

Introduction

The DFW rate for Business Calculus (Math 1200) is significantly higher than the average DFW (grade of D, grade of F, or Withdraw) rate across all undergraduate courses at DU:

Classes	DFW rate AY 23-24	DFW rate AY 24-25
All undergraduate courses at DU	5.41%	5.26%
Business Calculus	8.52%	9.47%

This is especially concerning because many DU students need to take the course for their degree program. Students not directly admitted to Daniels College of Business are required to successfully complete Business Calculus for admission to the college. Many students also take Business Calculus to fulfill the AI: Natural Common Curriculum requirement. As professors who teach multiple sections of this course every year, we wondered:

What factors impact student success in Business Calculus at DU?

We suspect that the following factors contribute to success rates in the course:

Possible factors impacting student success
Prior Algebra Knowledge
Math Anxiety
Attitudes toward Mathematics

During AY 23-24 and AY 24-25 we gathered student data on the factors above as well as student assignment and grade data to see which of these factors impact student success in the course. This study is still ongoing during AY 25-26.

Previous work in Math Education has studied all of these factors [1,2,3]; however, there is little work studying these factors in the context of a Business Calculus course. Moreover, the Business Calculus course at DU is unusual because it does not have any prerequisite requirements.

We plan to use our results to learn:

How can we better support students in Business Calculus?

The data from this study is baseline data for a larger intervention study on student success in Business Calculus using design-based research. This baseline data will inform later interventions which we hope will improve student success rates and experiences in Math 1200.

Participants

We collected data from students in Business Calculus at DU during AY 23-24 and AY 24-25.

- It consists of students in Business Calculus
 - across Fall-Winter-Spring from AY 23-24 and AY 24-25.
 - across 18 different sections; it includes sections taught by different instructors, but the class is highly coordinated
- Student participation is voluntary
- We recruited 253 students, out of a total of 940:
 - this corresponds to 26.9% of the students in those 18 sections of Business Calculus during AY 23-24 and AY 24-25

Data and method

Data collected

We collected course work from students in Business Calculus, which is already submitted as part of classwork. This includes:

- Algebra assessment:
 - Taken on day 1 of the class, without preparation
 - Multiple-choice questions only
 - Measures students' prior algebra knowledge
- Multiple surveys, including:
 - Attitudes Toward Mathematics Inventory [3]
 - Math anxiety survey (MARS-R Scale) [2]
- Reflections
 - Multiple short-answer questions, related to meta-cognition
- Midterm exams and midterm exam revisions
- Final exam
- Final grade

The algebra assessment, surveys and reflections are part of the students' coursework, but they are graded for completion for the class grade. The results do not impact final grades.

The data presented here is an analysis of the AY 23-24 data only.

Method for analysis

Measure of student success in Business Calculus:

- Final class grades as measure.
- Imperfect measure of success, but it is the one we have access to from class data.

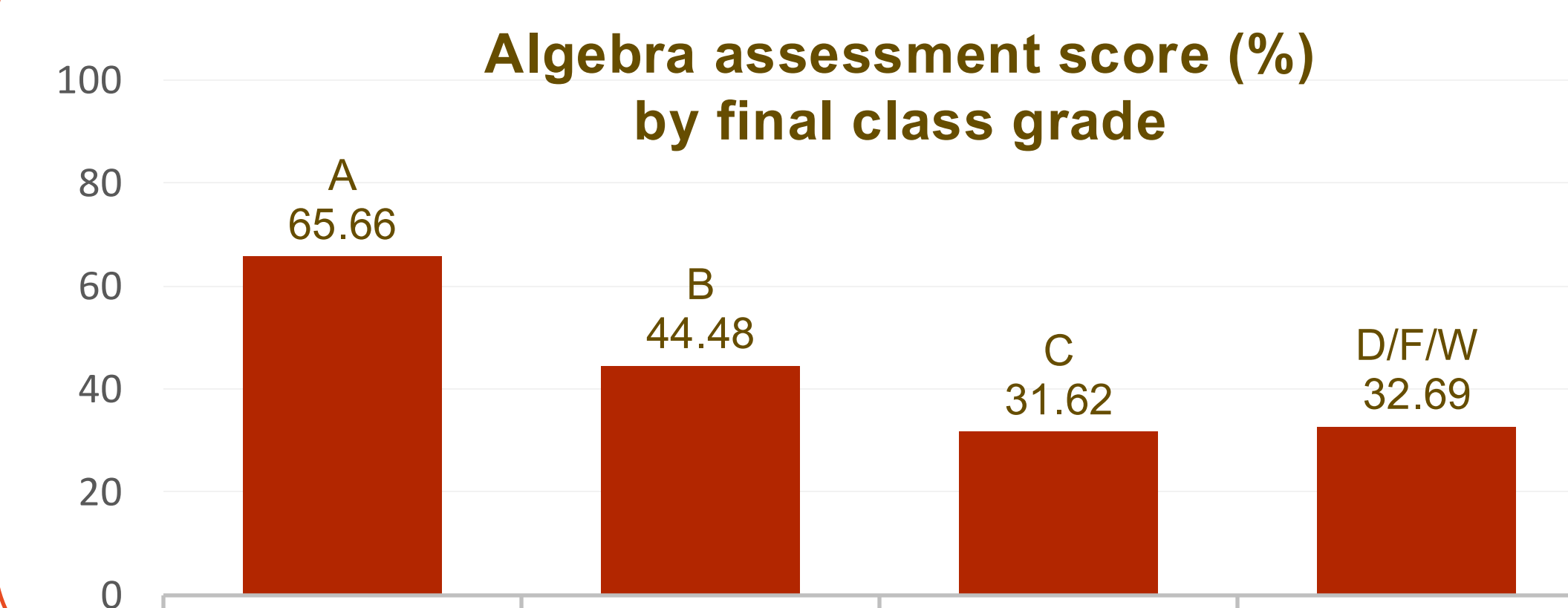
We sorted students in the following groups for most of the statistical analysis: Grade A / Grade B / Grade C / Grade D or Grade F or Withdraw with the following number of students in each group:

Grade	A	B	C	D/F/W
Number of students	56	55	18	8

- A grade of C or higher can be consider as success in the class
- We are also interested in possible differences between the A / B / C groups.
- We did not use +/- letter grades, as this would give too many small categories and would make the statistical analysis less meaningful.
- We grouped the D / F / W results together:
 - these groups are much smaller (any statistical analysis would be irrelevant)
 - all lead to the students having to retake the class.

Results

ALGEBRA ASSESSMENT



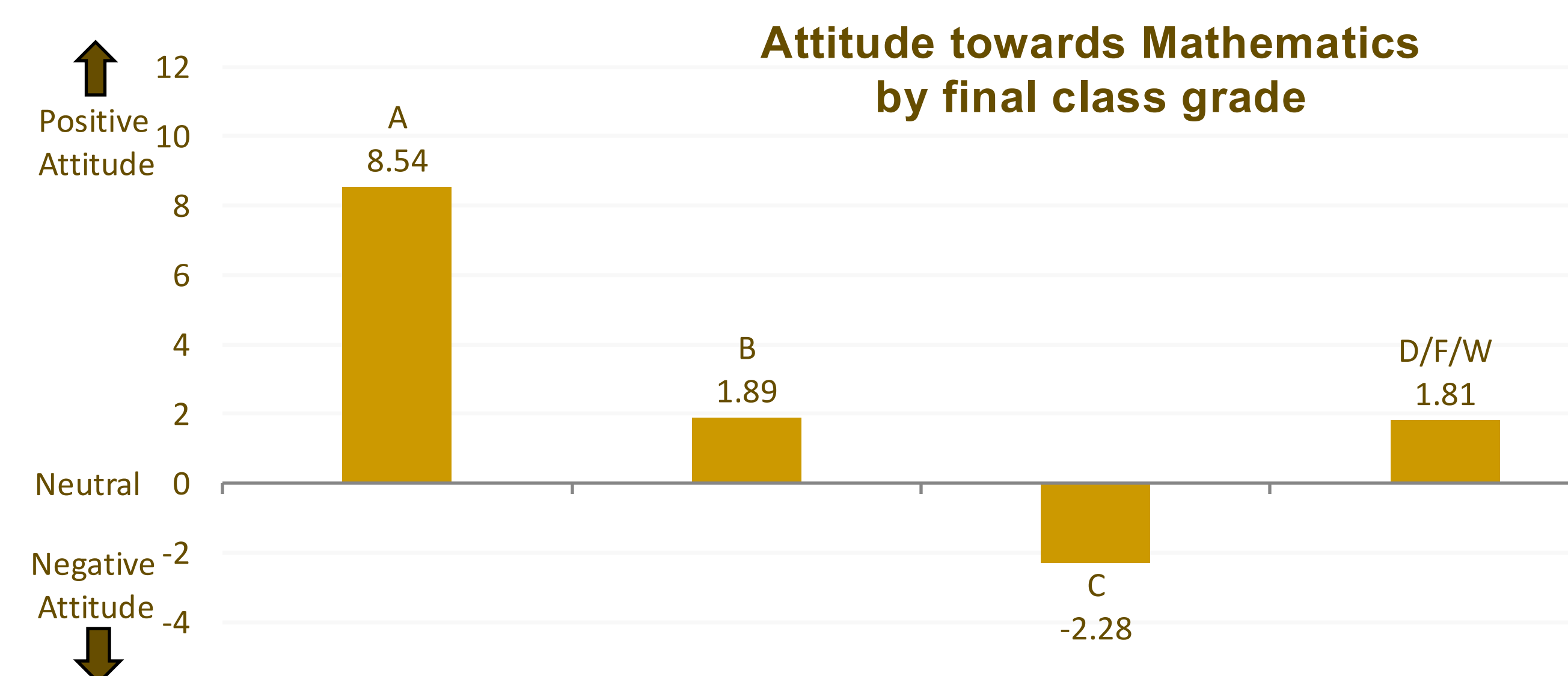
- The average score on the algebra assessment for all final letter grade groups is under 70%
- Across our entire sample, the average score on the assessment was 50.61% with median score 53.85%, indicating that a majority of students in Math 1200 may benefit from additional support with algebra.
- We find **significant differences (p-value 1.25×10^{-8}) between the average score on this algebra assessment across final letter grade groups** indicating that additional algebra support may help improve student success rates in the course.

ATTITUDE TOWARDS MATHEMATICS

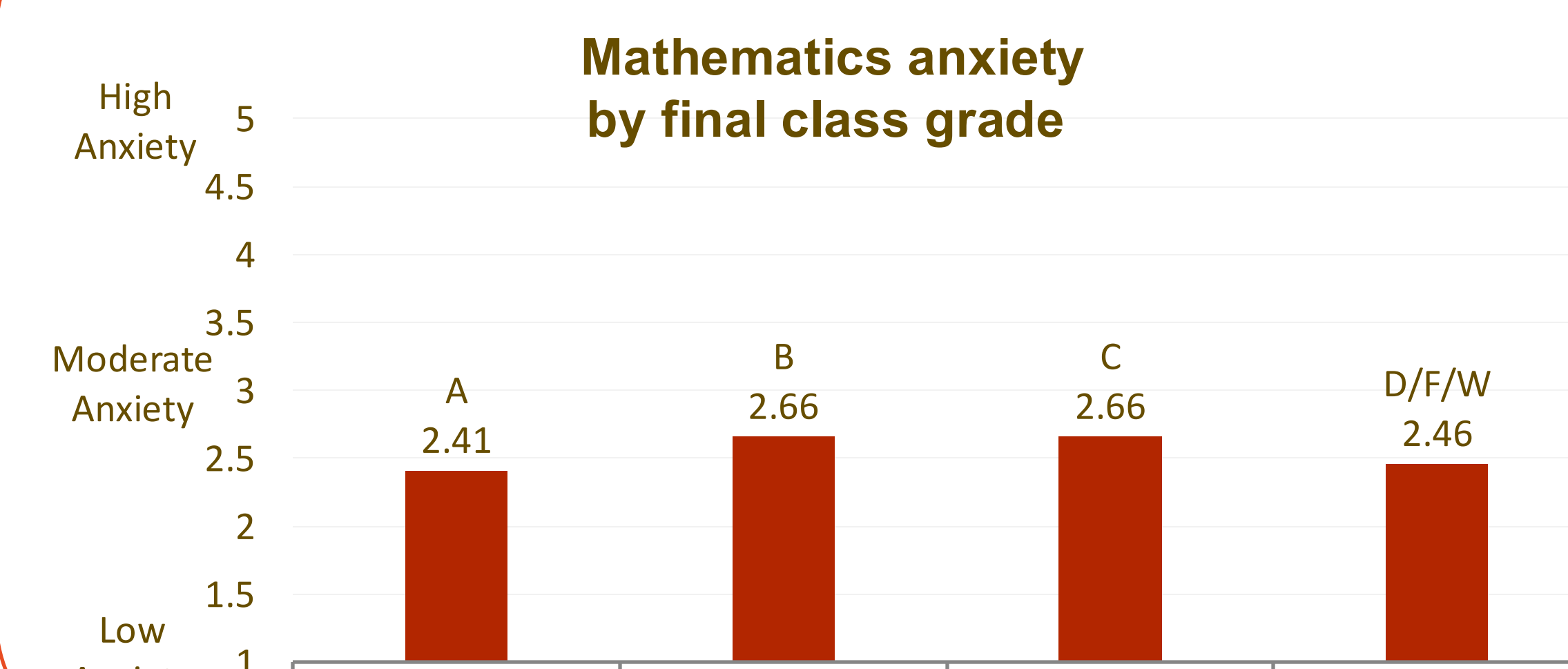
Measure of attitude toward mathematics:

- Measure as the sum of answers to the 30 question Attitudes Toward Mathematics Inventory [3]
- A response of 1 indicates a strong positive attitude, 0 indicates a neutral attitude, and -1 indicates a strong negative attitude.
- This yields an attitude measure between -30 (strong negative attitude) and 30 (strong positive attitude).

We find **significant differences (p-value 4.20×10^{-5}) between the mean attitude measure across final letter grade groups** indicating that interventions aimed at improving students' attitudes toward mathematics may improve student success rates in the course.



MATHEMATICS ANXIETY



Measure of mathematics anxiety:

- Measure as the average response to the 17 questions on the MARS-R Scale [2]
- A response of 1 indicates low anxiety; 5 indicates high anxiety.
- The average across all participants is 2.54 with median 2.53: many participants have at least a moderate level of mathematics anxiety.

We find **NO significant differences (p-value .38) between the mean mathematics anxiety measure across final letter grade groups.**

While there is no significant differences across final letter grade groups, we believe that interventions aimed at addressing mathematics anxiety may improve student experiences in the course.

Conclusion

We need to address the impact of students' attitudes towards mathematics:

- Possible interventions to change students' attitude have been studied [4], and we want to includes some of them in Business Calculus

Our study shows the importance of addressing the gaps in algebra knowledge:

- We used this study to create a new class! We are running a pilot algebra corequisite class (Math 1190 - Algebra Workshop for Calculus for Business and Social Sciences) during the Fall 25 quarter.

Co-requisite class – Math 1190

Using our preliminary results, we obtained internal funding to design a co-requisite algebra class to support students in Business Calculus.

- 1-credit workshop, taken concurrently with Business Calculus
- Provides support to strengthen algebra skills that are critical for success in calculus
- Helps students gain confidence in mathematics and problem solving
- Focused on active learning, with students working collaboratively on problem sets

Possible flaws in the data and analysis

For this study, issues may include:

- A self-selection bias:
 - Student participation is on a voluntary basis; our data set may be less representative of the whole student population
 - To minimize the impact, researchers can only access the list of consenting students after the final grades have been posted
- Quality of survey answers:
 - Students know that the instructors can see their answers to the surveys and may provide less honest answers
- Using final grades as a measure of success:
 - We are aware that grades do not always reflect learning or success

Future steps

We are running this study again in AY 25-26.

- We are hoping to get more participants, which makes our data set more representative.
- The Fall 25 participants will include students registered in Math 1190 (Algebra Workshop for Calculus for Business and Social Sciences); we will use this data to study the effectiveness of this co-requisite class.

We hope to go further with our current data set:

- We may refine some of the current analysis
- We are looking into the question "Is there a more accurate measure of students' success than final grades?"

We collected a lot more data that the analysis presented here. We will analyze some of the "forgotten" data, including:

- Qualitative data about students' expectations and experiences
- Study the effectiveness of midterm revisions

References

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