examples :

Quiz Quiz Trade
Parts, Purposes, and Complexities
Story Share Capture
Write, Draw, Talk Rewrite Strategy

Demographics

- 518 participants enrolled in four introductory engineering courses (Statics, Dynamics, Electrical Networking, Electrical Engineering).

- Female student participants represented 20.8% (108/518).

- The majority of individuals in the courses identified as Hispanic, a group significantly underrepresented in engineering.

Methods

Three surveys were administered each term. Questions were guided by the study's theoretical framework (Bandura, 2012) and used to determine a student's commitment to engineering pathways and levels of self-efficacy.

Structured focus group questions and experiences questionnaire was developed from the focus questions employed by Talley and Ortiz (2017).

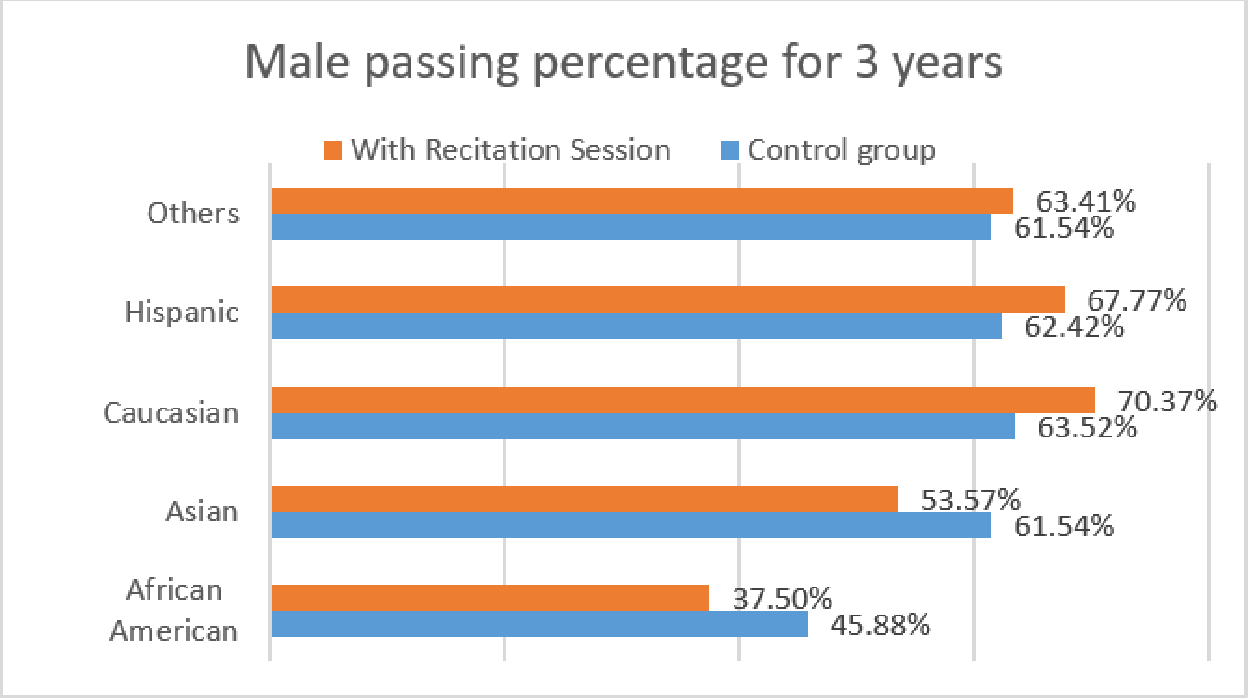
Grades (Academic Success)

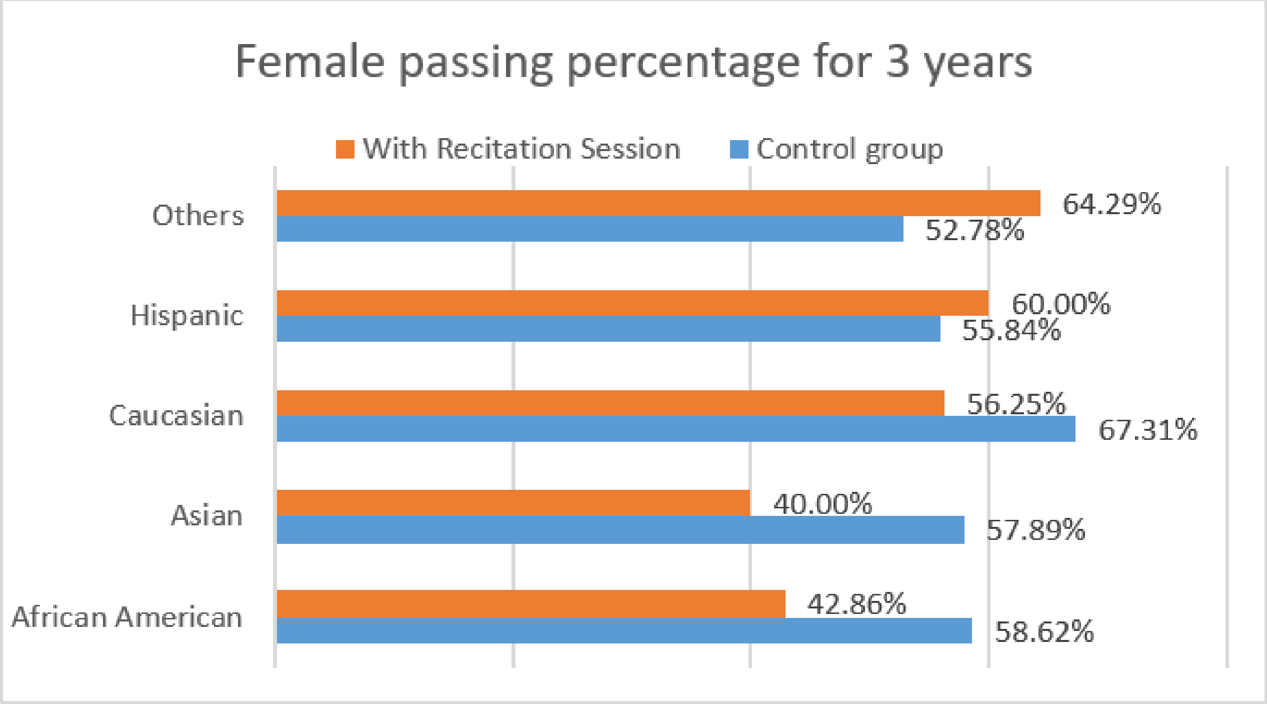
Commitment to Engineering Major (Retention)

Overall Student Academic Performance

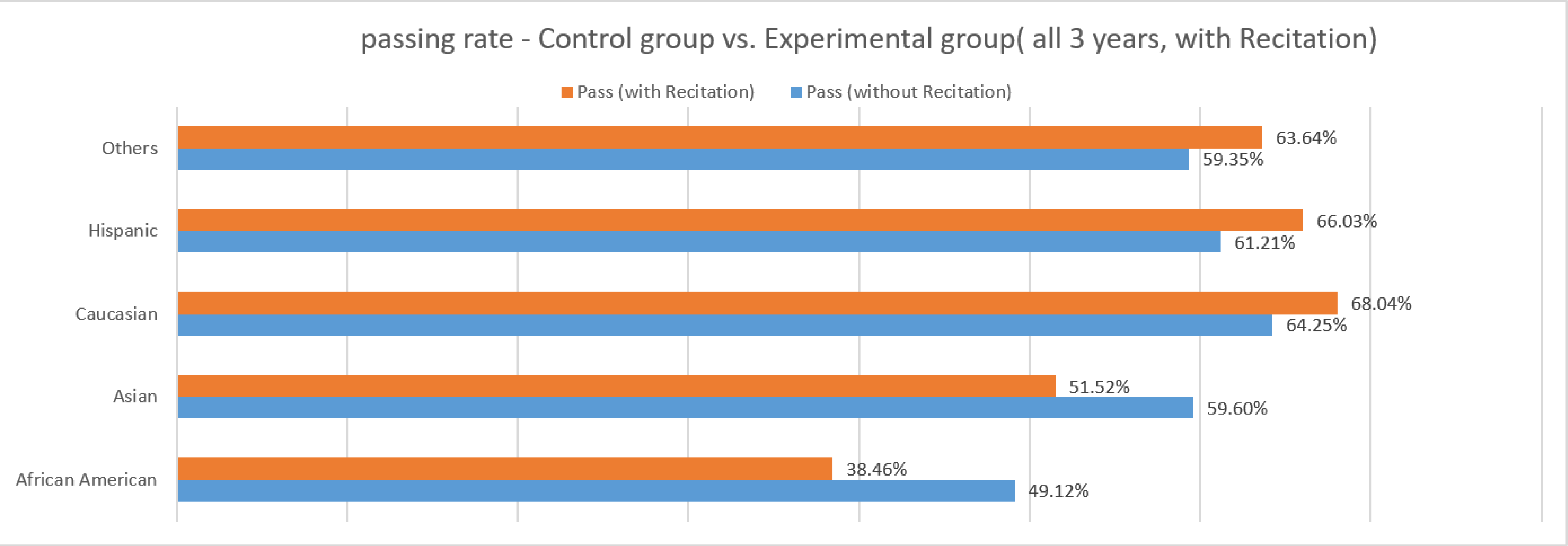
Course	Student Count	Semesters	Control Group Pass Rate	Experimental Group Pass Rate	Difference
Statistics	380 students	5 semesters: Sum 18, Fall 18, Sp 19, Fall 19, Sp 20	60.56% (691)	62.11% (236)	+2%
Dynamics	100 students	3 semesters: Sp 19, Fall 19, Sp 20	66% (212)	60% (60)	-6%
Electrical Networks	24 students	2 semesters: Fall 19 and Sp 20	59% (54)	71% (17)	+11%
Electrical Engineering	14 students	1 semester: Sp 20	71% (62)	86% (12)	+14%

Statics Results - Success





Statics Results – Success By Demographics



Academic Performance

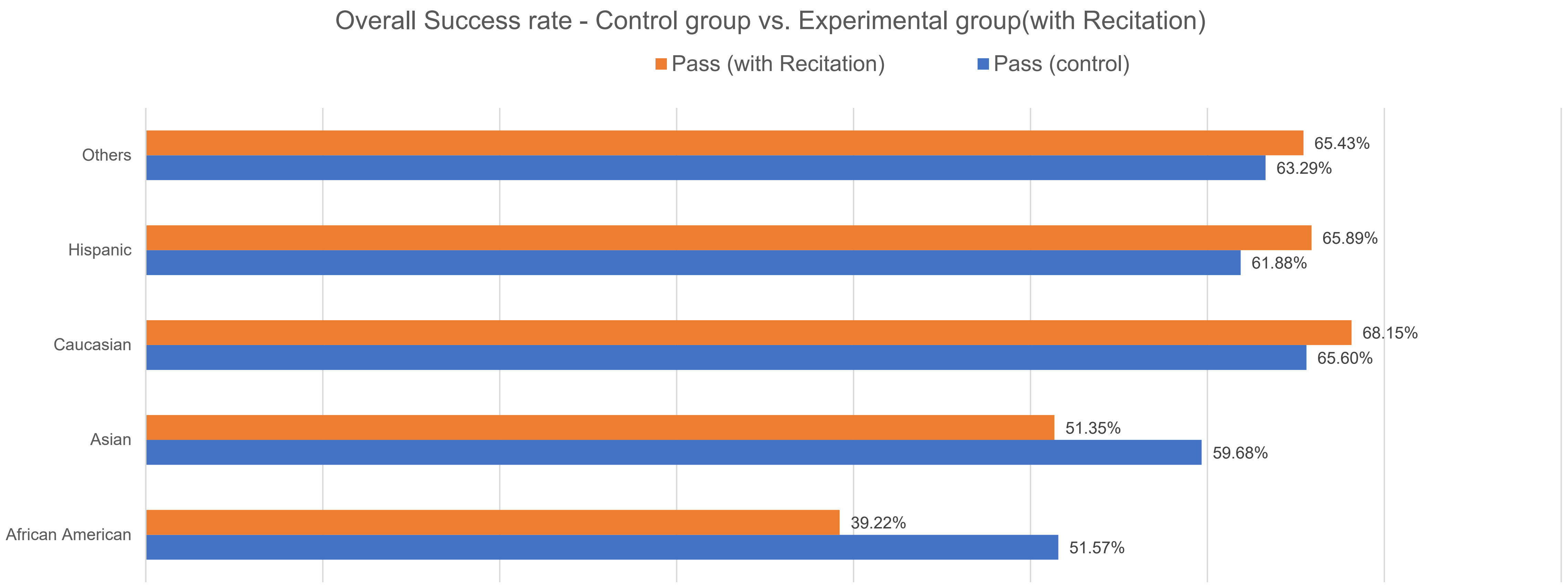
The pass rate was 62.74% (325 of the 518 students passed the courses).

The female student pass rate was 58.49% (62/106) compared to the male students' pass rate 63.83% (263/ 412).

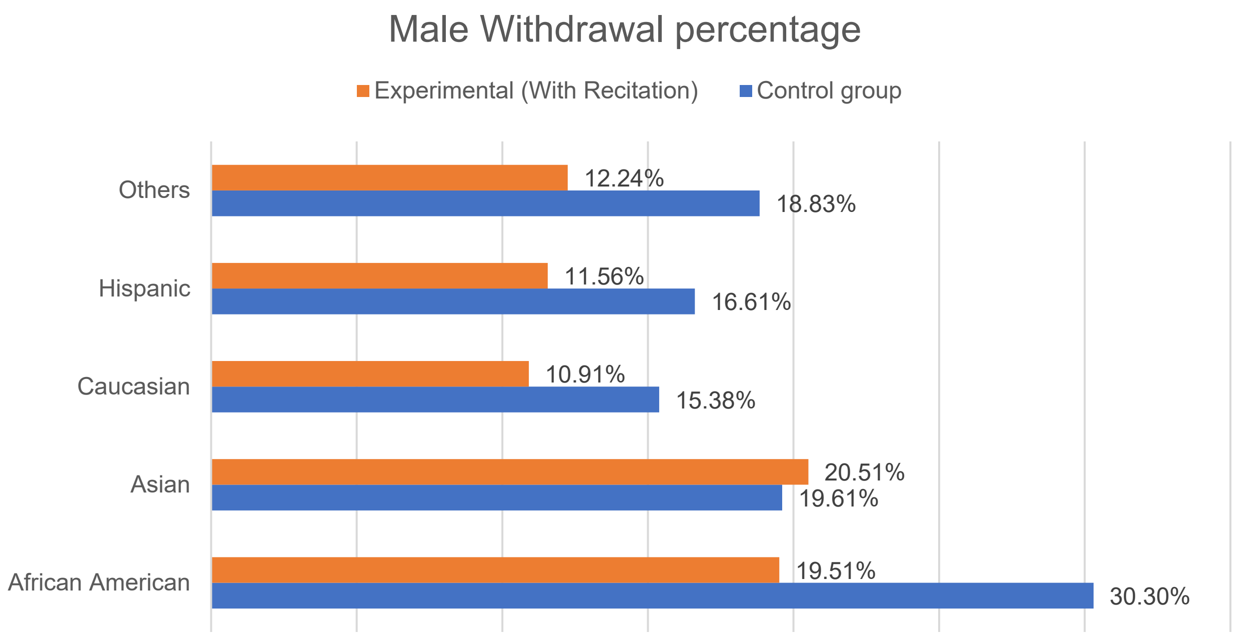
The highest pass rates in the engineering courses were seen in the Caucasian students in the experimental group at 68.15% followed by Hispanic students at 65.89%.

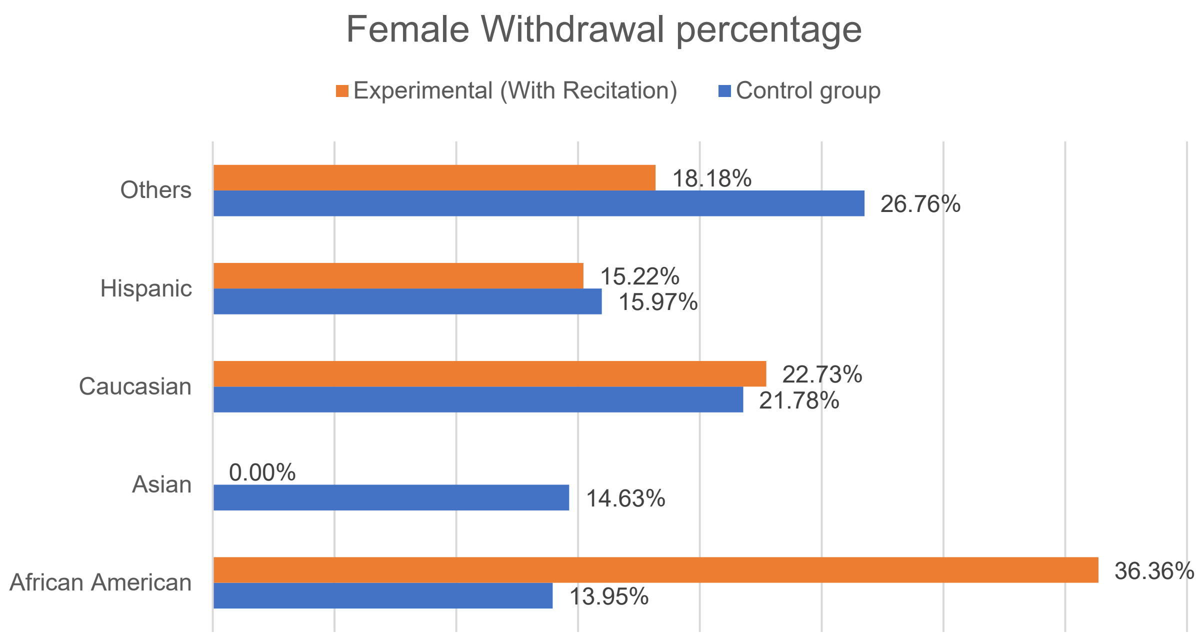
Additionally, students had the highest pass rates in both Electrical Engineering and Electrical Networks courses.

Overall three year Results of all four courses – Success By Demographics

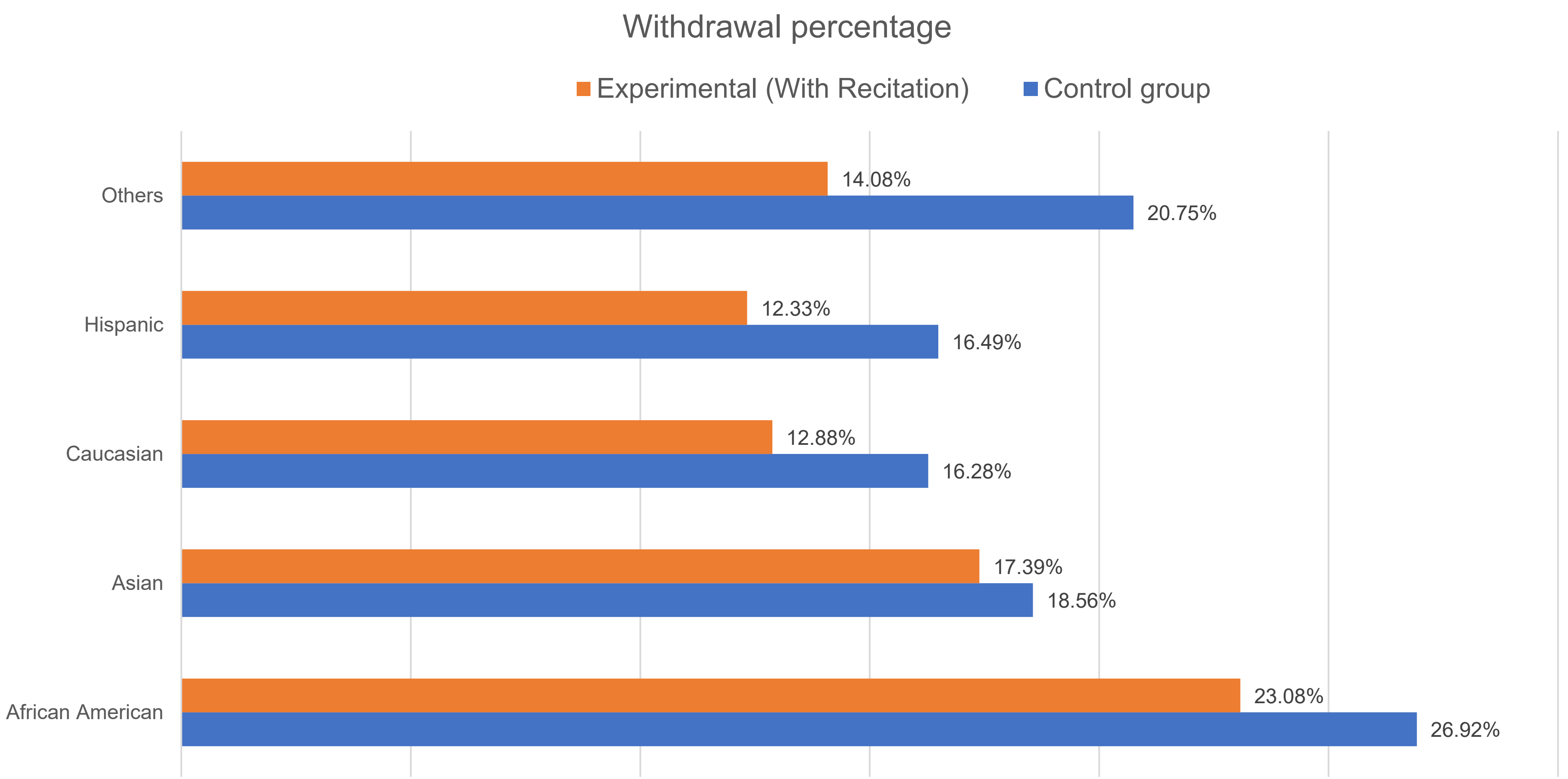


Overall Withdrawal Rate (Gender and Demographics)

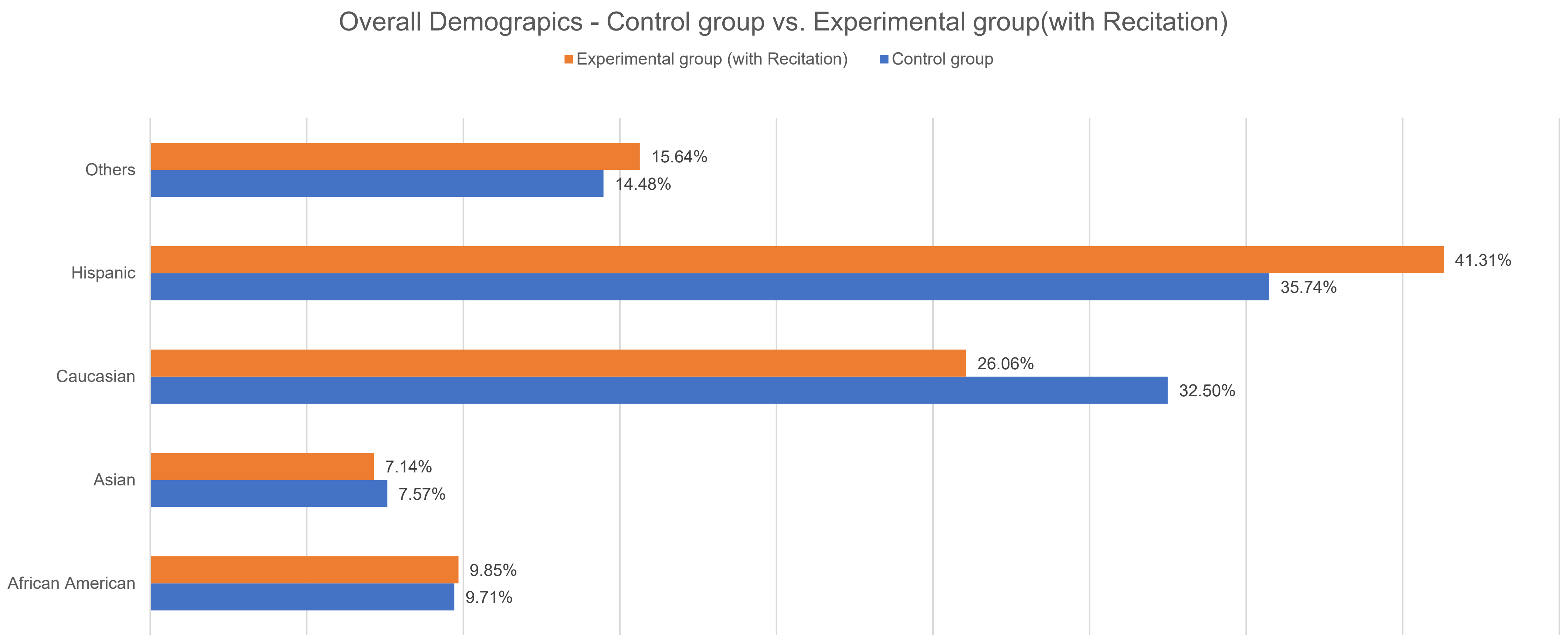




Overall Withdrawal Rate (Demographics)



Overall Demographics (all 4 courses)



Commitment to Engineering Pathways.

- 88% (208 of the 264) of the students in the experimental group who enrolled in and successfully passed the statics course remained in an engineering pathway at the institution and/or declared an engineering upon transfer to a four-year institution.
- 10% (23 out of 264) left engineering but remained in a STEM-pathway.
- 84% (71 of 85) of the students that took dynamics stayed in engineering
- 12% (10 of 85) left engineering but remained in a STEM-pathway
- 100% (18 of 18) of the students that took electrical networks remained in engineering.

Pre-Post Survey Results

The Survey results were from 295 students enrolled in courses in Summer 2018, Fall 2018 and Spring 2019.

- 97% of the students who participated in the PLTL activities remained as committed or felt more committed to the engineering pathway.
- 79% of the students felt that the activities helped improve their understanding of the course material covered in the traditional course.
- Prior to participation in the PLTL activities used in the recitation lab, less than 80% of the students were comfortable applying mathematical and physical concepts to real-world problems. The percentage increased by 8% as shown in the post-survey responses.

Pre-Post Survey Results

As a result of participation in the activities, 86% of the students felt that their analytical and critical thinking skills had improved by a great or moderate extent.

Over 80% of the students surveyed, agreed that the activities helped improve their class performance.

Experiences Questionaries

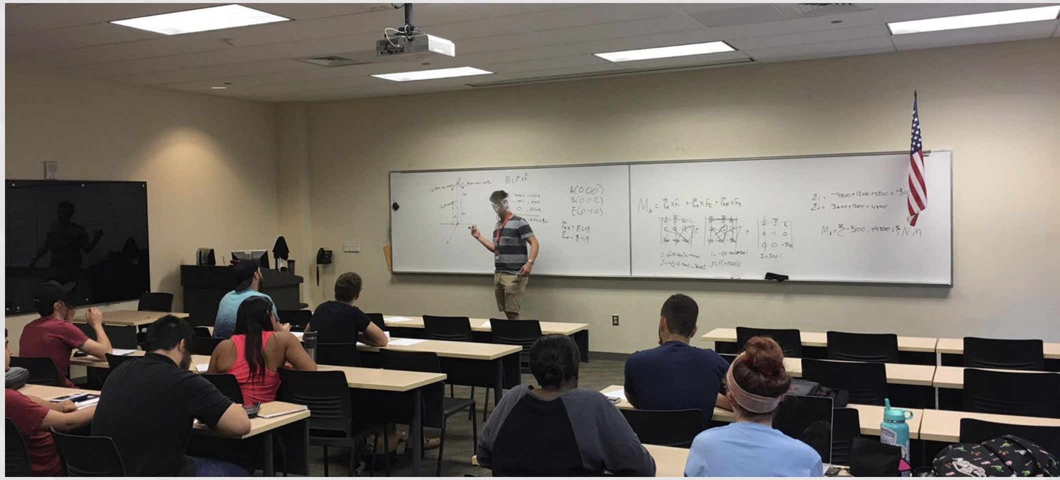
Oct 2019, We received feedback from seven students. Responses were compared to those of four students in STEM disciplines who did not participate in the PLTL activities.

The five most often reported experiences were: (a) feel comfortable using the tools needed for studies; (b) staff / faculty members making connections-course content and real world (i.e. community); (c) access to the tools needed for studies; (d) learned steps necessary for safety in the class or in labs; (e) learned ways to make a difference through a career in STEM.

Conclusions

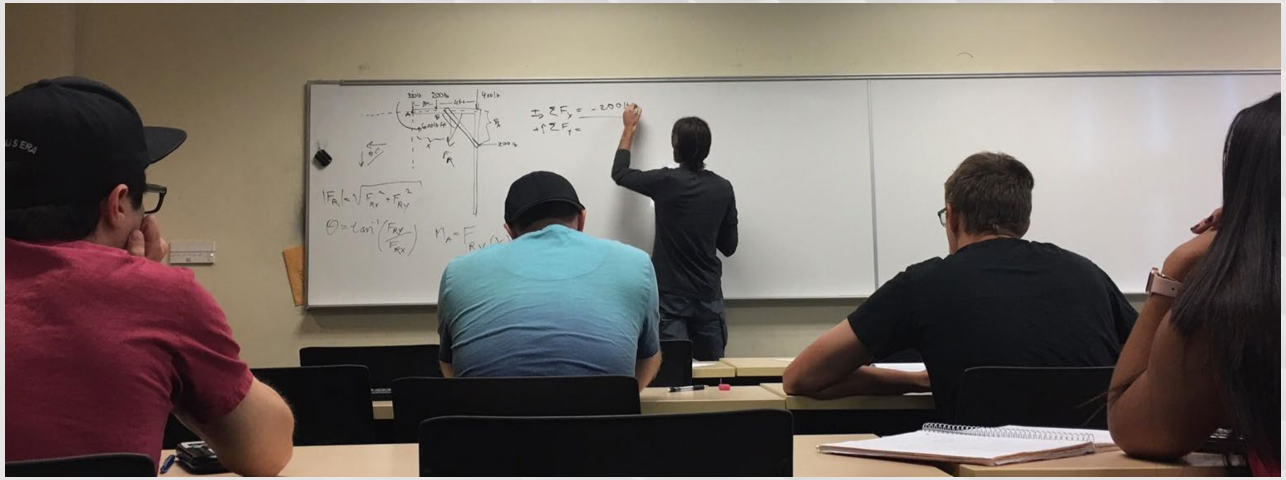
- As a result of the participation in the PLTL, 80% of the students were comfortable applying mathematical and physical concepts to real-world problems.
- 96% of the students felt that their analytical and critical thinking skills had improved.
- The average post-survey response to the question asking whether students felt comfortable applying mathematical and physical concepts to real-world problems showed females had the highest averages.

Recommendations



Offer peer leader professional development that includes training on how to engage diverse groups of students and incorporate active learning strategies into the recitation labs.

Provide peer-led, team learning opportunities to increase the network of peers and role models available to students, specifically those who are non-traditional students in engineering.



Incorporate methods of collaborative learning with upper-division peer leaders to build stronger commitments to engineering pathways and identity within the engineering and STEM community.

Thank you

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