

Department of Mathematics and Statistics

Response to Recommendation to Discontinue M.A. and Ph.D. Programs

The Department of Mathematics and Statistics is providing this document in response to the Provost's recommendations to discontinue Mathematics graduate programs, for the Chancellor to use in making his decisions on program terminations. It is not surprising that student success features prominently in the APR, since that has been a core priority for Chancellor Gilliam at UNCG for many years and is critical at a time when both governing boards and the general public are demanding success for their investments in higher education. It is disappointing, however, that news of our significant gains in student success seems to have not reached the administration, and that somehow the strong research and graduate programs are taking the blame for remaining challenges that the students in those very graduate programs are helping to address. In addition to this statement, we are providing an additional document containing some of the outpouring of support we have received for maintaining these programs. This includes support letters from departments at UNCG that depend on our graduate Mathematics programs, from the largest mathematics professional society in the world, from experienced and highly regarded mathematicians, from current and former graduate students from the programs, from UNCG students for whom Mathematics graduate students have been critical to their success, and from other members of the community.

On Friday, January 19, Chancellor Gilliam reported the recommendations of the Deans from the Academic Portfolio Review, which included the recommendation to discontinue the M.A. in Mathematics. On Monday, January 22, Provost Storrs added her own recommendation to discontinue the Ph.D. in Computational Mathematics. While we address specifics of the program below, we must point out that both programs in Mathematics were treated differently from all the other programs that had been recommended for discontinuation. As both programs solidly achieved "Meets Expectations" on the quantitative rubric, neither program was asked to provide any additional information or context statement (the B.A. in Anthropology also was in the "Meets Expectations" category, but Anthropology did supply a context statement). A last-minute request was made by Dean Kiss for a context statement for the M.A. in Mathematics (but was never reviewed in Phase 2 of the APR process), and the Ph.D. program was never asked to provide a context statement. While we provided a statement after the Provost made her recommendation, the Provost did not have any context to consider when she made her recommendation. Given that the information in the APR up to that point was strongly positive for the Ph.D. in Mathematics, both in terms of financial concerns and ranking in the top 20% of Ph.D. programs at UNCG, we were shocked when the Provost recommended discontinuation of the Ph.D. program. Given the overwhelmingly positive data about the program that was included in the APR process, the Provost clearly was relying on information outside of the APR to make her decision, which seems to be unique to the Mathematics programs. The reason for this disparate treatment has never been explained.

Information on the Department and Graduate Mathematics Programs

The department's mission is to teach as if UNCG is a teaching college, to pursue research as if UNCG is a flagship R1 university, and to mentor all students as if we are family. It is our culture, and it is contagious when you roam the halls of Petty. Our dedication to our mission is a point of pride for all of us, an immeasurable asset to UNCG, and what will be lost if the recommendation is approved.

Established in 2008, our distinguished PhD program in Computational Mathematics stands as a singular offering within the state of North Carolina. Since its inception, we have conferred 28 Ph.D. degrees, with an additional 8 students poised to achieve this milestone by the summer of 2024. The success of our graduates is exemplified by their diverse placements, with many securing faculty positions including postdoctoral positions at esteemed institutions such as the University of Miami, Duke University, Tulane University, and Utah State University, as well as coveted roles in industry and federal agencies, including the NSA. Notably, four of our PhD alumni have been honored with the esteemed Project NExT Fellowship awards by the Mathematical Association of America. At the heart of our program lies a commitment to not only nurturing exceptional researchers but also *cultivating exemplary teachers*, a strategy that has been pivotal in positioning our graduates for success in academia. It is a success story for graduate education in STEM at UNCG, and as a doctoral-level STEM program it benefits from higher funding in the revised state budget model.

The M.A. in Mathematics serves as a bridge between our strong undergraduate programs and the Ph.D. program. It allows our best undergraduates to pursue an accelerated bachelor's and master's degree and builds fundamental skills for beginning graduate students. The master's-level courses draw students from both the undergraduate and Ph.D. levels, and has zero cost on top of those two programs. Since there is no justification for discontinuing the M.A. program when the Ph.D. program is ongoing, we focus this document on the Ph.D. program and mathematics graduate studies in general.

Quality and Value of the Ph.D. Program

For a program review focused on the value and sustainability of programs, it is odd that the quality of the Ph.D. program that is recommended for discontinuation isn't even tangentially referenced in the recommendation for discontinuation. It's as if the quality of the program does not matter. The program is one of the strongest at UNCG, ranking 6th out of 30 Ph.D. programs in the APR rubric. The research environment established by this Ph.D. program is internationally recognized, as shown by the support letters that have come in from around the world. The program's focus is on Computational Mathematics, which combines the beauty of mathematics and statistics with the power of modern computing. The program is constantly adapting to include exciting new areas, with recent curricular offerings in the hot area of data science, and a concentration in the M.A. program in Mathematical Foundations of Data Science.

The department has a robust research environment and hosts a vibrant colloquia/lecture series by distinguished researchers for the benefit of all students, and has an excellent professional mentoring program. UNCG is also a participating institution of the Institute for Mathematics and its Applications and the National Institute of Statistical Sciences.

The department generated over \$1.3 million in external research funding last year. In recent years, faculty have received funding from a variety of sources, including the National Science Foundation, the Simons Foundation, the U.S. Army, the National Institutes of Health, and the National Security Agency. This is an extraordinary amount of success in mathematics, where funding is challenging to come by, and a bachelor's program could not be competitive (or even eligible) for much of this funding. The overhead funds from this research provide basic infrastructure funding at UNCG, which is hard to replace in times of tight budgets.

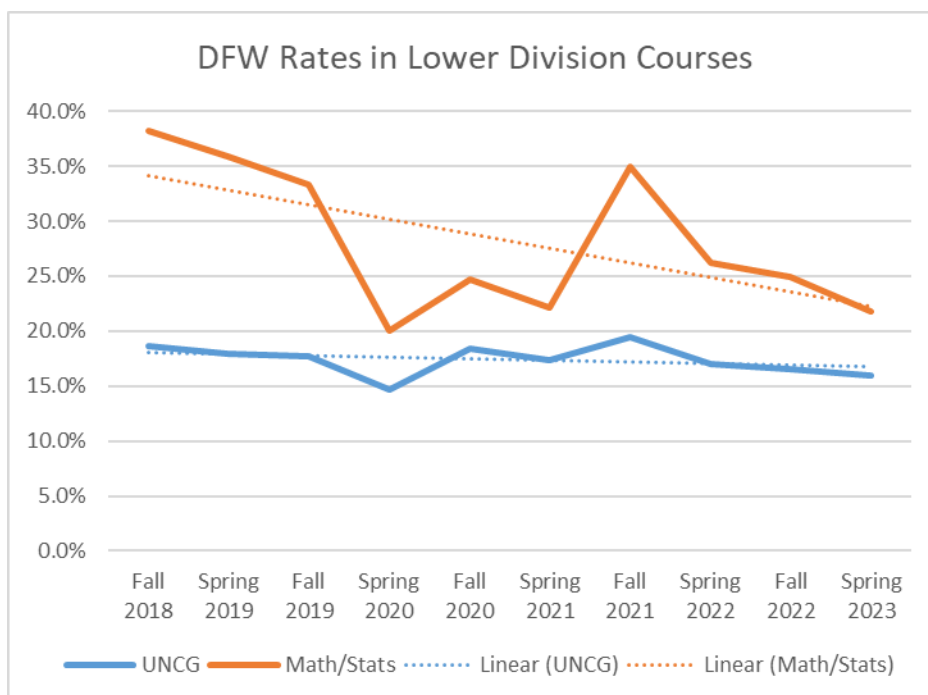
Discontinuing the Ph.D. program would undo years of hard work getting the program to the quality and prestige that it currently enjoys. Shutting down the program can be done with the stroke of a pen but re-establishing it in the future would be a huge undertaking. UNCG is recognized worldwide as a leading R2 institution, largely due to the reputation of the Computational Mathematics Ph.D. program. As a university on the cusp of R1 classification, terminating a successful Ph.D. program that produces high-profile STEM research would do significant damage to UNCG.

Student Success in Lower-Division Mathematics Courses

The Provost's stated reason for recommending discontinuation of the graduate programs is "an institutional need to prioritize efforts to ensure students in lower-division math and statistics courses succeed." Improving student success in introductory mathematics and statistics courses is a long-standing national challenge. We are aware of the difficulties that we face, and we have been striving to overcome them and enhance the student performance in these courses. We go into some depth here to show the efforts and successes we have had, and the challenges and plans for the future.

Data show that the Department of Mathematics has made highly successful efforts improving lower-division math and statistics course success, and the logic connecting Point A (removing graduate programs) to Point B (further student success in lower-division math and statistics) has never been explained. To the contrary, the support letters we have received from experienced mathematics faculty emphasize that success in graduate programs and undergraduate programs are inextricably linked: mathematics graduate students provide critical resources for undergraduates across the university to succeed in mathematics and statistics (please see attached letters of support). Mathematics graduate students provide 150 hours per week of one-on-one tutoring to UNCG students, free of charge to those students, and after significant training (and with faculty supervision) provide expert and accessible instruction.

Our department has made significant efforts and has seen excellent results in student success in lower-division mathematics classes. In fact, the decrease in DFW rates is among the highest in the university, and far exceeds the improvements university-wide. The chart below shows improvements for the university (blue line) and Mathematics and Statistics (orange line). As you can see, over the past 5 years the department has made real, significant, and steady improvements in student success. We expand this data by course number in the "Further Details on Student Success in Lower-Division Mathematics and Statistics" section at the end of this document.



These gains are a result of ongoing focus of faculty on mathematics education, including:

- Starting in 2019 and continuing to today, UNCG has been a pioneer of the Math Pathways project, which developed tailored mathematics pathways to improve student success. Multiple faculty have been involved in this effort over the years, most prominently former professional track faculty Tracey Howell and Professor Dan Yasaki. Pathways developed include MAT 112 for general MAC QR, MAT 118/120 for business students, MAT 183/184 for life science majors, MAT 190 (Precalculus) and MAT 191/196 (Calculus) for other STEM majors.
- Four faculty participated in a 2022 “Summer Course Reboot,” which led to the redesign of four lower-division courses: MAT 118, MAT 120, MAT 190, and STA 108. This effort involved faculty at a variety of levels, including two tenured faculty (Dan Yasaki and Igor Erovenko), and two professional track faculty who are at UNCG as Ph.D. students (Monika Goel and Matt Jester).
- We introduced and refined support co-requisite classes for students with weaker preparation, with MAT 181 supporting MAT 196 (Calculus A), and STA 107 supporting STA 108 (Elementary Introduction to Probability and Statistics). Results show that students who do the tasks provided in the support course have a significantly lower DFW rate (around 12 points lower for MAT 181 and MAT 196).

These efforts have earned regular recognition and praise by at least some parts of UNCG. While the work clearly isn’t done, the department believed that its strong gains were recognized and valued. For example, in a 2020 email from Dean Kiss, he relayed that

This morning at the Provost’s Council, we discussed that we improved our freshman retention rate by 5% this year, which is a significant achievement. Andrew Hamilton mentioned that Math Pathways played a role in this significant accomplishment.

And directly from Andrew Hamilton regarding the Math Pathways work:

This message is virtual applause from me for that tour-de-force presentation on re-structuring of access to and support for lower-division math courses you all gave this morning. That was something to watch! Right about now the rest of the Math Pathways folks in the System are scratching their heads trying to figure out how we got so far out ahead of them.

In the pursuit of excellence, the quality of teaching by mathematics and statistics faculty has been recognized by teaching awards, including

- Dan Yasaki (Professor) was awarded the UNC BOG Excellence in Teaching Award and the CAS Senior Teaching Excellence Award in 2023.
- Igor Erovenko (Professor and Associate Head) was recognized as the 2021 Career Undergraduate Research Mentor within the College of Arts and Sciences.
- Ratnasingham Shivaji (Professor) was awarded the MAA Southeastern Section Distinguished Teaching Award in 2020.
- Beth Lewis (Visiting Assistant Professor) winner of the 2020 UNC Greensboro Award for Excellence in Online Education.
- Haimeng Zhang (Professor) was awarded the College of Arts and Sciences Senior Teaching Excellence Award in 2019.
- Tracey Howell (Academic Professional) was awarded the College of Arts and Sciences Non-Tenure Track Faculty Teaching Excellence Award in 2019.
- Tom Lewis (Associate Professor) was awarded the CAS Junior Teaching Excellence Award in 2018 and is a MAA Project NExT Fellow.
- Sat Gupta (Professor) was awarded the College of Arts and Sciences Senior Teaching Award in 2018.

The department is committed to a process of continuous improvement and is always thinking of new ways to further our progress in student success. Some ideas for the future include:

- We will seek hiring in mathematics education as a top priority, through a combination of new positions, re-filling retirements or open positions, and shifting the focus of existing VAP positions as necessary.
- We will leverage the department's success in research to support lower-division success issues, using department overhead returns (when available) to bring in outside pedagogy experts (e.g., for trauma-informed pedagogy strategies after observations we have made that were similarly observed by advisors in CASA) and to send faculty and graduate student instructors to nationally recognized workshops for training in mathematics pedagogy.
- We will restructure the STEM service courses MAT 183/184, a "pathway" that had a troubled initial roll-out, to better align with the background and needs of biology majors at UNCG and to increase student success. The attached letter from Biology Department head Malcom Schug confirms they are enthusiastically in agreement with this: "Our faculty thought that the approach proposed by math was brilliant and continue to believe that this approach would substantially improve the success rate."
- We will restructure calculus for the other (non-biology) STEM students to better meet the needs of these students. We will incorporate ideas from the calculus support course that worked for

student success (such as promoting a growth-mindset, incorporating peer accountability to prevent burnout, utilizing trauma-informed pedagogy, etc.).

- We will prepare annual reports on efforts made and results achieved in student success. We believe that part of the problem is that our successes have not been communicated to all concerned parties.

Graduate student support will be an integral part of these endeavors, and not only as instructors of courses. We think the most effective contributions from graduate students will be leading more structured recitation sections in STEM precalculus and calculus courses, helping students succeed through the Math Help Center and serving as mentors and role models. The proposal to cut the Ph.D. program in Computational Mathematics led Nancy Bucknall (Director of College of Arts and Sciences Advising) to relay her concern:

I am concerned how the loss of the PhD program will impact the course/seat availability for both MAC Quantitative Reasoning courses and more specifically the Calculus sequence. Losing the graduate student instruction will likely mean fewer sections and larger enrollments, neither of which will be good for student progression, completion, or success.

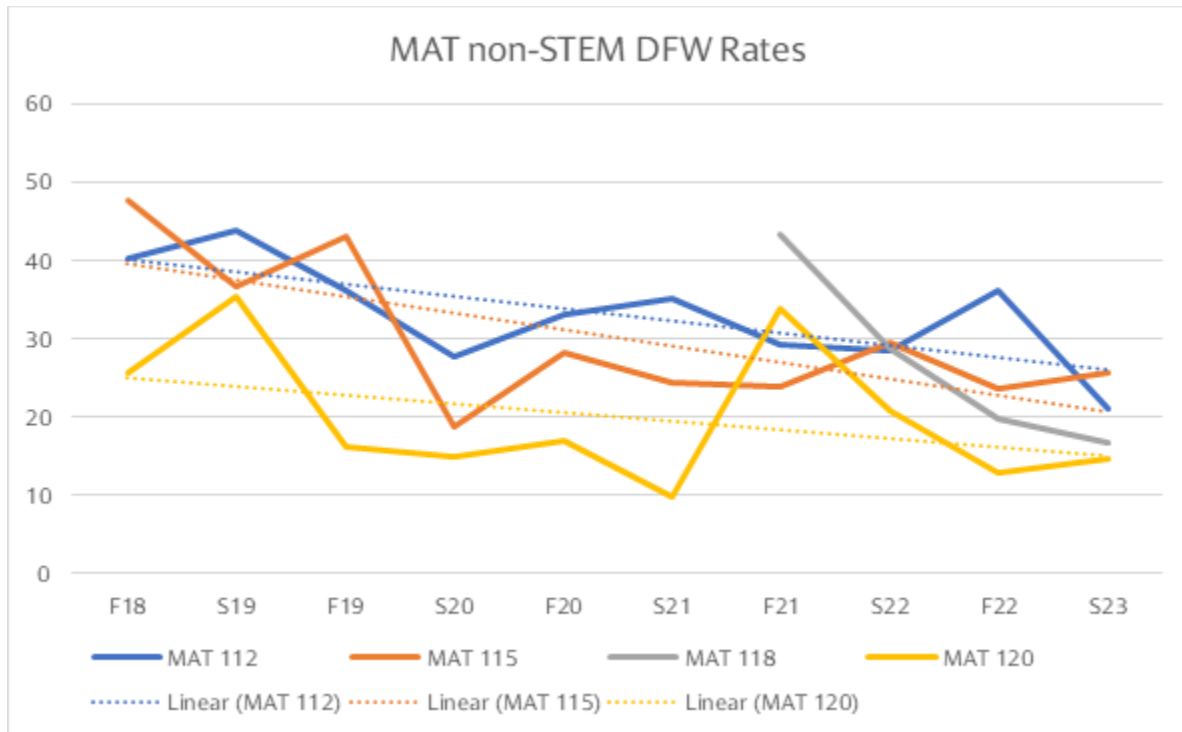
Conclusion

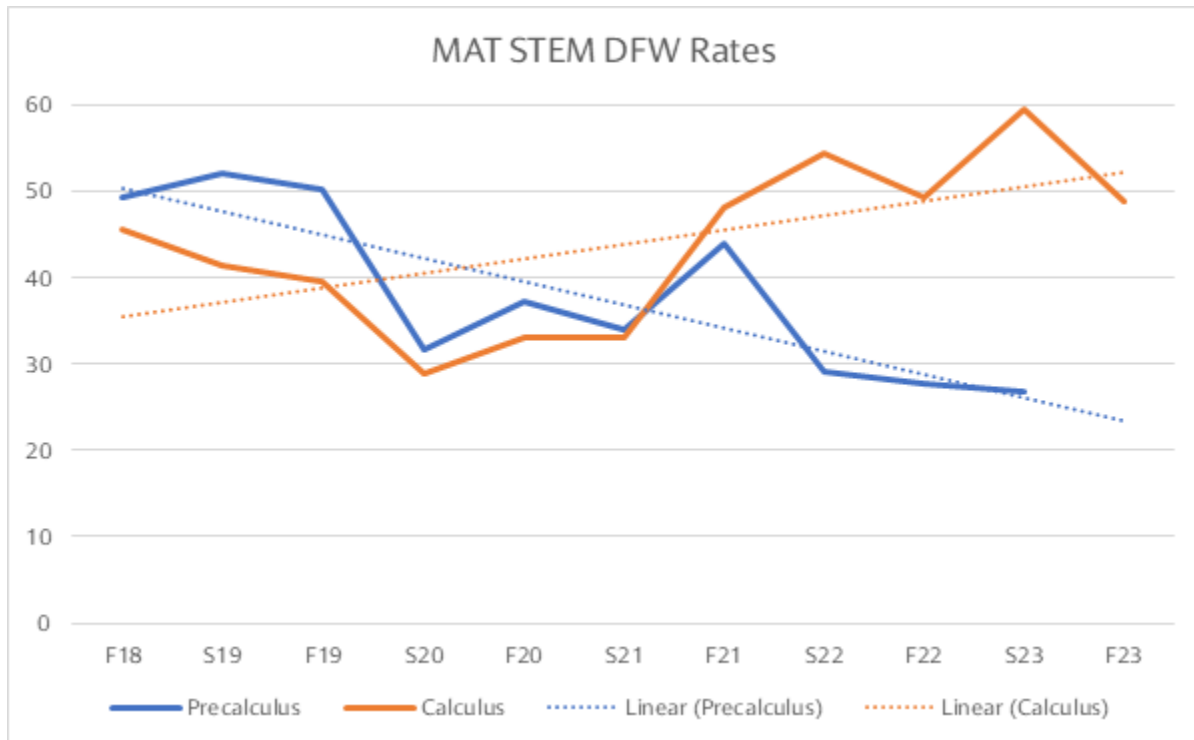
The administration has repeatedly recognized and praised our efforts and outcomes in improving student success in service courses. We have shown a steady decrease in DFW rates in these courses, and we remain dedicated to enhancing student success and retention at UNCG. Our faculty members will continue to seize every chance to deliver better courses. Many of our efforts inside and outside the classroom rely heavily on graduate teaching assistants, and we do not see a way forward without their support in the effort to sustain our hard-fought and noteworthy momentum in improving student success.

Further Details on Student Success in MAC Mathematics and Statistics

The department regularly gathers and analyzes data on the success of various initiatives, looking at data down to the level of DFW rates of different majors in courses. We present a small portion of that analysis here.

Looking at individual courses, the DFW rates in MAT 118 Business Algebra and MAT 120 Business Calculus are consistently low, below 20%. We redesigned these courses for Fall 2021, and they have improved significantly. The DFW rates for MAT 112 Contemporary Topics in Mathematics and MAT 115 College Algebra are also decreasing steadily, and we expect them to drop below 20% soon.





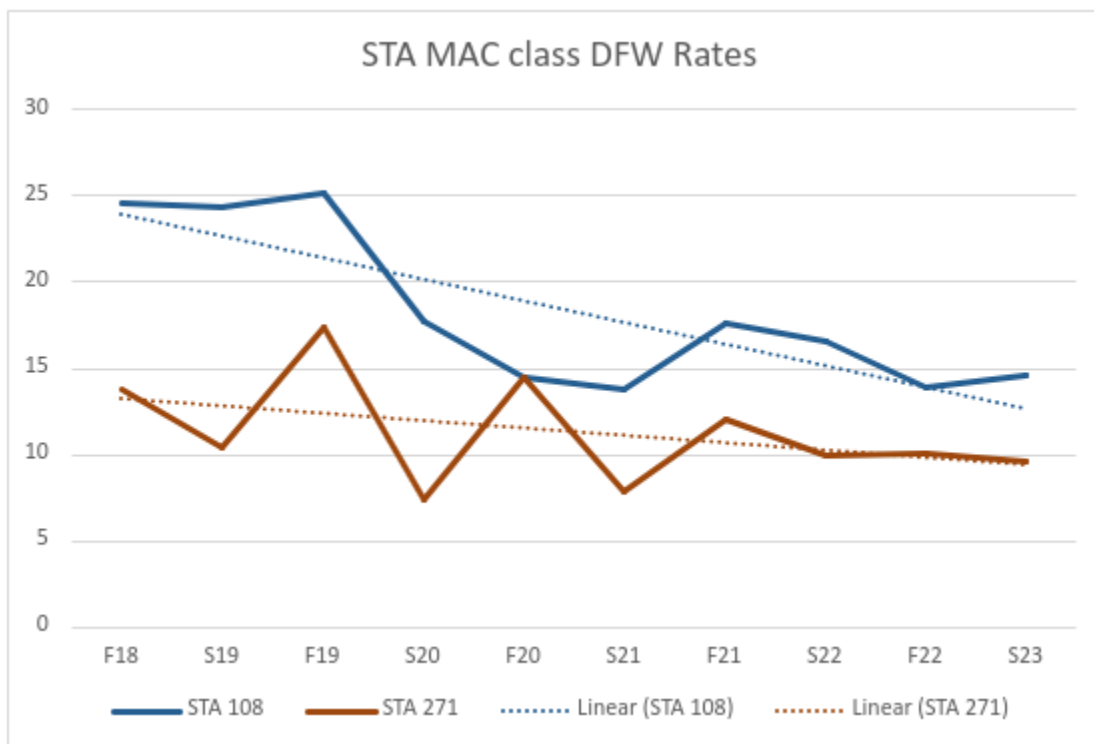
The DFW rates in STEM-pathway courses, Precalculus and Calculus, are higher, as expected, since these courses require strong mathematical skills for the students’ success in their majors. However, we are always working to improve our teaching and student outcomes in these courses. For example, following Math Pathways recommendations and with an eye toward reducing time to graduation, we introduced a new 4-hour one-semester Calculus course MAT 190 in Fall 2021, which replaced the old two-semester sequence of MAT 150 and MAT 151. This led to an immediate drop in DFW rates in Precalculus, which have continued to decrease. We also observed steady declines in the Calculus DFW rates before the pandemic, but they rose in Fall 2021. We believe a major contributor was the switch from our old four-course 3-hour Calculus sequence to a new three-course 4-hour sequence. Our goal was to make the transfer of credits between UNCG and other colleges and universities easier for UNCG’s significant population of transfer students, since most (including the NC Community College system) use the three-course sequence. Sadly, we found that our students had trouble with the pace of a 4-hour class (MAT 196 Calculus A). This change also coincided with the return to pre-pandemic standards, which was hard for the students to adapt to after the pandemic leniency. We identified specific problems with MAT 196, and made several changes to the course in Fall 2023. These changes included aligning the course better with its service course mission and giving more support to struggling students in the support course MAT 181. We lowered the class size in MAT 181 to allow more individual attention for students, made all sections face-to-face so students would receive direct in-person support, and we assigned only faculty to teach this course. This quick action resulted in an 11% drop in the DFW rate in Fall 2023 compared to Spring 2023, but we know that it is still too high. To address this issue, we are discussing the possibility of going back to the 3-hour Calculus courses to help our students handle their workload.

Looking at the efficacy of various interventions, we have found that the Math Help Center is one of the most valuable supports for the Calculus sequence. Data provided by the Math Help Center for Fall 2023 shows a dramatic increase in performance for students who utilize the services they provide. We cannot

emphasize enough that the vast majority of this support is provided by graduate students in Mathematics and Statistics.

MAT 196				
	ABC	DFW	Total	DFW %
Didn't use	55	96	151	63.57%
Used	122	74	196	37.75%
	177	170	347	49%
MAT 190				
	ABC	DFW	Total	DFW %
Didn't use	86	57	143	39.86%
Used	23	11	34	32.40%
	109	68	177	38.40%

Statistics classes STA 108 and STA 271 currently serve large numbers of UNCG students, with STA 108 providing MAC Quantitative Reasoning credit (Fall 2023 enrollment 348) and STA 271 currently being evaluated for MAC Data Analysis in the Natural Sciences credit (Fall enrollment 136). Together, these courses served 484 UNCG students in Fall 2023. The following chart shows DFW rates for these courses, and the steady gains we have made.



The data in this section shows only a small part of the data that the department regularly gathers and analyzes, looking for ways to improve courses. We have studied many variables including the effect of support classes, performance by major, performance in prerequisite courses, and more. The department is constantly looking for ways to improve student success.