

Introduction

In the US, attrition rates for Science, Technology, Engineering, and Mathematics (STEM) majors are high. Entry-level college mathematics courses have historically been a gatekeeper for students.

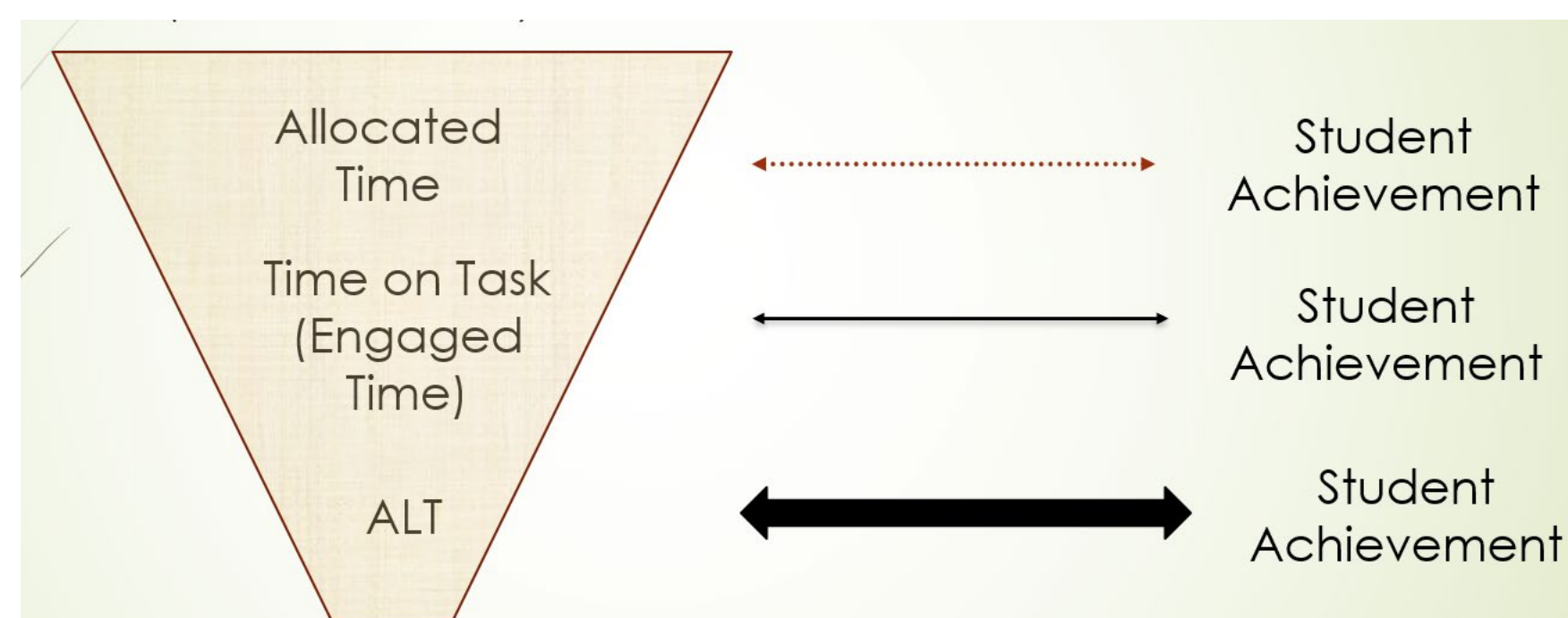
- At most, **40%** of students who initially want a STEM degree can complete one.
- Only **20 %** of the developmental course students can complete a college-level mathematics course within three years.
- 60 %** of college algebra students can get a required passing grade.
- Nationwide DFW rate in precalculus is **27.3%**.

Why High Attrition Rates in College?

Contrary to the common belief that the prevailing reason students leave STEM majors is the lack of preparation, it has been found to be the instructional practices they are exposed to. Overloaded curricula and fast-paced instruction have been linked to these practices.

Time & Teaching/Learning

The research highlights the need to improve the quality of instructional time rather than its quantity.



Research Question

What is the impact of a Think-Pair-Share intervention (a low-time commitment active learning strategy that allows for individual thinking time) on students' achievement and participation during the introduction of two big ideas in college precalculus classes?

Value of the Study

This study is unique in that it examines instructional time/pace and mathematics achievement at the college level from an instructional design perspective, which has rarely been explored.

Purpose

This quasi-experimental study aims to enhance precalculus instruction by incorporating more individual thinking time into classes.

Embedding purposeful individual thinking time is conjectured to slow the instructional pace and provide students with more opportunities to improve their conceptual understanding of precalculus topics, especially those needing more time to catch up with the conceptual advancement.

Methodology

Initial Observations

Intervention

Analysis

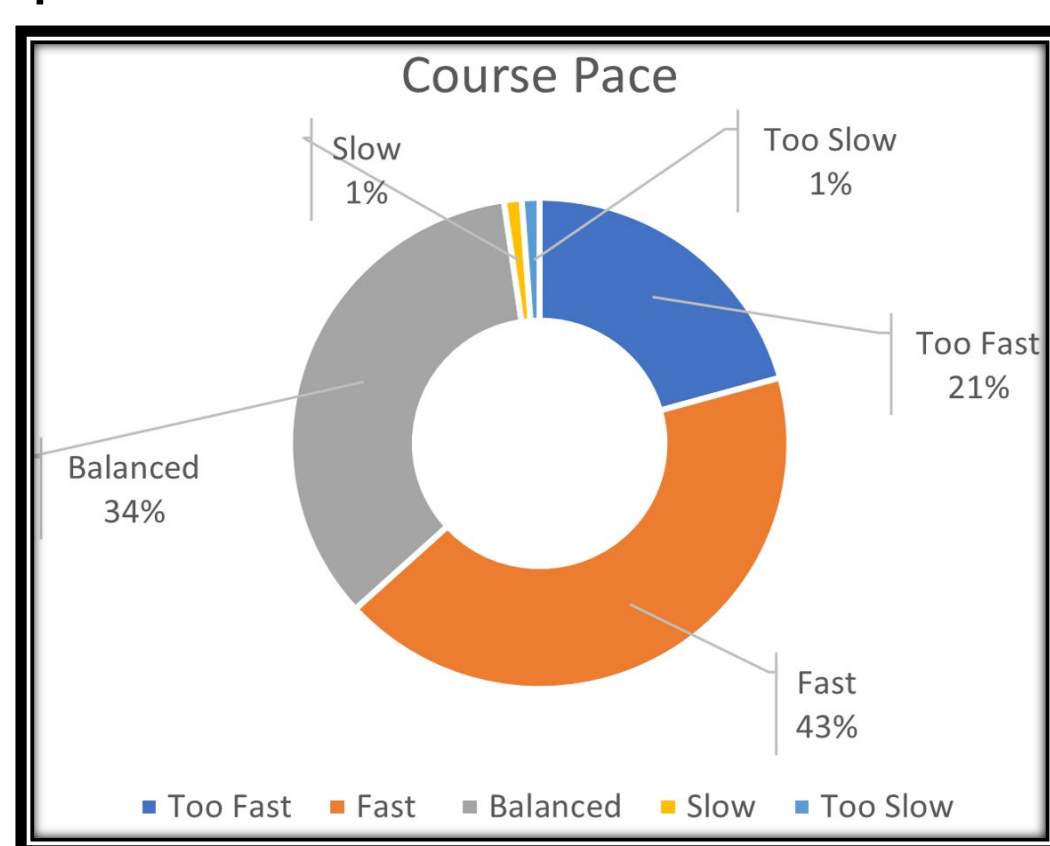
Initial Observations

Observation 1

We visited six different precalculus classes taught by three experienced instructors. The instructors asked more dialogue questions, after which waiting times were 3 to 5 seconds. However, the students in these classes were not explicitly given reasoning time except for two examples.

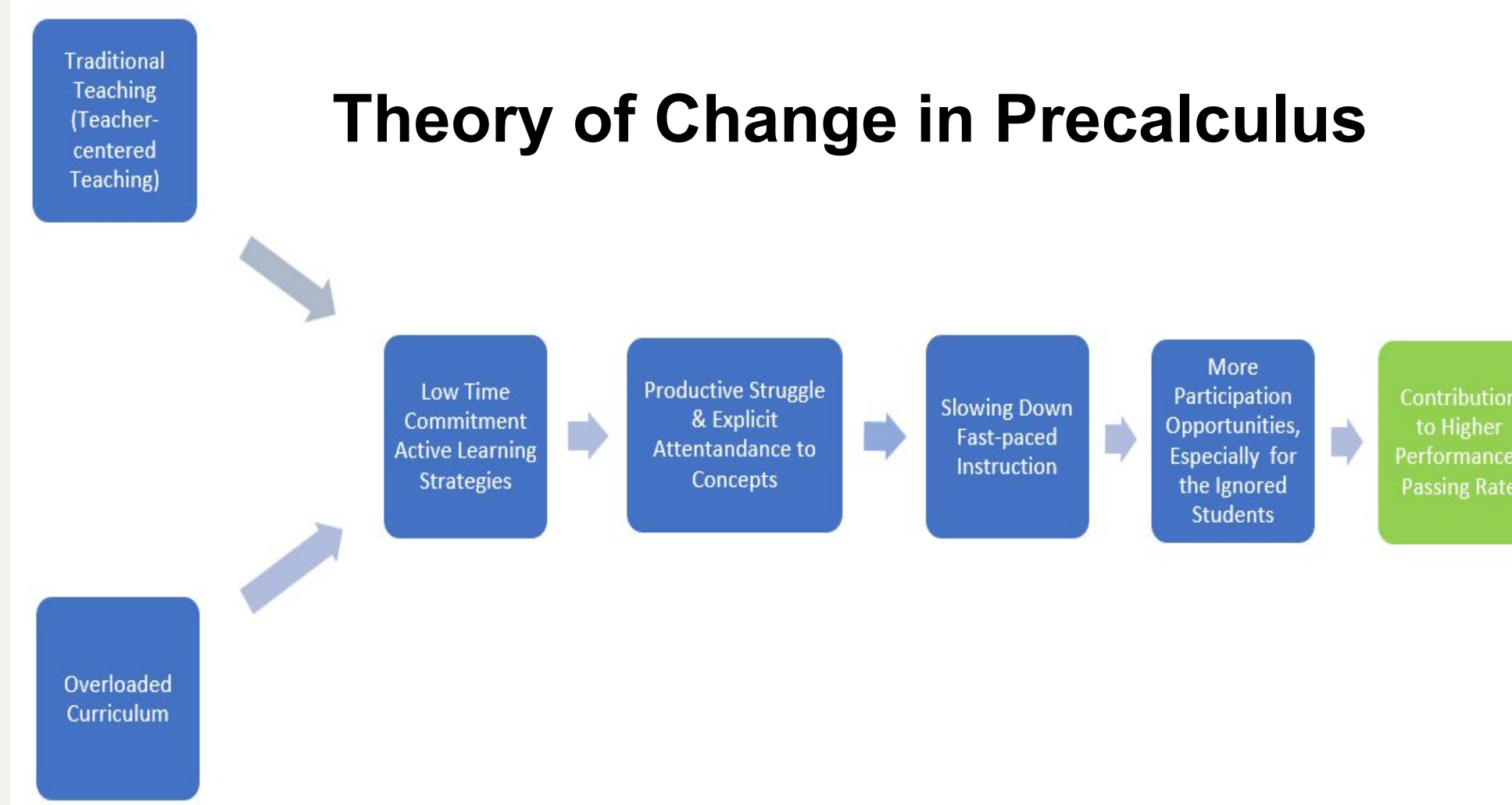
Observation 2

We asked students how they felt about the instructional pace in two synchronous online precalculus classes.

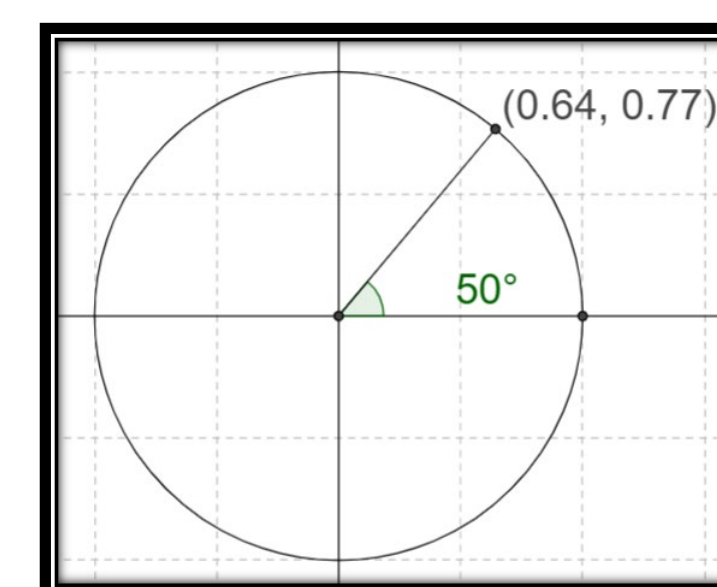
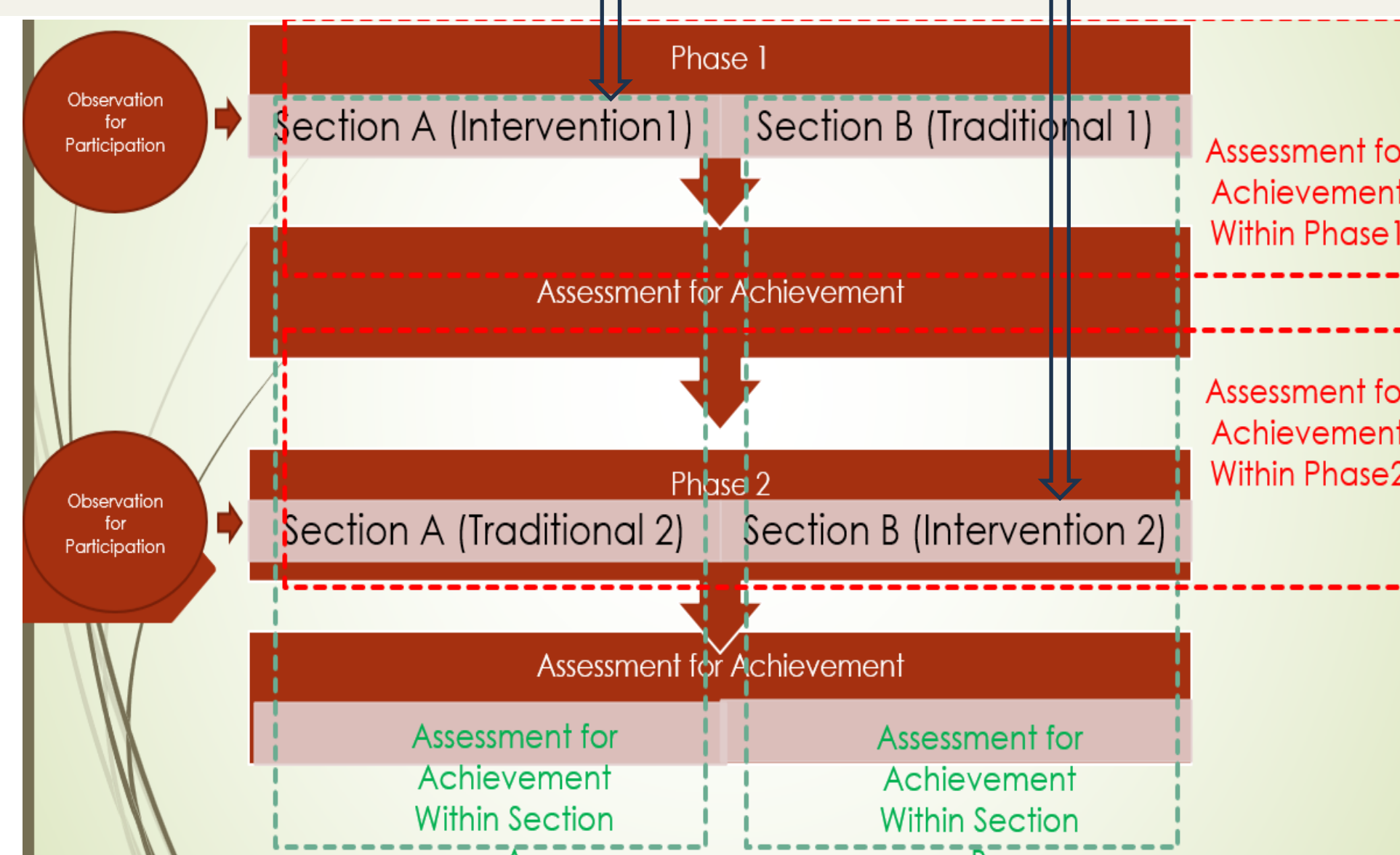
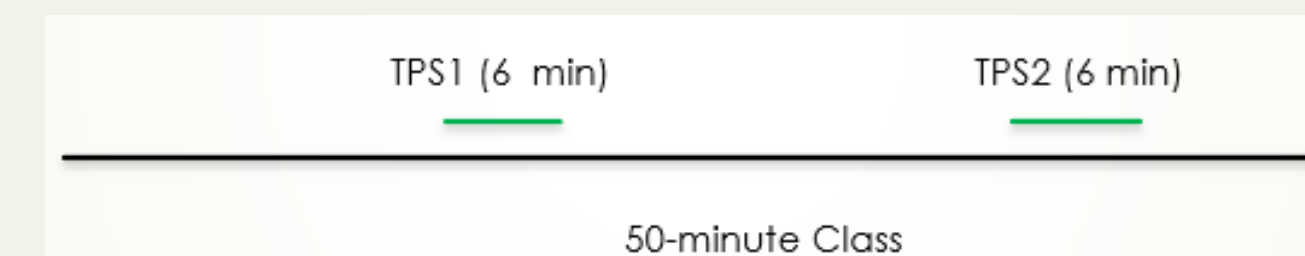


Although students' perceptions might not describe the exact situation, what they think might affect how they approach learning.

Theory of Change in Precalculus



Intervention



Sample Task & Guiding Question

- What changes in the coordinates do you observe as the angle changes?
- Do you observe any angles for which you get the same x-coordinate or y-coordinate?

Findings

The findings of this study are promising and indicate that the TPS activity has the potential to increase participation and improve achievement in precalculus classes.

Based on the following quiz scores (out of 10 points) and after controlling for the pretest, we found that $\beta_3 = 1.3879$ with a p-value of **0.00579**.

Achievement Scores (Out of 10)		
	Control	Intervention
Section A	7.46	6.71
Section B	4.5	7.68

After analyzing the verbal participation scores, we observed a significant difference in participation quality (ranging from 1 to 3) between participation during non-Think-Pair-Share (Non-TPS) and TPS time with a p-value of 0.01212 and an effect size of 0.29.

Participation Scores		
	Non-TPS Time	TPS Time
# Student Turns per Minute	1.06	1.30
Quality Points per Student Turn	1.42	2.36

Conclusion

Empirical evidence shows that active learning strategies considerably enhance student outcomes in college precalculus classes.

The findings of this study, in accordance with the research on active learning, suggest that meticulously designed classroom practices can significantly elevate student participation and achievement in college precalculus classes.

This study demonstrates a feasible classroom routine for college mathematics classes that can significantly improve achievement and participation.

Conducting further research on classroom practices in college-level mathematics education is essential to enhance student outcomes and reduce attrition rates in STEM disciplines.

References

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