

“Slow Down to Speed Up: Investigating the Impact of a Low-Time-Commitment Active Learning Strategy in Precalculus

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Introduction

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

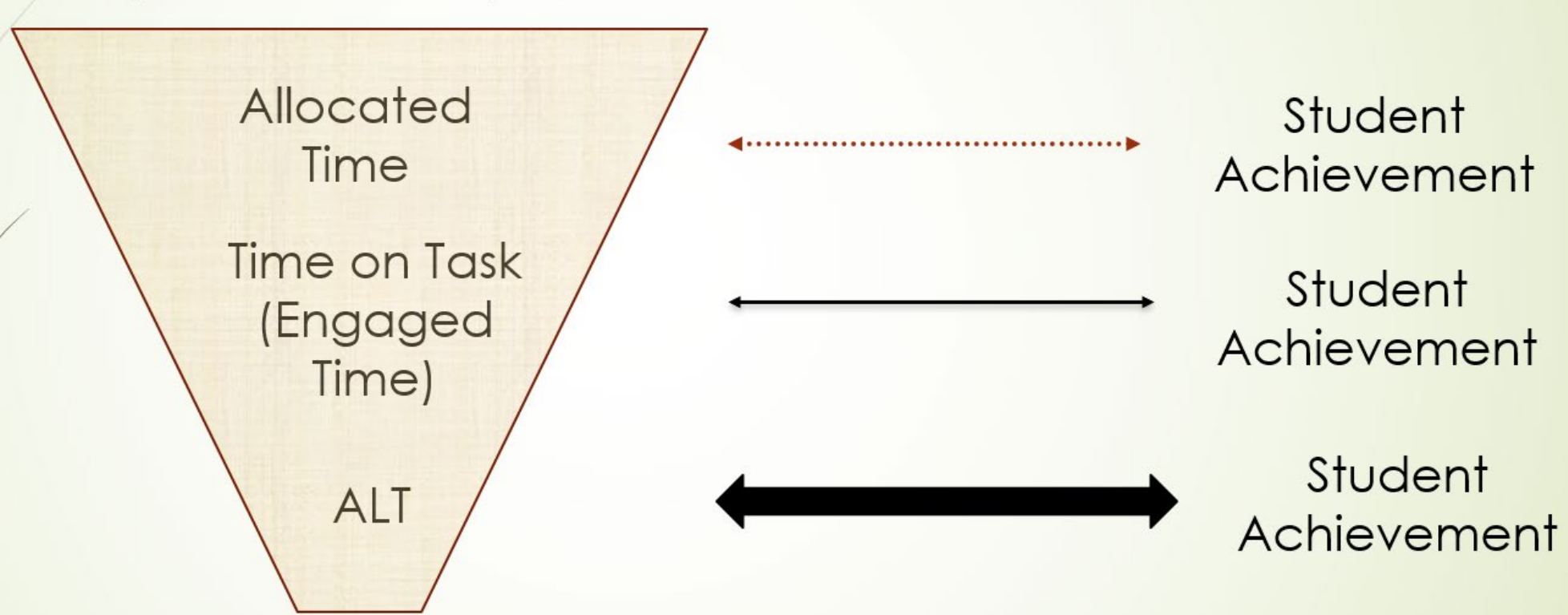
- At most, **40%** of students who initially want a STEM degree can complete one.
- Only **20 %** of the developmental course students can complete a college-level mathematics course within three years.
- 60 %** of college algebra students can get a required passing grade.
- Nationwide DFW rate in precalculus 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 emphasizes that the quality of instructional time needs to be improved rather than 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 improve precalculus instruction by embedding more individual thinking time into classes.

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

System's Thinking

This study conjectures that a significant portion of students in precalculus classes are ignored because of the issues verified by the research, such as curriculum overload and fast-paced instruction, which are likely to be associated with the current mode of instruction, direct instruction. However, more importantly, the school system is not designed to detect that these students are continuously ignored, and the issue of high DFW rates in precalculus classes continues to exist.

This study aims to draw the attention of educators to the problem of fast-paced instruction in precalculus classes and suggests slowing down the pace of instruction by exerting more active learning strategies that are supposedly more suitable for students' needs. Generally speaking, this study proposes that the university system should constantly get feedback from students on the instruction they are exposed to and look for ways to improve instruction in mathematics classes.

Methodology

Initial Observations

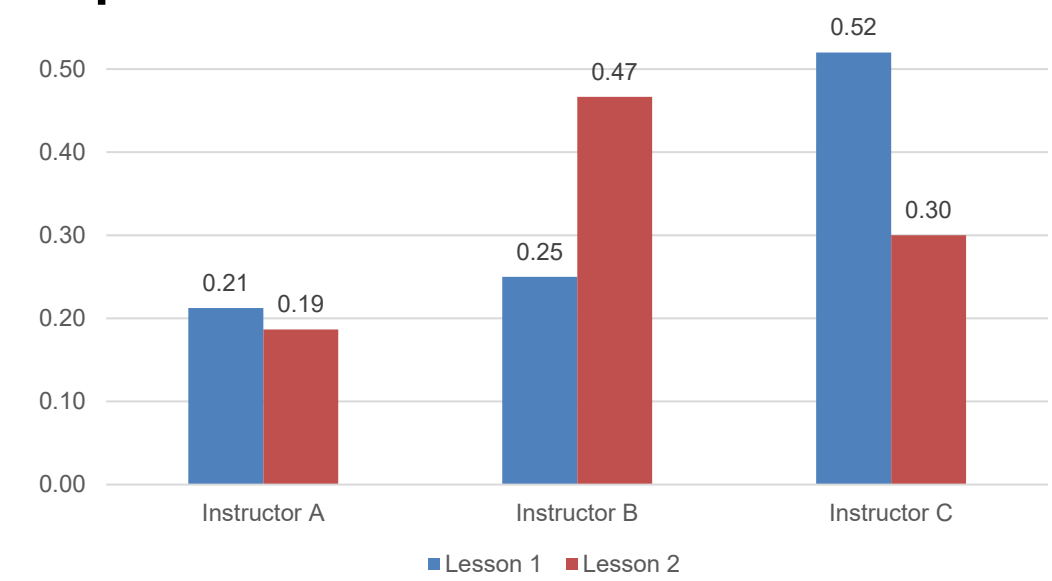
Intervention

Analysis

Initial Observations

Observation 1

We visited six different precalculus classes of three experienced instructors.

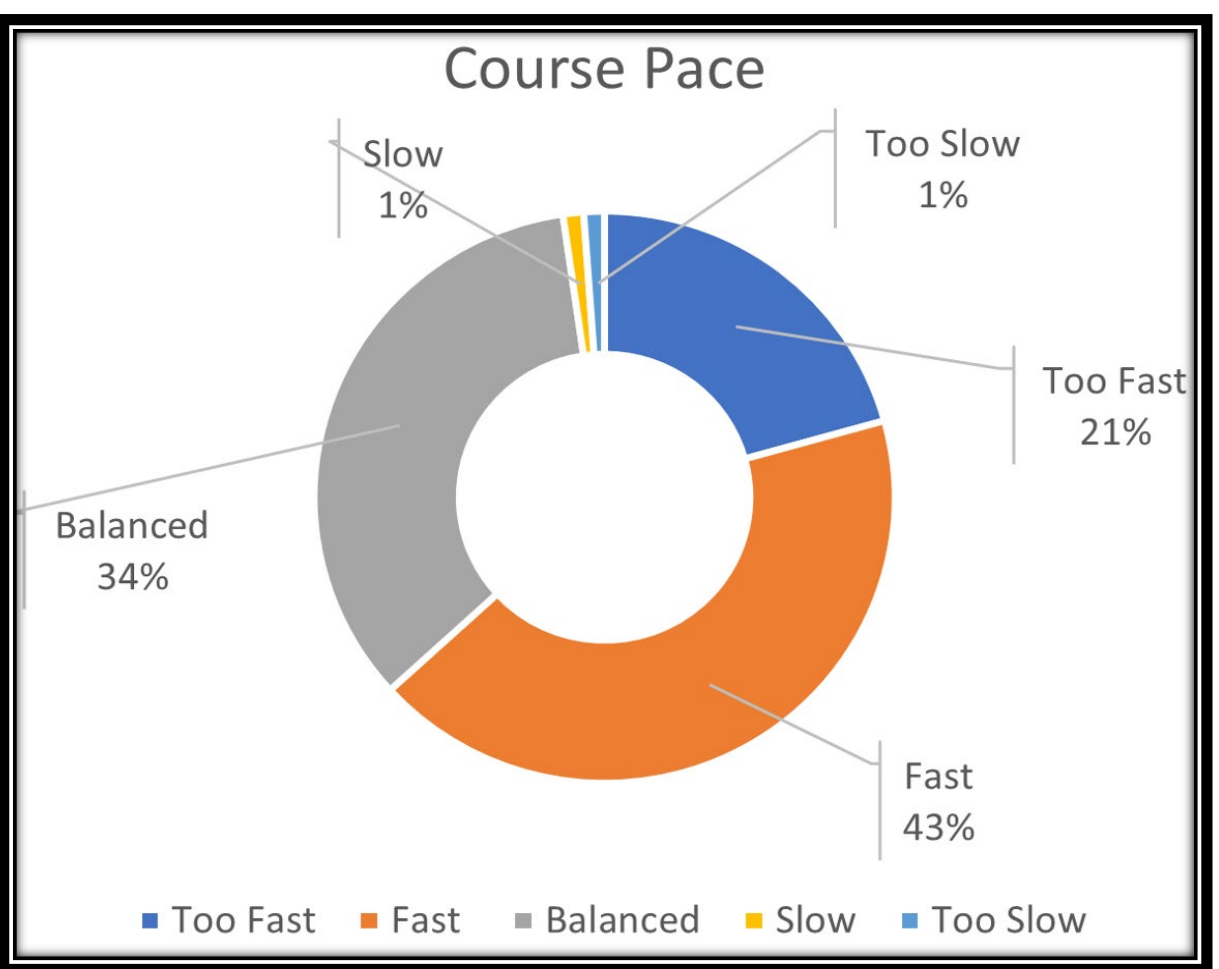


The questions asked by the instructors were more of dialogue questions, after which waiting times were 3 to 5 seconds. However, there was no explicitly given reasoning time to the students in these classes except for only two examples.

The instructors had to rush through quick questions without being able to provide students with individual thinking time (more than 5 seconds) for deeper conceptual understanding.

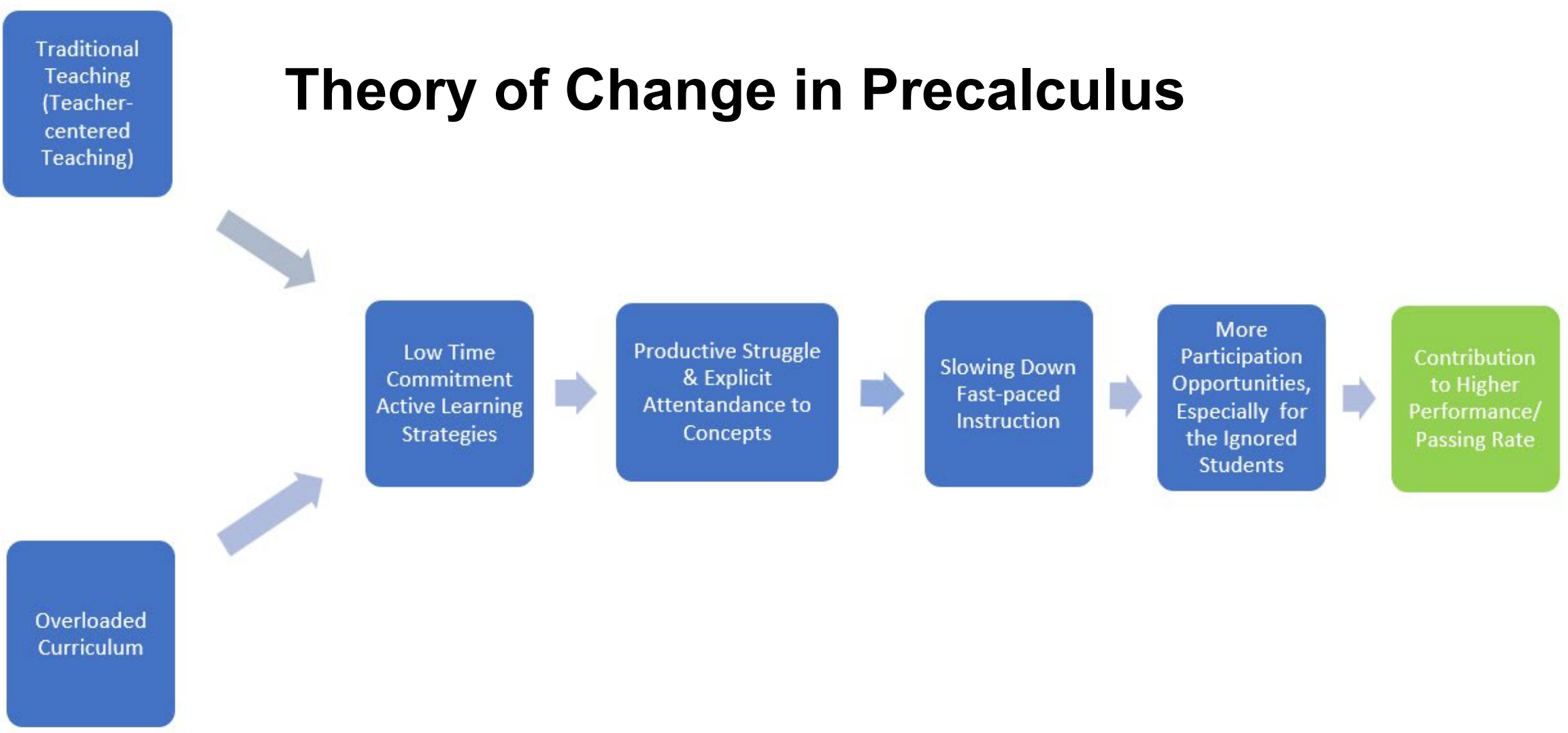
Observation 2

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

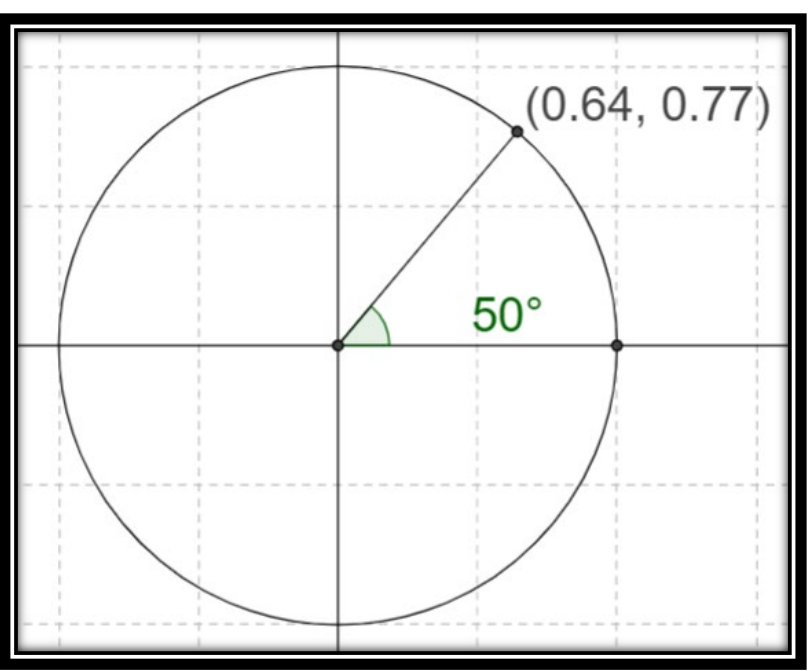
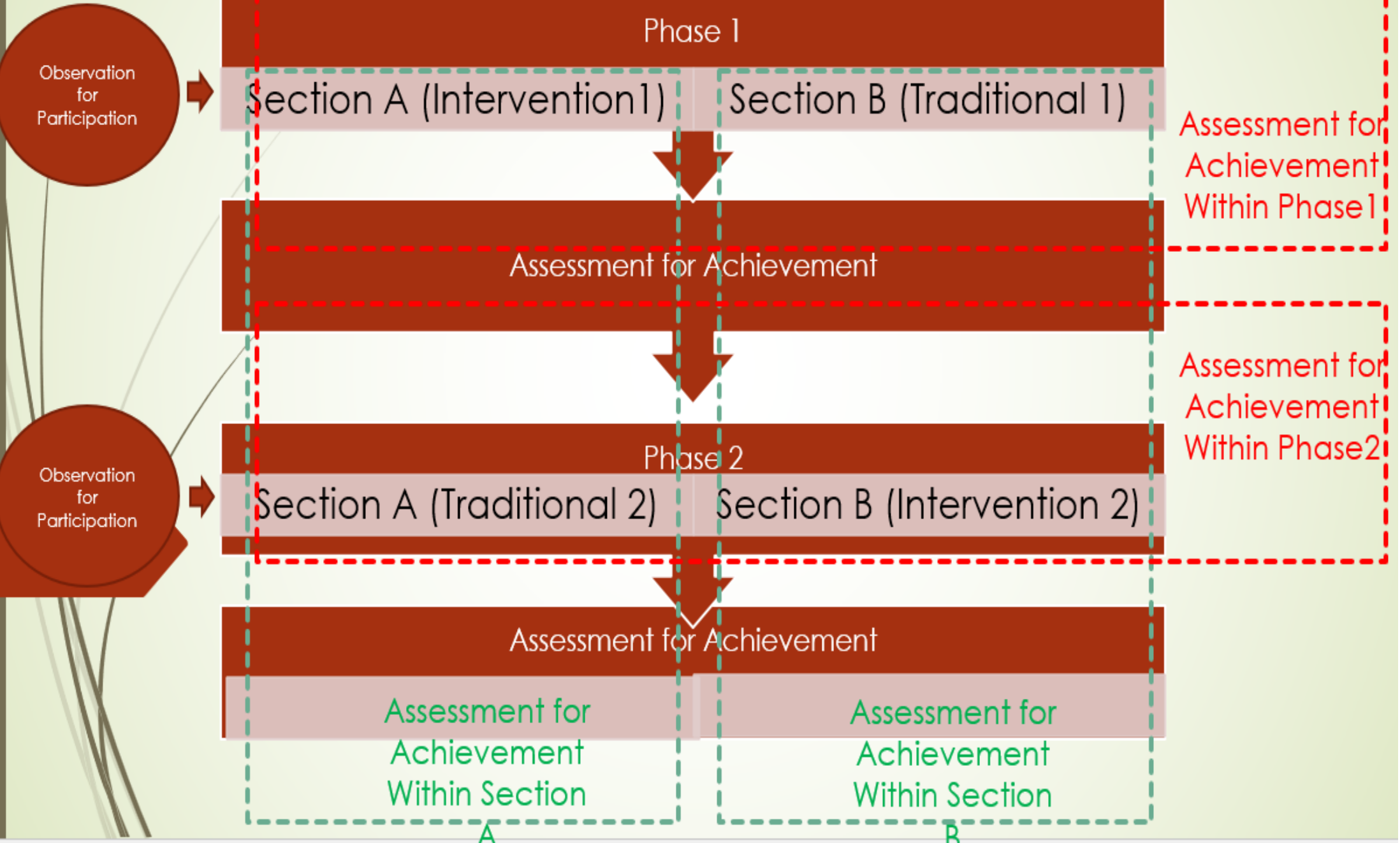


Although students' perceptions might not describe the exact situation, what they think might affect how they approach learning.

Theory of Change in Precalculus



Intervention



Sample Task & Guiding Questions

- 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?

Analysis

The effect of the intervention will be analyzed by a mixed-effects model, which allows controlling for section & topic differences and repeated measures on the same unit.

Students' participation will be identified based on a verbal participation framework.

Preliminary Findings

Preliminary findings indicate that TPS activities during instruction have the potential to improve achievement and increase participation in precalculus classes.

	Student Participation	
	Regular Minutes	Think-Pair-Share Minutes
Number of Class Minutes	33.50	16.50
Number of Student Turns	56.00	41.00
Number of Student Turns per Minute	1.67	2.48
Sum of Participation Points	89.00	78.00
Points per Minute	2.66	4.73
Quality Points per Student Turn	1.59	1.90

Conclusion

This study conjectures that slowing down the precalculus instruction, together with guiding questions and conceptual tasks, will provide students with

- more active learning opportunities
- more interaction with the instructor
- more teachers noticing the students' struggles
- more feedback from the instructor

Besides these expectations, students' backgrounds, instructors' beliefs, classroom environment, and instructional materials might influence students' performance

Based on the initial observations and preliminary results, we hope this study will contribute to improving the teaching/learning of precalculus, especially for the students who need more time to think during the instruction.

References

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