



Launching PLTL for MATH: Building on the Foundation of Supplemental Instruction

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Launching PLTL for MATH: Building on the Foundation of Supplemental Instruction

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Abstract

The paper describes the launch of Peer-Led Team Learning for Precalculus Engineering and Math at the University of Texas at Arlington (UTA) and the results that PLTL has had on pass rates. Historically, students placed into Precalculus, instead of being Calculus ready, have experienced higher failure rates than any other student grouping. While UTA has invested in many studies, programs and techniques that aid these underprepared students, a few strategies have emerged as being effective. These strategies have included the previous implementation of Supplemental Instruction (SI), with separate sections devoted specifically to Precalculus co-enrolled engineering-course students, peer-based instruction, and active learning activities as opposed to additional lectures. As a result of these findings, in the Fall 2020 semester, UTA combined all these strategies into a learning course integrating these best practices into a required PLTL learning lab with problem-based activities and studying practices for the engineering course and a self-selected PLTL option for the math course. The goal was to aid in increasing success rates in these classes. The students engaged in effective “study habits” and problem-based learning practices with a Peer-Led Team Learning (PLTL) leader. What we have found is the positive impact that PLTL has on pass rates for at-risk populations in addition to positive satisfaction surveys. This paper will show the effectiveness of PLTL by discussing success rates for the Fall 2020 and Spring 2021 semesters versus the other singular implementations from previous semesters, in this case Supplemental Instruction.

Keywords: Mathematics Readiness, Underprepared Students, Academic Support for Undergraduates, Passing Rates in Foundational and Gateway Courses, Active Learning, Supplemental Instruction, Peer-Led Team Learning

Introduction

The University of Texas at Arlington (UTA) is the largest university in North Texas and second largest in The University of Texas System. UTA is located in the heart of Dallas-Fort Worth and offers more than 180 baccalaureate, masters', and doctoral degree programs with more than 60,000 students engaged in campus or online coursework each year. UTA is designated as an HSI (Hispanic Serving Institution) and AANAPISI (Asian American, Native American, Pacific Islander Serving Institution) and has an undergraduate population that is 31% Hispanic, 14.9% African-American, and 12.8% Asian (Fast Facts – The University of Texas at Arlington, 2021).

The Academic Success Center (ASC) at UTA is a comprehensive office which houses centralized academic support for undergraduate students. These services include Supplemental Instruction (SI), Drop-In Tutoring, 1:1 Appointment based tutoring, eTutoring, and TRIO Student Support Services tutoring. The goal of the center is to support first year and second year foundational and gateway courses that have high DFW rates. This paper will discuss two academic support models, Peer-Led Team Learning and Supplemental Instruction. The models are defined below:

Peer-Led Team Learning (PLTL). The PLTL model uses students who successfully passed the course to lead 80-120 minute weekly collaborative group sessions with a small group who commits to study for the semester (Gosser & Roth, 1998). PLTL leaders liaise with faculty weekly and facilitate course material in the form of problem packets.

Supplemental Instruction (SI). SI is an academic support program which utilizes peers who have succeeded in historically difficult courses to assist other students as they complete these courses. The leader attends class and provides regular review sessions outside of class by facilitating collaborative group study, and teaches learning strategies (McDaniel & Zenger, 2004).

In Fall 2020, the ASC implemented Peer-Led Team Learning (PLTL) for two reasons. The first was to address the high DFW rate for the ENGR 1250 (Problem Solving in Engineering) course which is an introductory course for new engineering students. Altomare and Moreno-Gongora (2018) found that Supplemental Instruction improved pass rates for students in developmental math. Assisted by Supplemental Instruction and successful peer educators, the DFW rate for the course was decreasing, but not at a satisfactory rate for the institution. The course coordinator determined that the engineering students who did not successfully pass the course were students who were not Calculus ready. At the same time, learning loss from COVID 19 impacted the FTIC class and there was an increase in students

needing improved understanding of Precalculus. Supplemental Instruction had been previously offered for Precalculus but had not yielded the expected rate due to students not attending SI on a regular (weekly) basis and as a result did not achieve higher pass rates. PLTL has previously been seen to improve pass rates for all students including African-American and Hispanic populations in STEM courses (Hickman, 2016). It was decided in partnership with Engineering and Math faculty coordinators to launch PLTL as a new model to improve pass rates in Precalculus understanding in both the introductory Engineering (ENGR 1251) and Precalculus (MATH 1421) Courses for Fall 2020.

A new Coordinator I position was funded to oversee the PLTL program under the direction of the Director of the Academic Success Center. Funding was provided through tuition allocation funding. The PLTL model was implemented in two different ways. With advance planning, it was decided to add a two-hour lab for the Engineering Problem Solving course (ENGR 1251) where PLTL would be available for all students in the course. For MATH 1421, PLTL was offered as a voluntary academic support service.

The embedding of PLTL into a lab meant it was required that all students sign up for PLTL which is a slight deviation from the traditional PLTL model as students typically self-select to join PLTL. A total of 206 students actively participated in PLTL for the 2-hour lab, once per week, for a total of 12-weeks working problem packets developed by the faculty coordinator and facilitated by a student who had earned an “A” in the Problem-Solving course.

Study habits and problem-solving activities

One of the more unique focuses of this program was to add in some metacognition activities. The goal is to improve students’ abilities to solve real-world problems, not simply pass a “math” class. Therefore, part of the study skills activities in which the PLTL leaders would engage would be ideas of how to read and take notes from a book; how to study for an exam; how to methodically break down a problem they have never seen before; and other such activities. The goal of these activities was to increase students’ study skills to help them become more effective not only for this course but their subsequent courses.

A unique feature of this program is that no answer sheets were provided by the Engineering faculty for the problem sets. This encourages the leaders to work through the problems themselves and with each other thus practicing the problem-solving strategies and to process skills that they will model for their PLTL groups. The emphasis is on the process and steps involved in being able to approach any problem with confidence and conceptual understanding, as opposed to simply acquiring the solutions. Students in turn apply critical

thinking skills to the problem-solving methods they adopt and provide feedback on input from other group members. As a result, PLTL students develop process skills that can improve their performance in the course as well as be transferred to their other courses. In PLTL, “the emphasis is on learning to find, evaluate, and build confidence in answers... in a supportive environment” (Eberlein et al, 2008, p. 262-273).

Methods

This pilot launch of PLTL for Fall 2020 for Precalculus Math and Engineering was intended to determine if pass rates and student success would show improved results over the use of Supplemental Instruction to address deficiencies in understanding the concepts covered in Precalculus. Quantitative and Qualitative data were gathered around pass rates and gathered via grade data in the UTA Student Information System. Qualitative data were collected to understand student satisfaction with the PLTL model and the Question Pro survey tool was utilized to conduct the student satisfaction surveys.

Results

For Fall 2020 ENGR 1251 PLTL groups were typically 10-12 students with one PLTL Leader facilitating the session. Previously PLTL registration was typically self-selected however registration for ENGR 1251 was mandatory beginning Fall 2020. As a result there was a shortage of PLTL Leaders and we were unable to adhere to the group of eight students’ model (Hickman, 2016). The increased workshop size did not appear to affect the overall quality of the sessions.

MATH 1421 Fall 2020 semester sessions had between 1-4 students in a group as opposed to 8 students. Participation by the students was inconsistent throughout the semester. This was largely due to the program beginning approximately 4 weeks into the semester as opposed to the 2nd week of the semester. The launch of this pilot program was delayed due to funding not being available until the start of the new fiscal year on September 1. PLTL for MATH 1421 was voluntary whereas PLTL was added into the ENGR 1251 course lab and was attended by all students in the course. Participation numbers are represented in Table 1. In Spring 2021, MATH 1426 (Calculus I) was added as an offering and is also represented in the table below.

Table 1. PLTL Course Participation Numbers

Fall 2020	Number	Spring 2021	Number
ENGR 1251	222	ENGR 1251	139
MATH 1421	72	MATH 1421	118
		MATH 1426	142

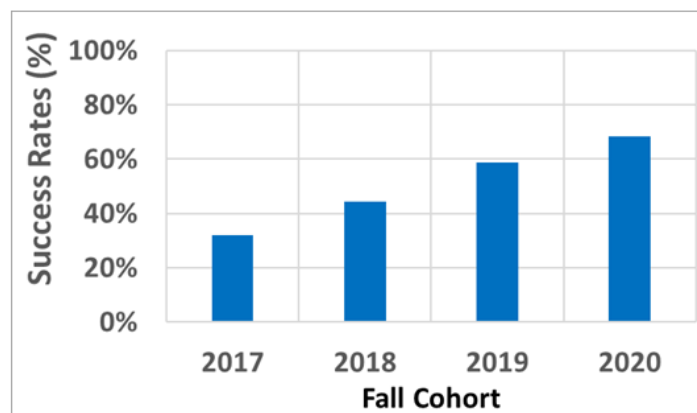
Pass rates

To assess the effect of this program, we compare results of the PLTL pilot to previous results from Supplemental Instruction. Before we get into specifics, we must define a few terms for clarity. First, “pass rates” in this course mean that students received an A, B, or C in the course. For Fall 2017, there was no intervention for Engineering 1250 (pre-cursor to ENGR 1251, in Fall 2018 SI was first implemented and continued in Fall 2019 for ENGR 1250. In Fall 2020, PLTL was introduced to Precalculus co-enrolled students in ENGR 1251. Class sizes and pass rates for ENGR 1251 are represented in Table 2 and Figure 1.

Table 2. Class sizes for each fall cohort

Fall Cohort	Number of students
2017	178
2018	208
2019	147
*2020	195

* PLTL was introduced in Fall 2020



[n=178 for 2017; n=208 for 2018; n=147 for 2019; n=195 for 2020]

Figure 1. Pass rates for Precalculus co-enrolled students with PLTL Pilot in Fall 2020

For Figure 1, it should be noted that Fall 2017 was the last semester that the problem-solving course was taught without any specific intervention for the Precalculus co-enrolled students. Fall 2018 included implementing Supplemental Instruction, which was an opt-in program. In fall 2019, Precalculus co-enrolled students were separated into cohorted sections and offered SI. However, attendance records showed that the students that needed support the most, were the least likely to attend SI. Those specific students included many UTA underrepresented minority populations. What is noted is that with the launch of PLTL in Fall 2020, the pass rates of the students in the PLTL cohort improved.

For Math 1421, despite a delayed start with the pilot in Fall 2020, the overall pass rate for PLTL attendees was 3.02 (on a 4.0 scale) which increased in Spring 2021 by half a grade (Figure 2). Supplemental Instruction was not offered for Math 1421 from Fall 2017 to Fall 2019.

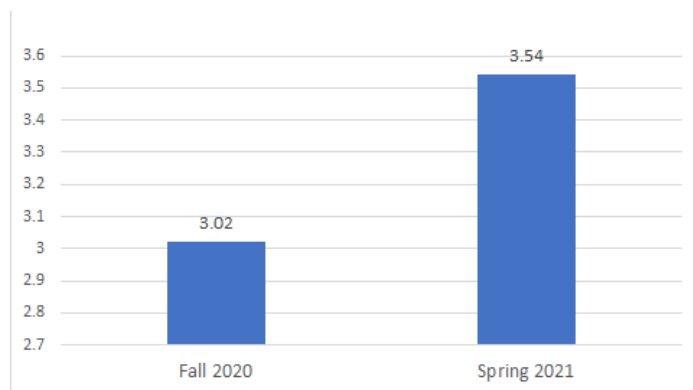


Figure 2. Pass rates for Math 1421 PLTL students

The PLTL intervention for Math 1426 was launched in Spring 2021. Participating students in Spring 2021 had a pass rate (grade average) of 2.75. Supplemental Instruction was previously offered for Math 1426; however, it can be noted (Figure 3) that the impact on pass rates diminished, and the attendance overall was low compared to the PLTL pilot introduced in Fall 2020. Figure 4 shows a 173% increase in participation with 142 students attending PLTL versus 52 attending Supplemental Instruction when last offered in 2019.

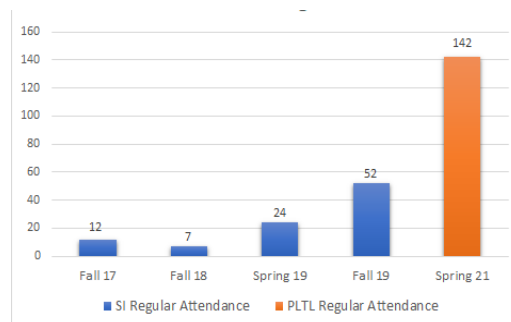
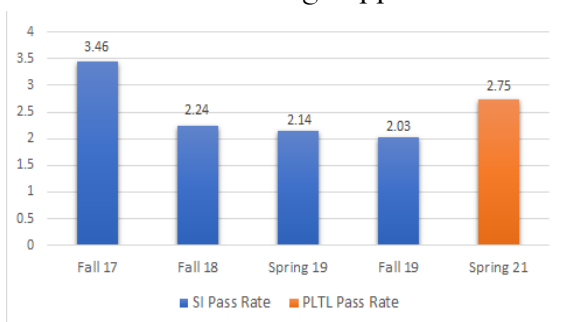


Figure 3. Pass rates for Math 1426 SI and PLTL students; **Figure 4.** Attendance for Math 1426 SI and PLTL students.

Ethnicity and gender

As mentioned previously, UTA is a very diverse campus and a HSI institution. It is important to assess the effectiveness of PLTL on this population and other underrepresented groups. First, as seen in Figure 5, the Asian population appears to be positively affected by the PLTL implementation (Ewing, Hickman, and Unite, 2021). Not only was the passing rate much better but also the letter grade distribution improved, although the overall trend did not seem to change (Ewing, et al., 2021). This cohort of students showed improved overall grades and lowering of attrition rates.

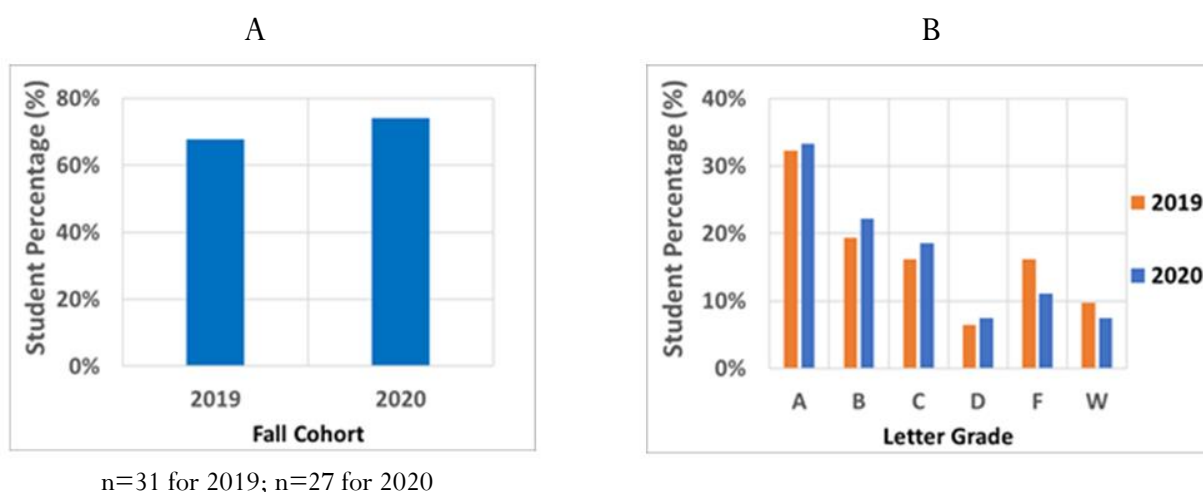
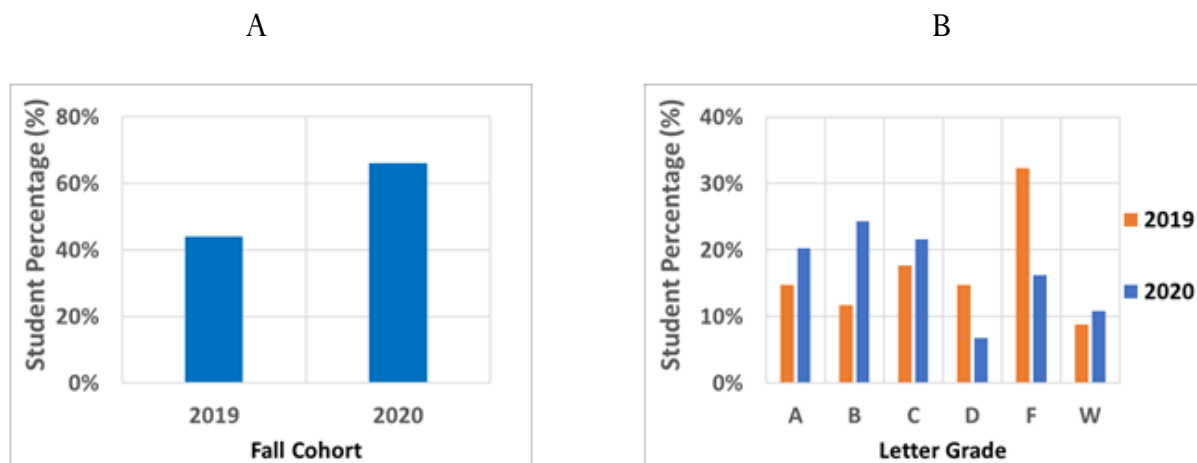


Figure 5. Pass rates for Asian population (A) and the corresponding letter grade distribution (B)

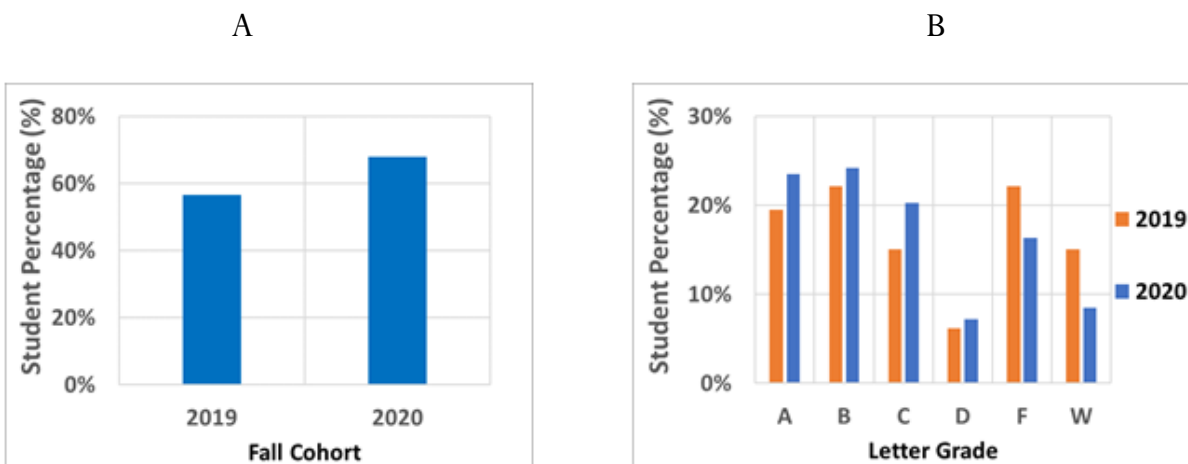
Ewing, et al (2021) found that large strides were made in increasing student success for the Hispanic population (Figure 6). The Pass Rate increase was over 20 percentage points, affecting over double the number of students from the previous fall semester. Student grades were shifted from D and F into the A-C range. PLTL, while beneficial for all students, was very effective for underrepresented and underprepared students in their success in the problem-solving class (Ewing et al., 2021).



n=35 for 2019; n=74 for 2020

Figure 6. Success rates for Hispanic population (A) and the corresponding letter grade distribution (B)

In previous semesters, male students were much less likely to attend SI and other voluntary programs (Ewing, et al., 2021). The mandatory co-enrolling of students into a PLTL lab revealed a significant increase in the success rate in the male population, as seen in Figure 7. Success rates and the overall letter performance in the class also increased (Ewing, et al., 2021). There was a decrease in the withdrawal rate of male students.



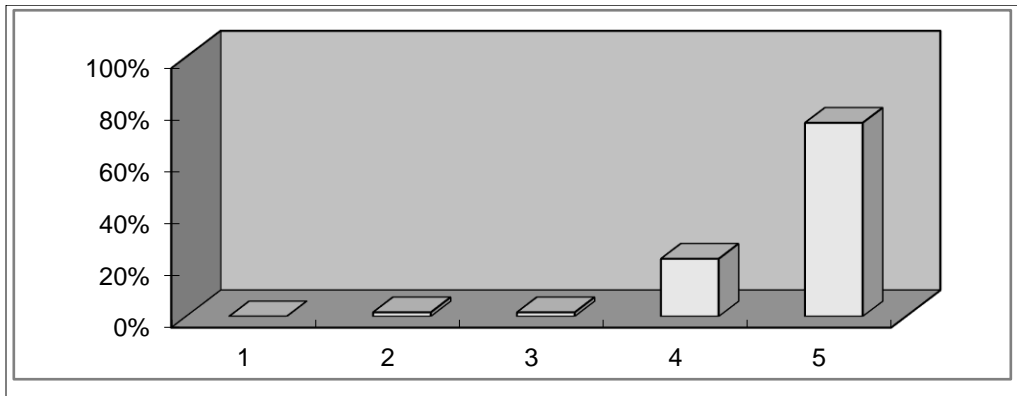
n=115 for 2019; n=153 for 2020

Figure 7. Pass rates for male population (A) and the corresponding letter grade distribution (B)

Survey Results

In addition to pass rates, qualitative information was collected from PLTL student participants on their experience with PLTL for Fall 2020 and Spring 2021. The satisfaction surveys were conducted at the end of the semester at the conclusion of PLTL sessions and are represented in Figures 8 through 13. Please note that the survey for the Engineering and Math courses in Fall 2020 were represented in one graph together (Figure 8), while each course results were separated for Spring 2021 (Figures 9 and 10).

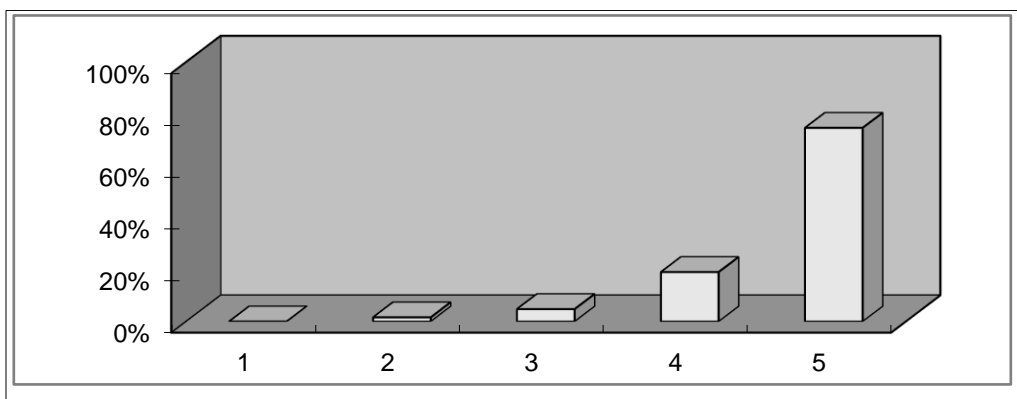
The overall rating for the Engineering and Math courses in Fall 2020 had high satisfaction by PLTL participants. Ratings were on a scale of 1 to 5 stars with 5 stars as the highest rating. The overall mean was 4.698.



Mean: 4.698; Confidence Interval @ 95%: [4.554 - 4.843]; Standard Deviation: 0.586; Standard Error: 0.074

Figure 8. The overall satisfaction rating of ENGR 1251 & MATH 1421, Fall 2020

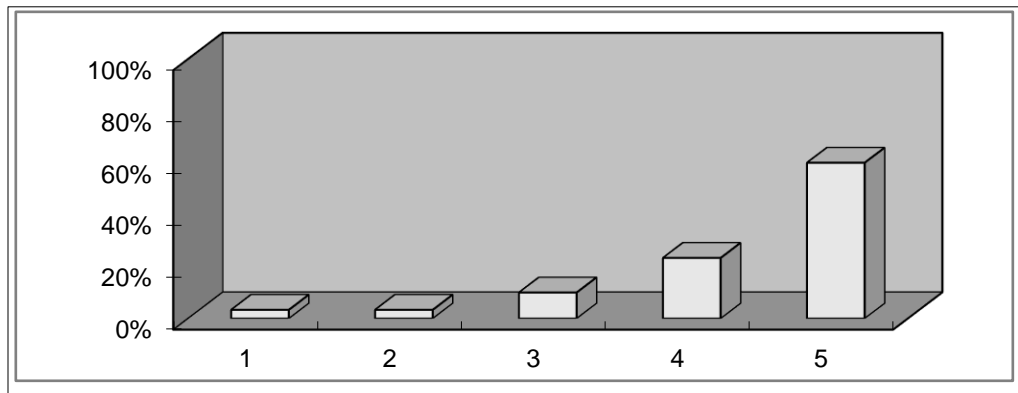
Similarly, for Spring 2021 the overall satisfaction rating of ENGR 1251 PLTL was high with a mean of 4.67.



Mean: 4.67; Confidence Interval @ 95%: [4.507 - 4.827]; Standard Deviation: 0.648; Standard Error: 0.082

Figure 9. The overall satisfaction rating of ENGR 1251 PLTL session Spring 2021

In addition, the overall rating for MATH 1421 PLTL session Spring 2021 had a positive mean of 4.333.



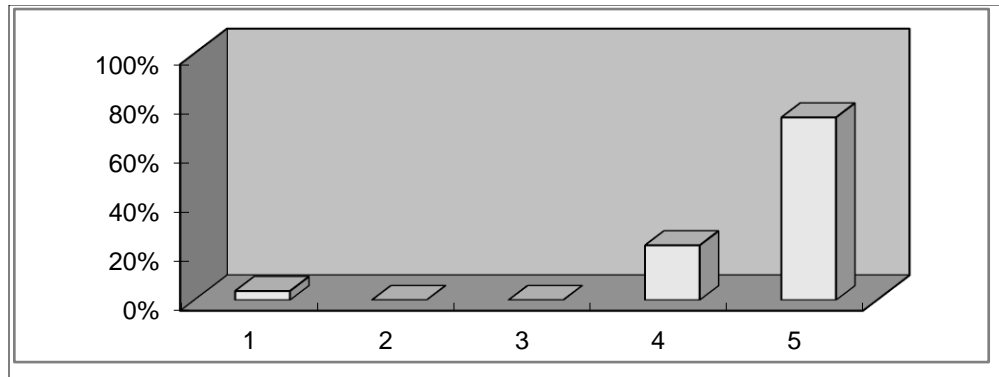
Mean: 4.333; Confidence Interval @ 95%: [3.965 - 4.701]; Standard Deviation: 1.028; Standard Error: 0.188

Figure 10. The overall satisfaction rating of MATH 1421 PLTL session Spring 2021

Other areas that were ranked highly included the following: ENGR 1251 & MATH 1421, Fall 2020 - *The PLTL Leader communicated effectively throughout the session* had a mean of 4.794; ENGR 1251, Spring 2021 - *The PLTL Leader communicated effectively throughout the session* had a mean of 4.78; and for MATH 1421, Spring 2021 - *The PLTL Leader communicated effectively throughout the session* had a mean of 4.567.

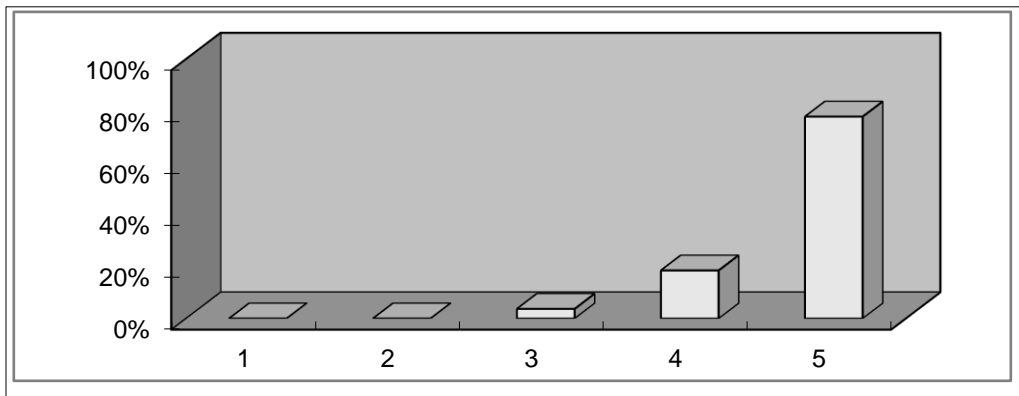
ENGR 1251 & MATH 1421, Fall 2020 - *The PLTL Leader presented difficult concepts with clarity and understanding* had a mean score of 4.698; ENGR 1251, Spring 2021 - *The PLTL Leader presented difficult concepts with clarity and understanding* had a mean of 4.778 and for MATH 1421, Spring 2021 - *The PLTL Leader presented difficult concepts with clarity and understanding* with a mean of 4.433.

PLTL was expanded to MATH 1426 (Calculus I) in Spring 2021. Consistent with the results for ENGR 1251 and MATH 1421, the satisfaction Survey data for MATH 1426 for Spring 2021 showed high satisfaction by PLTL participants. Ratings were on a scale of 1 to 5 stars with 5 stars as the highest rating. The results are represented in Figures 11-13.



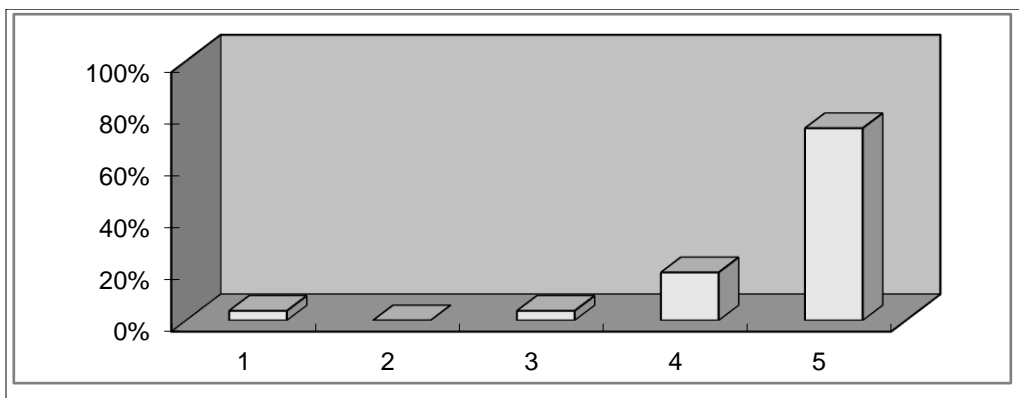
Mean: 4.630; Confidence Interval @ 95%: [4.313 - 4.946]; Standard Deviation: 0.839; Standard Error: 0.161

Figure 11. MATH 1426, Spring 2021 - The PLTL Leader communicated effectively throughout the session



Mean: 4.741; Confidence Interval @ 95%: [4.542 - 4.939]; Standard Deviation: 0.526; Standard Error: 0.101

Figure 12. MATH 1426, Spring 2021 - The PLTL Leader presented difficult concepts with clarity and understanding



Mean: 4.593; Confidence Interval @ 95%: [4.258 - 4.928]; Standard Deviation: 0.888; Standard Error: 0.171

Figure 13. The overall satisfaction rating of MATH 1426 PLTL session Spring 2021

Discussion

The adoption of Peer-Led Team Learning for Precalculus math as a collaborative learning technique has been successful at UTA. This collaborative learning approach made an impact in learning for Hispanic students in the introductory Engineering course. Evidence from the Fall 2020 semester in both ENGR 1251 and MATH 1421 showed PLTL to be a promising practice for gateway STEM courses. At the conclusion of the Fall 2020 semester the provost received an inquiry from a student asking if PLTL would be available for Calculus I. This, in addition to the student satisfaction survey, indicated that once students are exposed to PLTL, they look for this support in the subsequent courses.

In Spring 2021, PLTL was launched for Calculus I and the participation numbers escalated to the need for a waiting list to be established for both MATH 1421 (Precalculus) and MATH 1426 (Calculus I). Again, survey feedback at the conclusion of the Spring 2021 semester was positive and data showed higher pass rates for students in PLTL *versus* those not in PLTL and that it is effective for retention. The result of the implementation of PLTL is that SI is no longer offered for Precalculus MATH and PLTL is being expanded. The expansion of PLTL now includes Calculus II, General Chemistry I, and Chemistry for Engineers for Fall 2021 and will expand to General Chemistry II in the Spring 2022 semester. The future direction of the Academic Success Center is to continue to expand the number of leaders and thus, the number of PLTL study groups offered for these courses.

It is worthy to note that PLTL is a more expensive collaborative learning model than SI. Whereas in SI, there is one leader for the entire section of the course, we are striving to have one leader for each small group of eight students in PLTL for each of the courses. Despite that, the impact on pass rates provides justification for the expense of expanding PLTL for gateway STEM courses.

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