

Measuring the Efficacy of a Flipped Classroom Intervention in Calculus



Trefor Bazett

Department of Mathematical Sciences
University of Cincinnati

Kathy Koenig

Department of Physics
University of Cincinnati

11 Traditional Sections
(5 instructors)

12 Flipped Sections
(6 instructors)

- Common Exams, Online Homework, & Coordination (Logistics Coordinator + Pedagogy Coordinator)
- Follow up of 2015 Study by K. Koenig.



What We Did

Flipped Classes

Traditional Class:

- 1) Foundational knowledge
- 2) Work on Problems

During Class

Homework
After Class

Flipped Class:

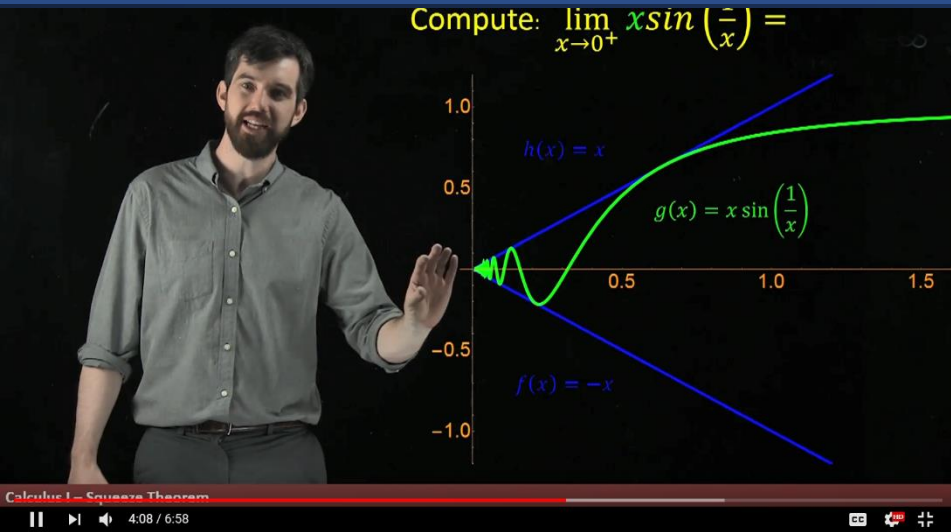
- 1) Foundational knowledge
- 2) Work on Problems

Videos Before Class

During Class

What We Did Pre Class

[YouTube.com/TreforBazett](https://www.youtube.com/TreforBazett)



Formative Assessment

Learning Objectives

Extra Resources

What We Did In Class

Collaborative Problem Solving



Printed Package of
Problems

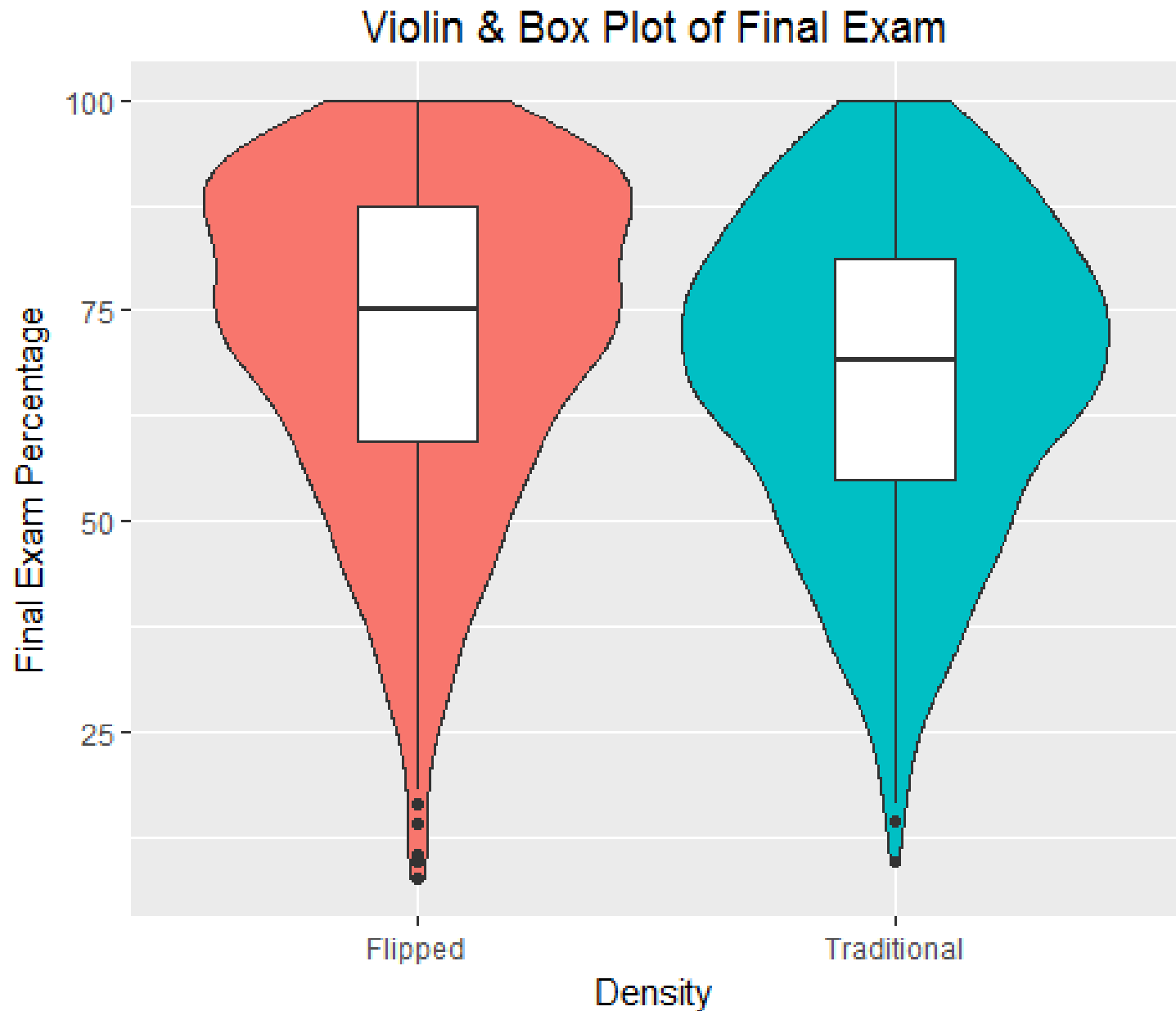
Conceptual
Understanding &
Sense-making

Group Quiz @ End

How We Measured It

- Pre & Post Concept Inventory (CKA)
- Pre & Post Attitude Inventory (ATMI)
- Student Engagement Survey (MAA)
- Faculty Engagement Survey
- COPUS Class Observations
- Performance Data

How We Measured It



How We Measured It

ANCOVA: Does Pedagogical Environment affect Final Exam performance?

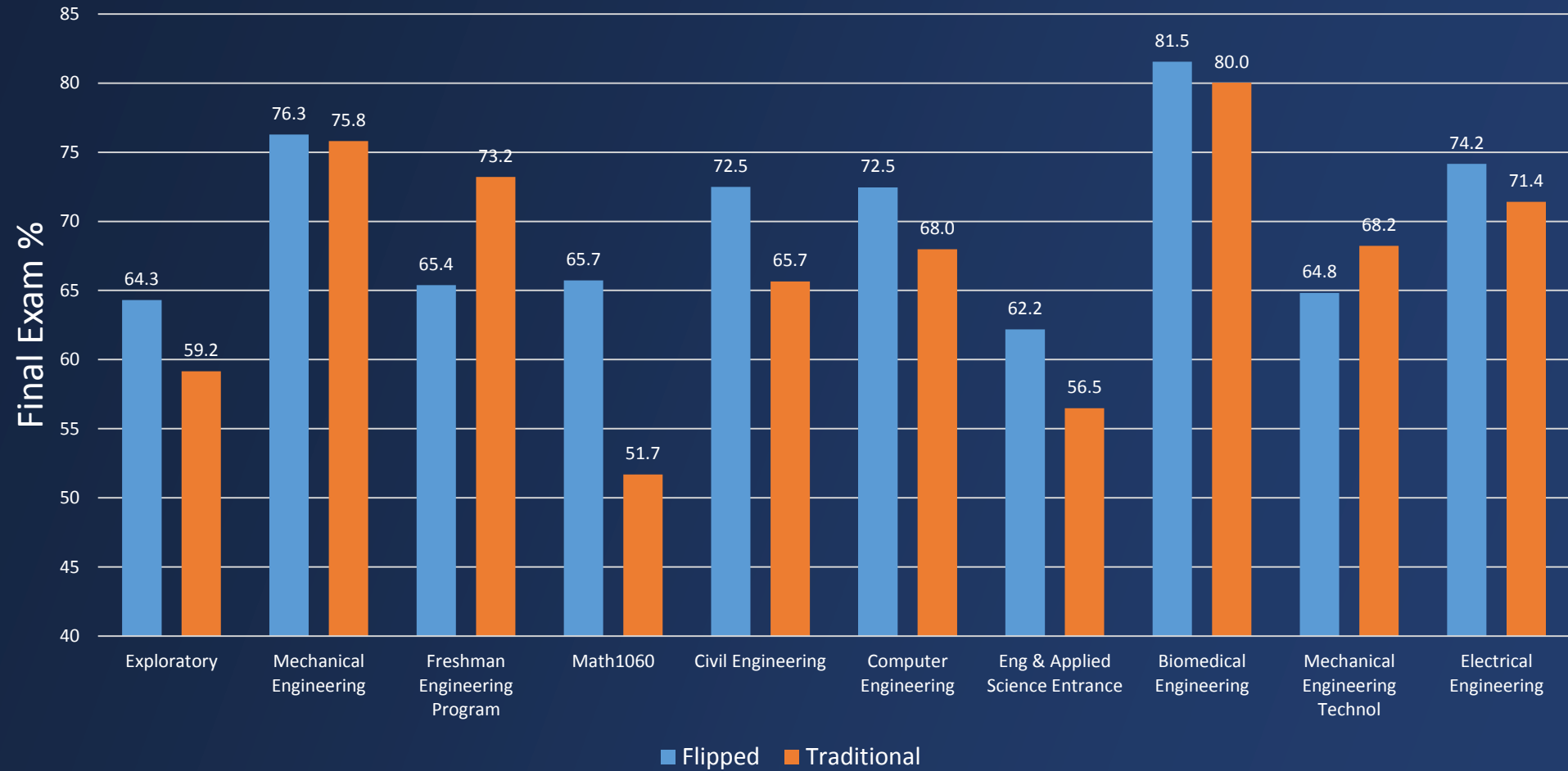
Controlled for:

- PreTest Performance
- Highschool Calc Y/N
- Academic Plan (ex Chemical Engineering)
- 1061/1060

Significant with $p < 0.01$

How We Measured It

1061 Final Exam Averages by Program



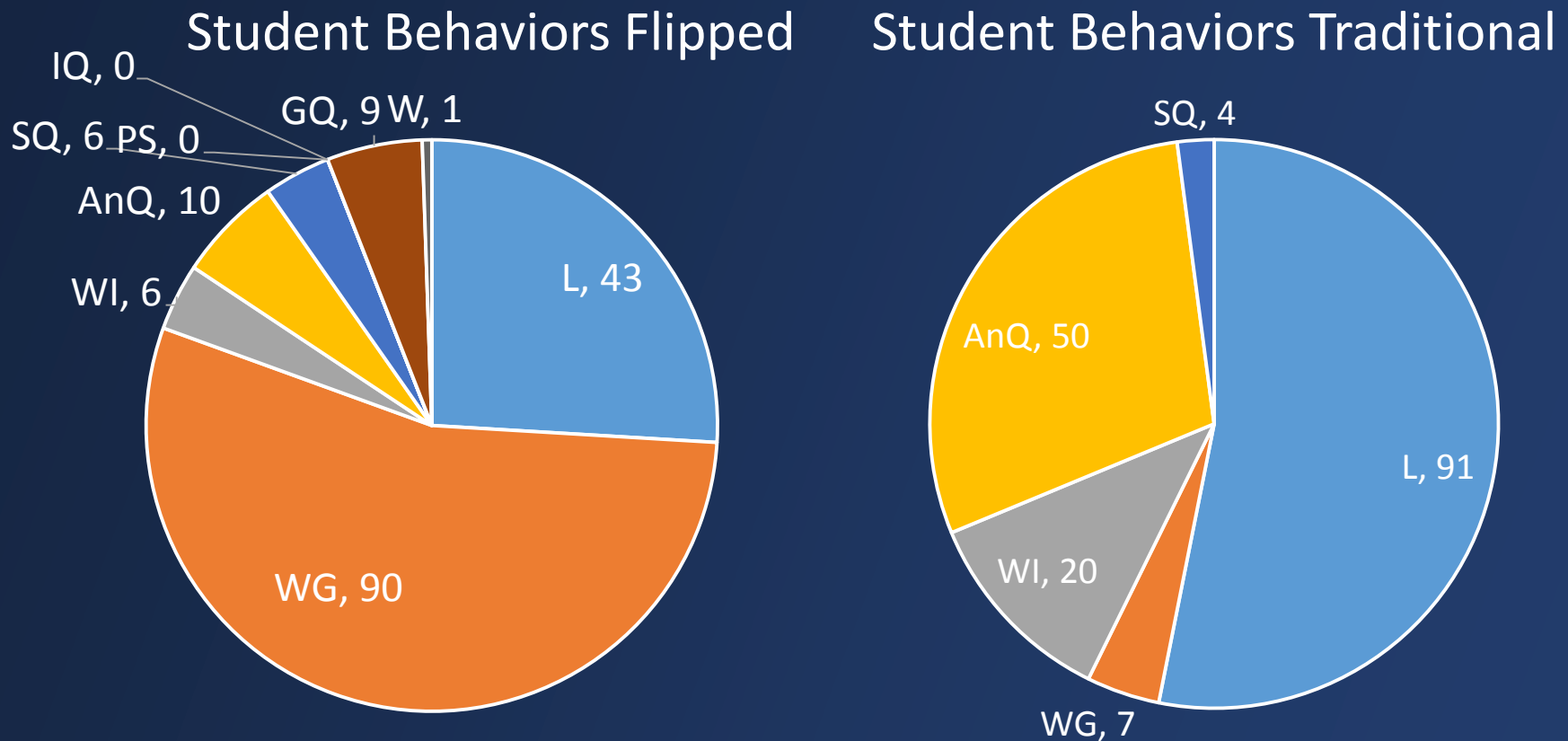
How We Measured It

Class Behaviors

- Measured via modified COPUS instrument
- Instructor and Student Behaviors measured every 2 minutes
- Two observations per instructor
- Classroom behaviors corroborated with Faculty Engagement Survey & Student Engagement Survey

How We Measured It

Class Behaviors

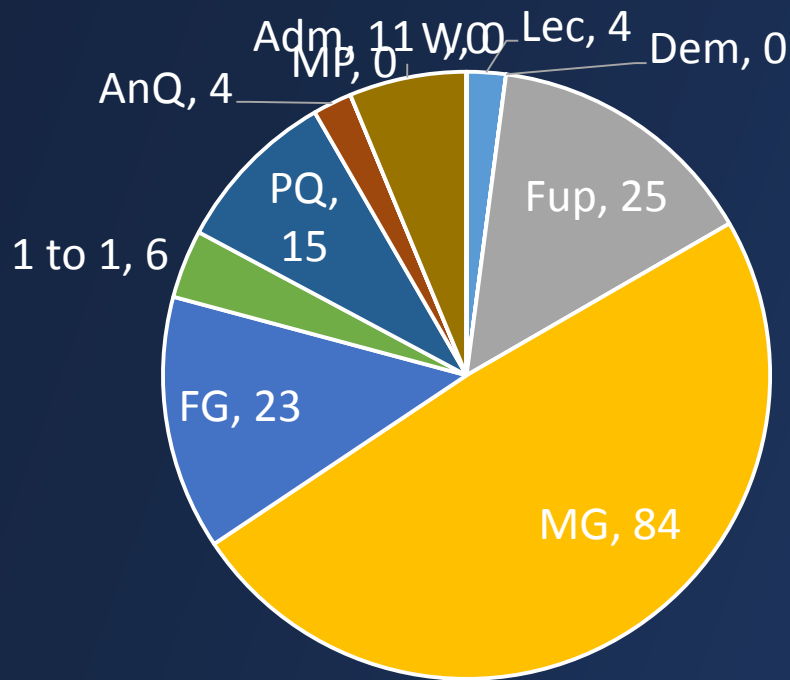


L= Lecture, WG = Working in Groups, WI = Working Individually,
AnQ = Answering Instructor Question, SQ=Student Asking Question,
GQ = Group Quiz, W=Waiting

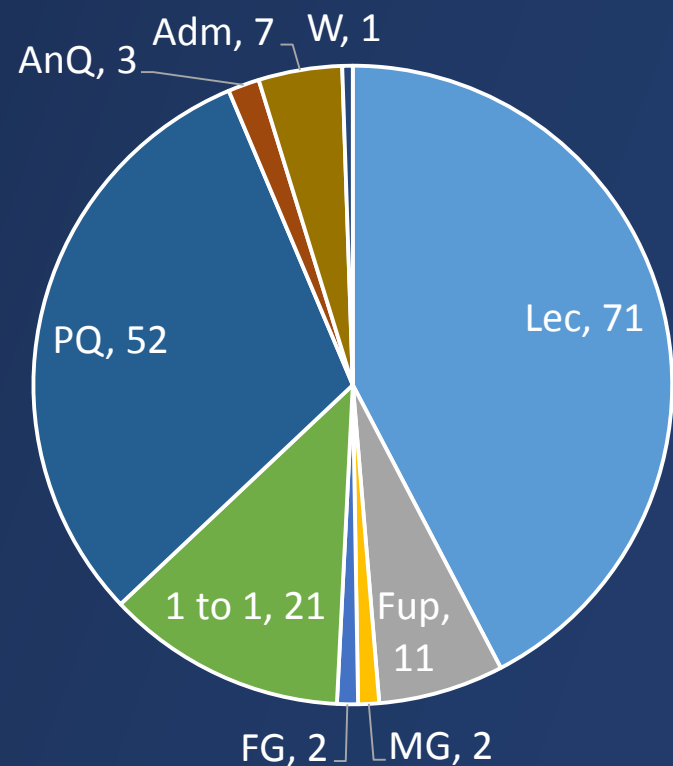
How We Measured It

Class Behaviors

Instructor Behaviours Flipped



Instructor Behaviours Traditional

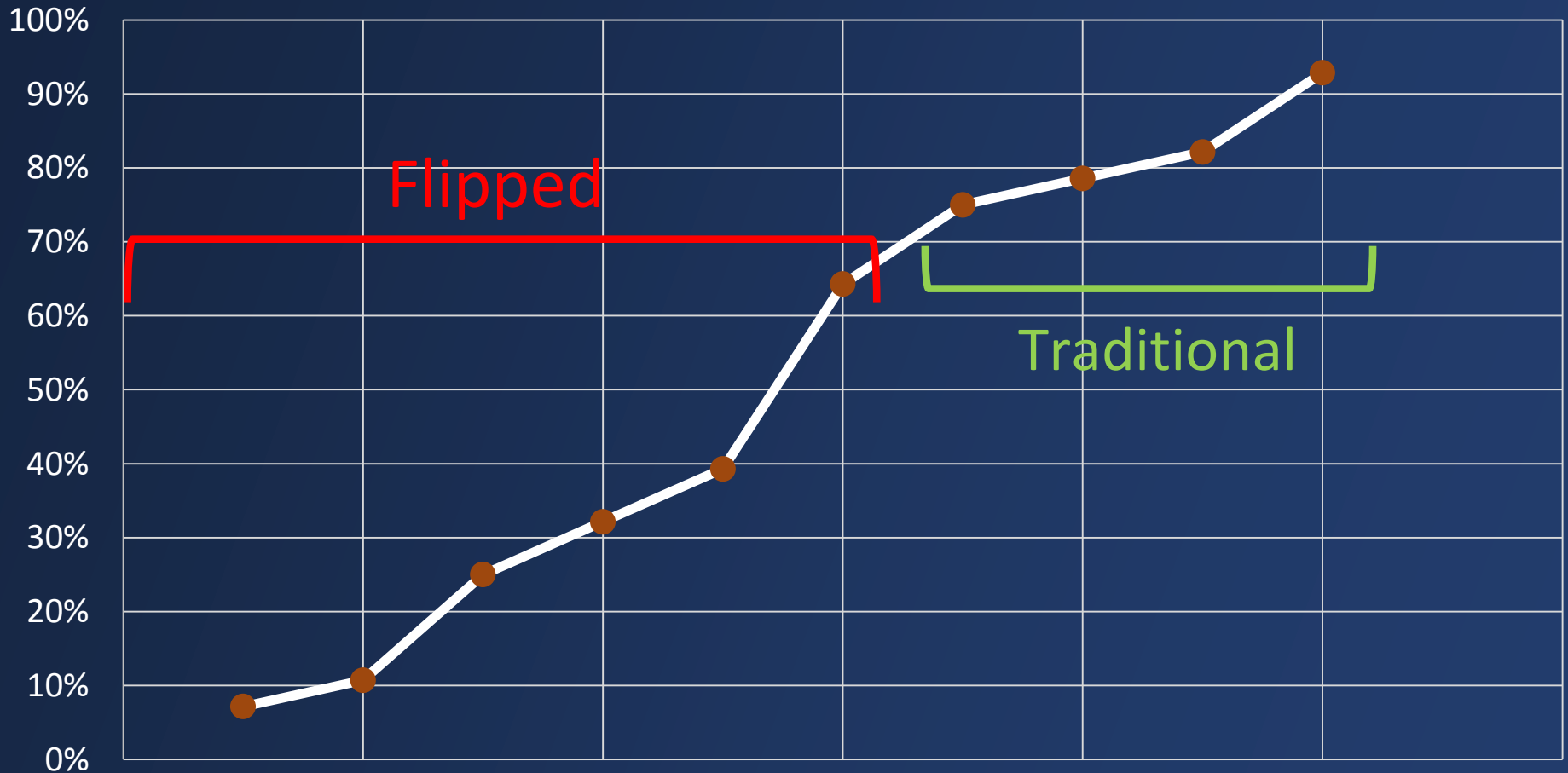


Lec=Lecture, Fup = Follow Up, **MG = Manage Groups**, FG = Focused on Group, 1 to 1 = Focused on Individual, PQ = Pose Question, AnQ = Answer Question, Adm = Administration, W = Waiting

How We Measured It

Class Behaviors

Percentage of Class Time Presenting



What We Learned

Module Engagement

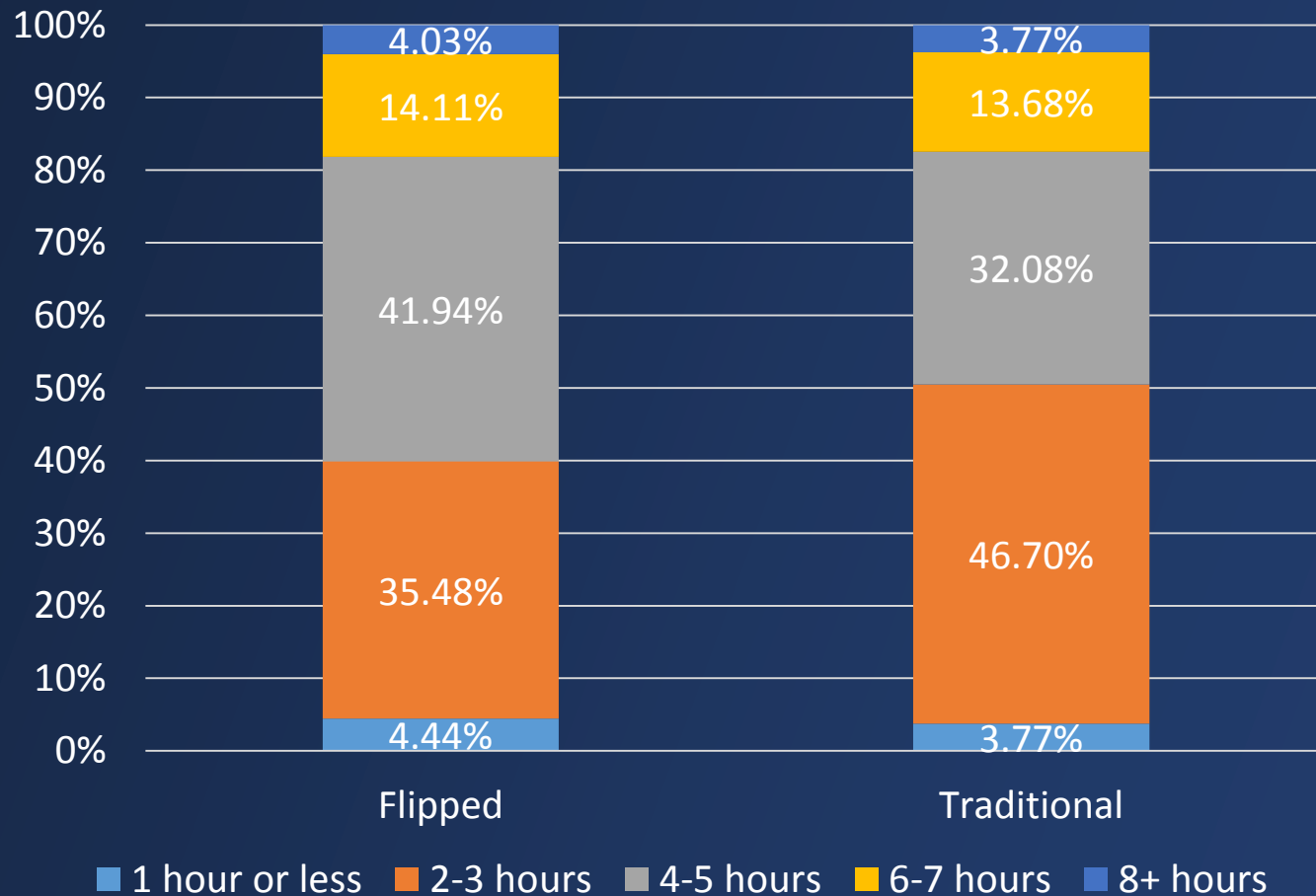
2017 Student Population	Percentage of students reporting watching more than 75% of videos
MATH1061 ALL	79%
MATH1061 under 80% on Test 3	82%
MATH1061 no highschool calculus	87%
MATH1060 - Calculus I with PreCalculus Review	94%

Compared to 37% in 2015 with Publisher produced videos

What We Learned

Time On Task

Hours per week outside of class
Flipped v Traditional



What We Learned

Attitudes

- Measured 40 Likert questions of pre- and post attitude.
- Students begin with net positive attitudes towards mathematics
- Calc 1 lowers attitudes significantly across the board*
- Slightly larger drops for flipped classrooms:
Flipped .76 drop; Trad .67 drop on -2 to 2 scale.

*Bressoud, D. M., Carlson, M. P., Mesa, V., & Rasmussen, C. (2013). The calculus student: insights from the Mathematical Association of America national study. *International Journal of Mathematical Education in Science and Technology*, 44(5), 685-69

What We Learned

Attitudes

Question	Flip	Trad	All
When I hear the word mathematics, I have a feeling of dislike.	1.46	1.38	1.42
I would like to avoid using mathematics in college.	1.52	1.26	1.39
It makes me nervous to even think about having to do a mathematics problem.	1.44	1.21	1.33
Mathematics makes me feel uncomfortable.	1.31	1.24	1.27
My mind goes blank and I am unable to think clearly when working with mathematics.	1.28	1.22	1.25

Numbers represent **increase**, from start to end of the course, on a 5 point Likert scale

What We Learned

Attitudes

Question	F	T	All
I am comfortable expressing my own ideas on how to look for solutions to a difficult problem in math.	0.29	0.50	0.39
I plan to take as much mathematics as I can during my education.	0.04	0.20	0.12
I like to solve new problems in mathematics.	0.44	0.57	0.50
I believe I am good at solving math problems.	0.45	0.54	0.49
I have a lot of self-confidence when it comes to mathematics.	0.16	0.22	0.19

Numbers represent **decrease**, from start to end of the course, on a 5 point Likert scale

What We Learned

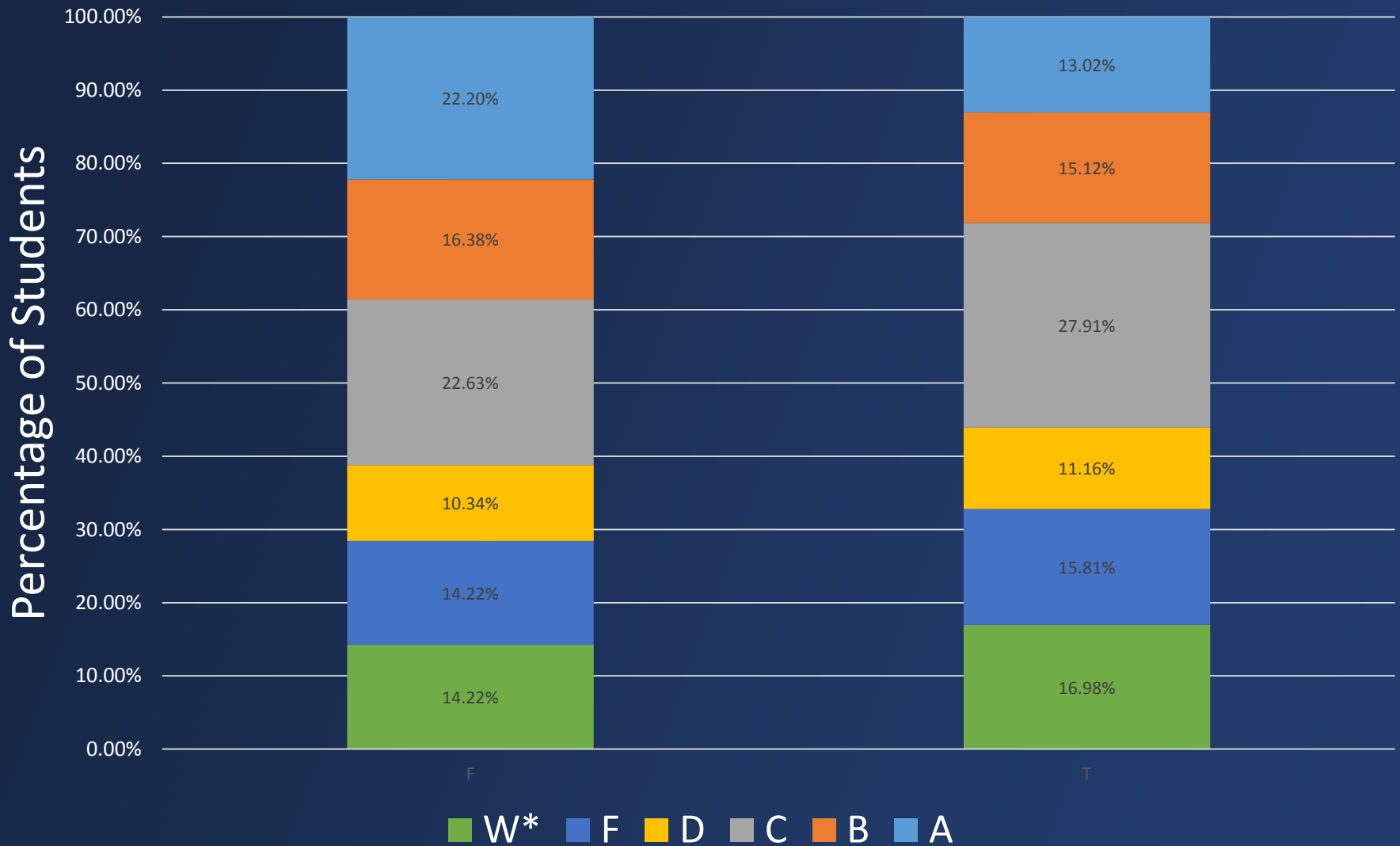
Attitudes

What is your preferred learning environment for a calculus class?	Flip	Trad
I prefer a blend of lecture and group/individual problem solving.	57%	47%
I prefer mainly group/individual problem solving in class with foundational content presented before class in videos.	23%	8%
I prefer to mainly listen to the instructor lecture while I take notes.	16%	39%
I am not sure as I haven't experienced enough of the above to comment.	3%	6%

Numbers represent **decrease**, from start to end of the course, on a 5 point Likert scale

How We Measured It

1061 Final Exam Letter Distribution



What We Learned

- Performance is significantly improved
- Technology was a big jump in engagement
- Poor attitudes remain problematic
- Open question as to how to optimally deliver flipped classrooms

Thank you!

Trefor.Bazett@uc.edu

Twitter [@TreforBazett](https://twitter.com/TreforBazett)

YouTube.com/[TreforBazett](https://www.youtube.com/TreforBazett)