Student Success in Business Calculus

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Introduction

The DFW rate for Business Calculus (Math 1200) is significantly higher than the average DFW rate across all undergraduate courses at DU:

Classes	DFW rate for AY 22-23
All undergraduate courses at DU	6.16%
Business Calculus	22.35%

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 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. 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.

- It consists of students in Business Calculus
  - across Fall 23 / Winter 24 / Spring 24
  - across 9 different sections; it includes sections taught by different instructors, but the class is highly coordinated
- Student participation is voluntary
- We recruited 138 students, out of a total of 516:
  - this corresponds to 26.7% of the students in those 9 sections of Business Calculus during AY 23-24

Data and method

Data collected

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

- An algebra assessment:
  - This assessment is taken on day 1 of the class, without preparation
  - It consists of multiple-choice questions only
  - We use this assessment to measure students' prior algebra knowledge
- Multiple surveys, including:
  - Attitudes Toward Mathematics Inventory [3]
  - Math anxiety survey (MARS-R Scale) [2]
  - Both surveys above are administered online at the beginning of the quarter
- Reflections
  - Multiple short-answer questions throughout the quarter, usually 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.

Take the attitude toward mathematics survey and see how your result compares to the results from our students!

You can access a shorter survey using the QR code:

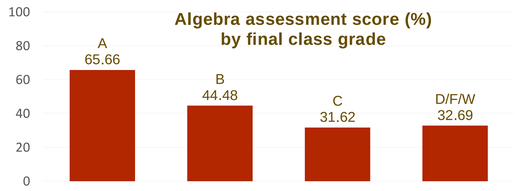
Method for analysis

To measure student success in Business Calculus, we used final class grades. While this is an imperfect measure of success, it is the one we have access to from class data.

We sorted students in A / B / C / DFW groups for most of the statistical analysis.

- While a grade of C or higher can be consider as success in the class, we are 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, as these groups are much smaller (any statistical analysis would be irrelevant otherwise), and all lead to the students having to retake the class.

Results

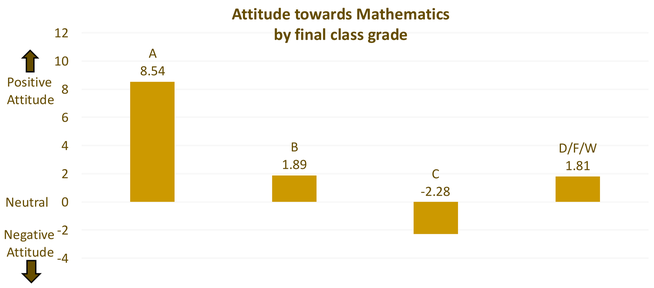


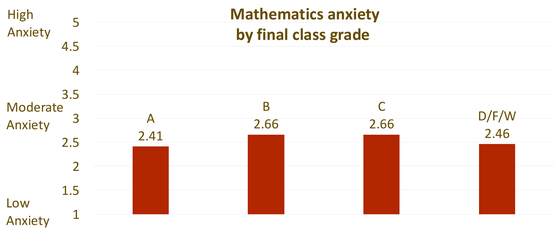
The average score on our algebra assessment for all final letter grade groups is under 70%. Across our entire sample, the average score on the assessment was 50.61% with median score 53.85%, indicating that a majority of students in Math 1200 may benefit from additional support with algebra.

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.

We measure student attitude toward mathematics by computing the sum of their answers to the 30 question Attitudes Toward Mathematics Inventory [3] where a response of 1 indicates a strong positive attitude, 0 indicates a neutral attitude, and -1 indicates a strong negative attitude. This gives an attitude measure for each student 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.





We compute a mathematics anxiety measure for each student by computing the average response to the 17 questions on the MARS-R Scale [2] where a response of 1 indicates low anxiety and a response of 5 indicates high anxiety. We do not find significant differences (p=.38) between the mean mathematics anxiety measure across final letter grade groups.

The average mathematics anxiety measure across all participants is 2.54 with median 2.53, indicating that many participants have at least a moderate level of mathematics anxiety. While we do not see significant differences across final letter grade groups, we do believe that interventions aimed at addressing mathematics anxiety may improve student attitudes towards mathematics and experiences in the course.

Conclusion

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

- We are currently working on a possible co-requisite class (this is the best-case scenario!)
- If this co-requisite cannot be created, we will develop some algebra support modules for students

We also 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

Next steps

Possible flaws in the data and analysis

While we may not be able to correct all the possible issues from our data set, identifying them is an important step. For this study, issues may include:

- A self-selection bias:
  - Student participation is on a voluntary basis, which can make our data set less representative of the whole student population
  - To minimize the impact, the researchers can only access the list of consenting students after the final grades have been posted
- Quality of survey answers:
  - While surveys are graded for completions, 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:
  - As professors, we are very aware that grades do not always reflect learning or success

Future for this study

We are running this study again in AY 24-25.

- We are hoping to get more participants, which makes our data set more representative.
- We are only making minor changes or addition to some survey questions and reflections, to fill in some possible gaps from the AY 23-24 version.

We hope to go further with our current data set:

- We may refine some of the current analysis: surveys and scales can be divided into specific categories for a more precise picture.
- 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:

- Code and analyze the qualitative data about students' expectations and experiences in Business Calculus.
- Study the effectiveness of midterm revisions, comparing student's scores on each midterm, midterm revisions and final exam for each topic.

References

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