It is Time to Think! Investigating the Impact of Reasoning Time in Precalculus

Zafer Buber, Ph.D. in Mathematics Education
Department of Mathematics, College of Science and Engineering, Texas State University

Background

Educators wonder “to what extent the time we use for teaching/learning impacts students’ achievement.

Time & Teaching/Learning

The first attempt to improve achievement from a time perspective was a quantitative approach: increasing allocated time for mathematics instruction.

No clear consensus about the effect of increased allocated time among researchers has been reached. However, a substantial compromise about the quality of instructional time has been pointed out.

Achievement in College-Level Introductory Mathematics Courses

College-level introductory mathematics courses have always been a gatekeeper for students.

- 20 % of the remedial course students can complete their college education.
- 60 % of college algebra students can get a required passing grade.
- At most, 40% of students who initially want to have a STEM degree can complete one.

Why High Attrition Rates in College?

Research has identified various reasons preventing college students from achieving science, technology, engineering, and mathematics (STEM) degrees. These reasons include

- Students' cultural & social backgrounds and college courses design issues.
- Problems rooted in structural and cultural sources. Only 15 % of students in US secondary schools have the opportunity of sense-making and reasoning activities.
- Overloaded curriculum and fast-paced instruction, which make students more likely to drop out of mathematics.

Contrary to the common belief that the prevailing reason students leave STEM majors is not the lack of preparation but poor instructional practices in introductory level college mathematics courses.

Purpose

This study aims to improve precalculus instruction by embedding more private reasoning time into the classes.

Adding purposeful private reasoning time is conjectured to slow down the instructional pace and provide students, especially those who need more time to catch up with the instructional pace, with more opportunities to improve conceptual understanding of precalculus topics.

Research Questions

- What is the impact of private reasoning time during the instruction on college students’ precalculus achievement?
- What is the optimal waiting time after students are given private reasoning time in precalculus classes?

Value of the Study

The originality of this study lies in its approach to the time & mathematics achievement relationship at the college level, which has rarely been investigated from an instructional design perspective.

Initial Observations

Observation 1

We visited six different precalculus classes of three experienced (over 10 years) instructors. Four of them were 50 min classes, and two were 80 min classes. The followings were obtained from 360 min of precalculus instruction.

	# Questions (# min)	
Inst1	17 (80)	14 (80)
Inst2	10 (50)	21 (50)
Inst3	26 (50)	15 (50)

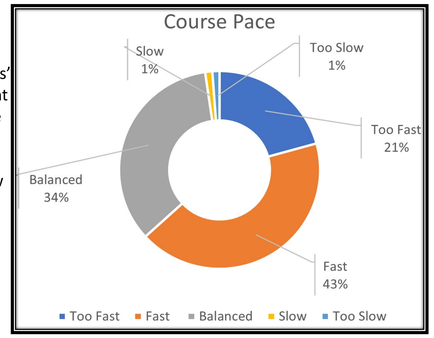
The questions asked by the instructors were more of dialogue questions, after which waiting times were 3 to 5 seconds. However, there was no explicitly given reasoning time to the students in these classes except for only two examples.

The instructors had to rush through quick questions without being able to provide students with more reasoning time for deeper conceptual understanding.

Observation 2

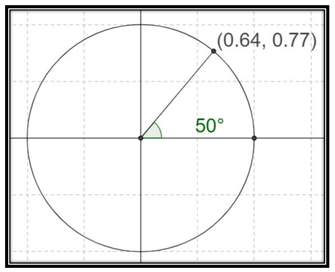
- We asked students how they feel about the instructional pace in two different online precalculus classes. We got 87 answers.

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



Design/Method

- Mainly, precalculus classes will be designed to have more private reasoning time to slow down the instructional pace and to provide more conceptual support to the students.
- Students will be given explicit private reasoning time intervals (about 30 seconds to 1 minute and at least three times in a 50 min class) and appropriate tasks that support a better conceptual transitioning (elevation). These tasks will be supported by well-thought guiding questions that facilitate student thinking.



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?

- We will measure the impact of the planned intervention by using pre and post-design tools.
- Additionally, we will analyze semi-structured interviews with some students before and after the intervention to capture the change in their reasoning attitudes.

Expected Results

Due to the highly complex nature of teaching/learning activities, we are not sure to what degree increasing reasoning time might improve the learning of precalculus concepts. However, we conjecture that slowing down the precalculus instruction, together with guiding questions and appropriate tasks, will help students with having

- more active learning opportunities
- more interaction with the instructor
- more teachers’ noticing of the students’ struggles
- more feedback from the instructor
- less math anxiety
- better achievement.

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

Conclusion

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

References

Apkarian, N., Bowers, J., O'Sullivan, M. E., & Rasmussen, C. (2018). A case study of change in the teaching and learning of precalculus to calculus 2: What we are doing with what we have. *Primus, 28*(6), 528-549.

Boaler, J. (2015). *Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages and innovative teaching*. John Wiley & Sons.

Seymour, E. (1992). " The Problem Iceberg" in Science, Mathematics, and Engineering Education: Student Explanations for High Attrition Rates. *Journal of College Science Teaching, 21*(4), 230-238.

Stigler, J. W., & Hiebert, J. (2009). *The teaching gap: Best ideas from the world's teachers for improving education in the classroom*. Simon and Schuster.

TEXAS STATE UNIVERSITY
The rising STAR of Texas
MEMBER THE TEXAS STATE UNIVERSITY SYSTEM