Thomas Harriot College of Arts and Sciences
Department of Chemistry
Self-Study: 2017-2024

Executive Summary

The Department of Chemistry has completed a self-study of the department's BA, BS, and MS programs, including the teaching, research and service components. For this self-study, we considered the programs in the context of the mission and strategic goals of the department, the Harriot College of Arts and Sciences, and the University. We are committed to the University's mission of student success, regional transformation and serving the public, and the department's high quality instructional, research and service activities are a critical and on-going part of that mission.

Our graduates' rigorous preparation and technical skills have resulted in strong placement rates into graduate programs, professional schools, and local industry. Multimillion-dollar pharmaceutical companies and other regional industry partners rely on our programs for their workforce needs. We play a central role in efforts to expand the pipeline of K-12 STEM educators for eastern North Carolina. Many of our students remain at ECU after graduation to continue preparing for careers in the health professions at the ECU Brody School of Medicine and the ECU School of Dental Medicine. Further, the department's engagement in interdisciplinary research makes it a valuable resource in supporting the University's overall research mission.

The department's solid performance relative to our institutional and peer programs' levels of research productivity and external funding, coupled with a shrinking and aging group of tenure track faculty, merits investment in the department to maintain or increase research productivity. We have a long and fruitful association with the Interdisciplinary Doctoral Program in Biology Biomedicine & Chemistry (IDPBBC), dating back to 2007, that has produced thirteen PhD graduates from our department. To further expand/enhance our footprint in graduate education and research, progressing towards a stand-alone Chemistry PhD program has been proposed.

a. Overall quality of each degree/certificate

BA and BS Chemistry

The BA degree in Chemistry provides excellent grounding in chemistry principles, including specially focused 3000-level coursework. The BS degree in Chemistry offers in-depth coverage of all major areas of chemistry, featuring challenging advanced coursework for our majors. Students who earn a BA or BS in Chemistry are equipped with skills that enhance their marketability to a wide variety of employers in technology and science and are well-prepared to enter graduate school in chemistry or professional school such as medical, dental, or pharmacy school. Our BS degree is certified by the American Chemical Society, the largest professional scientific organization in the world.

Our programmatic assessment results (Section 3a) have consistently met the criteria for success in the assessment in the General Chemistry (CHEM 1151 and 1161 lab practical results) for research methodology following the transition to the Argument-Driven Inquiry (ADI) approach. Clearly, the ADI approach has directly addressed the desired outcomes, prompting the department to transition the organic laboratory curriculum (CHEM 2753 and 2763) to ADI. Progress on subject knowledge is more variable (Section 3a). Regardless, student survey results are positive, as the vast majority indicate that they are satisfied or very satisfied overall with the program, our preparation, advising, and job placement rates.

Beginning in Fall of 2021, the department introduced a major curriculum change (adopting the Chemistry, Life, the Universe, and Everything (CLUE) curriculum) in general chemistry, which has been shown to improve student success.

MS Chemistry/Grad Programs

The MS degree in Chemistry consists of an interdisciplinary core curriculum, additional coursework in the chosen concentration, and several options including a research-based thesis track, a non-thesis track, and a Professional Science Masters. Students who earn a MS in Chemistry are well equipped with skills that enhance their marketability to a wide variety of both regional and national pharmaceutical industry employers and are well-prepared for further study in chemistry or professional school such as medical, dental, or pharmacy school.

Over the time period of the review, enrollment has averaged 20 full-time and 4 part-time students per year, with 11 graduates per year. The degree completion rate has remained consistent and high; the average 3-year graduation rate is 96%. The time-to-degree has been consistently around 2 years (with a slightly higher single year due to the pandemic). The MS program graduates have a near 100% job placement or admission to a graduate/professional program.

As mentioned above, the Department of Chemistry also actively participates in the Interdisciplinary PhD in Biology, Biomedicine, and Chemistry (IDPBBC) along with the Departments of Biology (located on the main ECU campus) and Biochemistry & Molecular Biology (located within the Brody School of Medicine campus). While this program is administered by the Thomas Harriot College of Arts and Sciences (THCAS), the department plays a significant role by admitting and providing stipend support to students in the chemistry track, as well as contributing to administrative and curricular decisions. The program has demonstrated success within our department, with nine students successfully completing their degrees during the review period. Because of its significance within our graduate offerings, some relevant data is included in the following report.

b. Strengths and weaknesses of the department

Teaching

The Department of Chemistry continues to perform well in peer and student teaching evaluations and our faculty are consistently recognized for their exemplary teaching. During the self-study period, two faculty members have received the Board of Governors Award for Excellence in Teaching, (an award given to only one person on ECU's campus per year) four faculty members have received the Board of Governors Distinguished Professor for Teaching, two faculty members are ECU Scholar-Teacher Award recipients, two faculty members have received the Harriot College Fixed-Term Faculty Award for Excellence, one the Max Ray Joyner Award for Outstanding Teaching in Distance Education, and one the Robert L. Jones Teaching Award. Several of our faculty are recognized campus-wide for their outstanding teaching and have led workshops through the Office for Faculty Excellence.

Additional support in terms of appropriate classroom space, learning assistants and graduate teaching assistants are necessary. ECU Chemistry is significantly below the institutionally identified peers in the amount of resources provided by the university, with fewer faculty members and Graduate Teaching Assistants (GTA) per student. It is anticipated that these investments would quickly translate to savings in terms of increased student success and lowered course repeat rates. For example, we have found that the incorporation of more problem-based learning in the classroom has resulted in lower DFW (grades of

D, F and withdrawal) rates in those sections, and with additional resources, we could expand offerings of problem-based learning sections, especially if section enrollments remain high.

As mentioned above, the department has recently moved to a new curriculum for the general chemistry sequence. Published research about this curriculum (called CLUE: Chemistry, Life, the Universe & Everything) has been shown to improve outcomes for all students, with particularly large impacts for students at the highest risk of dropping out of the courses. Working with ECU's Institutional Planning, Assessment and Research (IPAR), we were able to demonstrate that this improvement in student success holds true for ECU students as well, with students from low wealth school districts and students identifying as under-represented minority (URM) students showing significant improvements in student success. Concomitantly, the top scorers continued to perform well. Following successful implementation of the Argument Driven Inquiry curriculum into General Chemistry labs, the department has expanded that curriculum to include the Organic Chemistry labs.

Associate Professor Walker was the PI of two NSF grant funded efforts to introduce and enhance Course-based Undergraduate Research Experience labs (CUREs) offered by the Department of Chemistry. There is strong evidence that these types of experiences result in higher levels of student engagement, enhanced technical skills, stronger presentation skills, and critically a higher retention rate in the field and university. These courses are very popular with the students, serving as an important recruiting tool for majors and research students into faculty labs. The Department's offerings under her leadership have now expanded to include eight different lab courses taught this way.

Research

Publication (average 26.1 per year over self-study period) and presentation (average 42.3 per year) numbers, while showing some variation year-to-year, have remained steady. This sustained effort is reflected in grant submissions (averaging $9.56 million/year) and awards (averaging $974 thousand/year), although loss of tenure track faculty members may have begun resulting in a slight downward trend in external proposals, awards, and expenditures. While many of the awards are from traditional funding agencies like the National Science Foundation and National Institutes of Health, department faculty have successfully competed for other sources of funding. Many of these awards support cross-department, College and University collaborative research projects. Chemistry is poised to play a solid role in the University's likely move to Carnegie R1 status later this year.

A major highlight of the last seven years was the recognition of Professor Yu "Frank" Yang with the ECU Lifetime Achievement in Research and Creative Activity Award in 2022-2023. Associate Professor Joi Walker and Associate Professor Adam Offenbacher were both recipients of the Harriot College Dean's Early Career Award. Associate Professor Walker has been named the Kinnear Chair, Distinguished Visiting Professor at the US Naval Academy.

Service

Our faculty have served important leadership roles campus-wide, including memberships on workgroups and taskforces, Faculty Senate committees, and administrative roles. Faculty members have reviewed over 250 articles and served as ad hoc and panel reviewers for the NSF, NIH, and others. Drs. Jason Pajski and Sambuddha Banerjee have served as Chair, Chair-Elect and Councilors for the ACS Local Section. Regional service includes organizing Science Olympiad events, judging science fairs, and activities with local science museum *A Time for Science* and Scouting America.

The department recently concluded an NSF-REU summer research program. This program ran from 2019 – 2023 and brought students from around the country to ECU for a research-intensive experience. Organizing events such as the ECU Biophysics Symposium and the LaserTAG Imaging Competition and Research and Creative Achievement Week visiting speaker help build awareness and cross campus collaborations.

Regional Transformation

The department contributes personnel, coursework, and professional development activities to the university's Eastern Region Pharma Center, building on the strong, ongoing relationship the department has built with regional industry. Dr. Jack Pender organizes an annual Pharmaceutical Conference that attracts local industry professionals for two days of mini-courses in industry-related topics and an outstanding vendor show. Many of our own students use this conference as an opportunity to network with local industry and make critical contacts with recruiters.

c. Major findings

The department has successfully maintained instructional quality in our three programs under review (BA in Chemistry, BS in Chemistry (American Chemical Society Certified), and the MS in Chemistry). Post-pandemic student success struggles have been addressed via curriculum changes (such as CLUE for general chemistry), additional team and problem-based classes with Learning Assistants, and other proven best practices, bringing DFW rates back in line with pre-pandemic rates. CURE offerings have been expanded.

Consistent with national and state-wide trends, our undergraduate enrollments in Chemistry majors have declined. Yields among admitted students have also declined over the review period, suggesting that beyond continuing to actively recruit new students through ECU events, additional outreach to admitted students is necessary following admission.

In addition to the strong research productivity in terms of publications and presentations, over the period of the self-study (2017-2024) Higher Education Research and Development (HERD) expenditures have averaged nearly $1,000,000 annually, compared with previous seven-year review period in which expenditures averaged $133,000, demonstrating the return on investment of those new hires and a small expansion in the number of GTA positions (two additional PhD lines) available. As discussed above, the loss of tenure track faculty members may have led to a slight downward trend in external funding proposals, awards and expenditures. The department believes additional investment in research and instructional infrastructure is merited and will be rewarded with improved student success and research productivity.

d. Significant actions or changes planned

In summary, the most significant actions planned in this self-study are provided below:

- Continue to request tenure-track hires at the Assistant Professor rank, particularly in Chemical Education but there are also current or pending needs in the Analytical, Physical, and Inorganic fields.
- Addressing aging research infrastructure by seeking external funds to replace the workhorse 400 MHz NMR, obtain a new high-resolution mass spectrometer, and obtain a new 700 MHz NMR needed for macromolecule work in Chemistry and collaborators in the departments of the Brody School of Medicine.

- Move towards a PhD program in Chemistry with a concomitant increase in the number of graduate teaching assistantships required to expand the MS program, participation in the Interdisciplinary PhD and eventually launch the stand-alone PhD.
- Continue to incorporate team-based learning, problem-based learning, argument-driven inquiry (ADI) and related pedagogical approaches into our lectures and labs. Published and internal studies at ECU have established that these approaches improve student success as measured via DFW rates and engagement in the material. Continue to advocate for upgraded instructional space appropriate for team-based learning and additional support for learning assistants and graduate teaching assistants to support teaching activities and student success.
- Strengthen, expand, and promote our undergraduate internship program. Over the last seven years, participation in these opportunities for credit (CHEM 5993) have decreased.
- Continue to actively recruit new students into the BA and BS majors, using opportunities like CURE labs and increased recruiting in second year courses to expand the pool of internal potential majors. Continue to participate in all university opportunities to recruit potential majors from the admissions pool and ensure updated and engaging materials are available on the department website.
- Consider applying for an NSF S-STEM grant designed to expand the graduate program and expand the reach and access to the program further out into the region.

Table of Contents

Full Report

1a. Program Purpose: BA Chemistry/BS Chemistry

1.1a. Program Purpose

The BA degree in Chemistry provides excellent grounding in chemistry principles, including specially focused 3000-level coursework. Students who earn a BA in Chemistry have a broad education in the chemical sciences, are equipped with skills that enhance their marketability to a wide variety of scientific companies, and are well-prepared to enter fields such as medicine, dentistry, pharmacy, and forensics. This flexible 4-year plan leaves room for exploring other interests and is a popular major to pair with other science majors.

The BS degree in Chemistry offers in-depth coverage of all major areas of chemistry, featuring challenging advanced coursework for our majors. Students who earn a BS in Chemistry are equipped with skills that enhance their marketability to a wide variety of employers in technology and science, and are well-prepared to enter graduate school in chemistry or professional school such as medical, dental, or pharmacy school. Our BS degree is certified by the American Chemical Society, the largest professional scientific organization in the world.

These two degrees capture a much larger student population than either program would alone. Students with advanced math skills, as evidenced by ACT/SAT scores and/or AP credit for Calculus, are well-suited to begin the highly sequenced ACS-certified BS Chemistry program as freshmen. The BS Chemistry degree requires three semesters of traditional Calculus (MATH 2171, 2172, and 2173; Calculus I, II, and III) and calculus-based Physics (PHYS 2350 and 2360; University Physics I and II). However, students who may not have been well-prepared in high school mathematics and may need to begin college mathematics at the College Algebra (not even the Pre-Calculus) level could be less likely to major in Chemistry if the BA degree were not available to them. The BA Chemistry degree requires only two semesters at the survey level for calculus (MATH 2121 and 2122; Calculus for the Life Sciences I and II) and algebra-based Physics (PHYS 1250 and 1260; General Physics I and II). Because ECU serves a large number of students with average, but not advanced, math skills, we believe it is important to facilitate their engagement in Chemistry with the BA degree. The requirement of at least 4 (sometimes 5) semesters of chemistry coursework by several other life and allied health sciences majors, such as the BS Biology degree, which also require the condensed survey of life-sciences calculus and algebra-based physics, allows us to recruit additional students to the BA Chemistry major upon their exposure to chemistry.

In collaboration with the Department of Biology, we play a critical role in the oversight and curricular design of the BS degree in Biochemistry, specifically the Concentration in Chemistry. This concentration for the BS degree is rooted in structural biochemistry and emphasizes the dynamics of biochemically important systems and was designed to pair well with the BS Chemistry major. Our students in both concentrations are encouraged during the advising process to double major as this makes a strong case for admission to highly competitive graduate and professional programs and adds valuable content and skills for employment in the biotechnology sector. In spring 2024, ECU's BS in Biochemistry degree received full accreditation from the American Society for Biochemistry and Molecular Biology (ASBMB).

1.2a. Program Alignment

The BA and BS programs' purposes align with the University's mission and strategic initiatives as follows:

- Mission Priority 1: Student Success
    - Our thoughtful course sequencing, suggested four-year plans, faculty advisor- and faculty-student interactions, and smaller upper-division classes have all contributed to our steady graduation rates (M1.1).
    - Our strong and ongoing undergraduate research program is perfectly aligned with the university's commitment to expanding undergraduate research (M1.2).
    - As a major provider of coursework required for the nursing, public health, and exercise physiology majors, and for pre-medical and pre-dental students of any major, we are well aligned with the University's commitment to expanding the number of high-quality health professionals (M1.3 and V3.1).
- Mission Priority 3: Lead Regional Transformation
    - Several multi-million-dollar international companies (Mayne, now Catalent; ThermoFisher) rely heavily on our graduates for their workforces (M3.1).
    - As mentioned above, our lower division service courses are critical components of preparing a workforce for STEM and healthcare professions (M3.1).
    - Associate Professor Joi Walker and her work in STEM Education aligns with addressing the critical need for K-12 STEM educators (M3.3).
- Vision Priority 1: Social and Economic Mobility
    - Multiple degree pathways provide access and advancement opportunities for diverse learners (V1.1).
- Vision Priority 3: Rural Health and Well-Being
    - See M1.3 above

1.3a. Features

The BA in Chemistry is a very common double major with the BS in Biology and other similar majors, as it is only three additional courses (with labs). This double major offers a desirable option for pre-professional school applicants by providing a skill set that makes them very employable regionally, and in some cases, leads to a MS in Chemistry.

The department has multiple faculty-advised student groups, including the CHEM Club (which is an ACS Affiliate) and Out in Science, Technology, Engineering, and Mathematics (oSTEM). Additionally, we support the Chemistry and Physics Living Learning Community (CAPs LLC), which aims to improve retention and success rates among intended and declared majors in both disciplines, many of whom are also in the CHEM Club.

The department offers Course-based Undergraduate Research Experience labs (CUREs) in Organic (CHEM 2753 and 2763), Quantitative and Instrumental Analysis (CHEM 3251), Elementary Inorganic Chemistry (CHEM 3451), Biological Chemistry (CHEM 3771), Instrumental Analysis (CHEM 4351), and the Physical Chemistry labs (CHEM 3951 and 3961) include elements of the CUREs and inquiry-based lab work.

Enrollments in our pharmaceutics-focused coursework at the undergraduate (Pharmaceutical Industry Skills Laboratory: Good Manufacturing Practices) and graduate (Current Good Manufacturing Practices) have remained high, nearly 30 per annum, and our local industries have provided strong support for the

course. Typical feedback from the employers is that the course saves approximately six months of training and makes our graduates quite attractive as potential employees.

In addition to offering a Minor in Chemistry, the Minor in Pharmaceutical Methods and Technology was developed and launched during the 2021-2022 AY. The minor provides a multidisciplinary approach for students to develop the scientific competencies of 1) experimentation and then analysis and interpretation of resulting data, 2) development of the ability to present scientific information in written and oral formats, and 3) mastery of documentation requirements for carrying out chemical and biological methods under regulatory conditions. Courses in the minor expose students to the experimental methods and techniques commonly used in research, development, and manufacturing in the pharmaceutical field.

The department provides research support for our undergraduates through competitive Promoting Undergraduate Research in Chemistry (PURC) at ECU awards, supported via the financial return to the department of a portion of the cost of the undergraduate lab manuals. The average award amount is typically $1,000. Tying this type of support to a requirement that students apply for Undergraduate Research and Creative Activity Awards (URCA, campus-wide competition involving proposed research) and present at Research and Creative Achievement Week (RCAW) has resulted in an average of six URCA awards and eight presentations at RCAW per year since 2017. In addition, twenty Chemistry Honors theses have been prepared under the guidance of Chemistry Department faculty since 2017. Numerous Signature Honors Projects (SHP) have also been completed by ECU Honors College students under the mentorship of departmental faculty during the same period. Notably, a sizeable portion of these Honors College students come from other disciplines (Engineering, Public Health, Biology, etc.) thus expanding the reach of our department across the university.

We were the first in the university to create an Undergraduate Teaching Assistantship program in 1998, obtained partial funding for the program from Metrics, Inc. in 2003, and are currently funded, in part, by Catalent (who provides $10,000 per year to support the students in the program). Students spend the first semester shadowing experienced faculty mentors, meet every Monday with the instructor of CHEM 2301, which provides the pedagogical underpinnings for the program, then transition into teaching their own section under the supervision (and jointly with) a faculty member or Southern Association of Colleges and Schools (SACS) credentialed GTA.

We have an established Undergraduate Learning Assistant program, with financial support from Academic Affairs and Bate Foundation. Since fall 2017, 83 learning assistants have worked with faculty members to facilitate group work in large general and organic chemistry lecture courses, providing both important support for students in the course and an enriching experience for themselves.

1.4a. External Factors

There will be increasing opportunities for our graduates here in eastern NC, including those at local and regional pharmaceutical and biotechnology companies (which is already robust, with nearly 7000 employees at companies east of I-95; the recent acquisition of Patheon (Greenville, NC) by ThermoFisher and new or expanded facilities from Johnson & Johnson, Schott Pharma, and others in nearby Wilson, NC will likely expand demand. ECU and Pitt County are also part of the Biopharma Crescent (https://www.biopharmacrescent.com/), a geographic designation of counties in Eastern NC with the goal of recruiting outside investment from the pharmaceutical industry. In addition, the recent designation of NC 264 as Interstate 587 will likely spur more growth in this region.

Nationally, the US Department of Labor (Bureau of Labor Statistics, Occupational Outlook Handbook, 2022-2023 Edition) projects above average growth (8% over the next 10 years).[1] Quoted here is the pertinent section:

"Overall employment of chemists and materials scientists is projected to grow 8 percent from 2023 to 2033, faster than the average for all occupations.

About 7,800 openings for chemists and materials scientists are projected each year, on average, over the decade. Many of those openings are expected to result from the need to replace workers who transfer to different occupations or exit the labor force, such as to retire."

1b. Program Purpose: MS Chemistry

1.1b. Program Purpose

The MS degree in Chemistry provides flexible pathways tailored to different student needs and career goals: a research-intensive thesis track emphasizing independent laboratory investigation, a coursework-focused non-thesis track providing broader exposure to chemical concepts with limited research experience, and a Professional Science Masters (PSM) integrating business and chemistry concepts, meeting professional standards established by the National Professional Science Masters Association (NPSMA).[2] The program features an interdisciplinary core curriculum complemented by specialized coursework in the student's chosen concentration. Our graduates have demonstrated excellent career outcomes, with successful placements across multiple sectors (data summarized in section 2.6b). This diverse range of outcomes reflects both the program's comprehensive preparation and its ability to serve students with different career goals. The skills and knowledge gained through our MS program make our graduates competitive candidates for both regional and national employers, as well as top doctoral and professional programs.

1.2b. Program Alignment

The MS Chemistry program directly supports several of ECU's key strategic priorities:

- Mission Priority 1: Student Success
    - Our MS program provides transformative research experiences through thesis work and laboratory training (M1.2).
    - The MS offers flexible pathways (thesis, non-thesis, PSM) to meet diverse student needs and career goals (M1.1).
    - Our multidisciplinary curriculum exposes the students to several chemistry aspects in a set of four required courses:
    - Core courses spanning multiple chemistry disciplines
    - Recent addition of Research Methods in Chemical Education to core selection
    - Elective options across biochemistry, analytical, organic, and inorganic chemistry
    - Integration of modern instrumental techniques and data analysis
- Mission Priority 3: Lead Regional Transformation

[1] Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook*, Chemists and Materials Scientists, at https://www.bls.gov/ooh/life-physical-and-social-science/chemists-and-materials-scientists.htm

[2] https://professionalsciencemasters.org/

    - The MS experience strengthens the regional workforce through placement of experienced graduates in local pharmaceutical and chemical industries (M3.1).
    - Research driven MS program produces strong synthetic and analytical skills in our graduates (M3.3).
    - Exposure to Current Good Manufacturing Practices class and/or Professional Science Masters (PSM) track helps provide skilled employees for the local pharmaceutical industry.
    - We maintain active partnerships with regional employers (M3.2), facilitating internships and employment opportunities in local and regional industry positions.
- Vision Priority 1: Social and Economic Mobility
    - Multiple degree pathways provide access and advancement opportunities for diverse learners (V1.1).
    - Program outcomes demonstrate successful career placement and advancement across various sectors.
    - Thesis research opportunities provide hands-on experience valued by employers and doctoral programs

1.3b. Features

Over the period of the self-study (2017-2024) the Department of Chemistry faculty have been featured on approximately 185 journal articles or book chapters, featuring approximately 140 unique student co-author designations (i.e., not double counting on collaborative efforts).

As mentioned above, enrollments in our pharmaceutically-focused courses at the undergraduate (Pharmaceutical Industry Skills Laboratory: Good Manufacturing Practices) and graduate (Current Good Manufacturing Practices) have remained high (about 30 per annum, with the majority of the MS students taking this course), and our local industries have provided strong support for the course. Through direct communications from managers at local businesses such as Thermo-Fisher and Catalent, the course saves approximately six months of training and makes our graduates more attractive as potential employees.

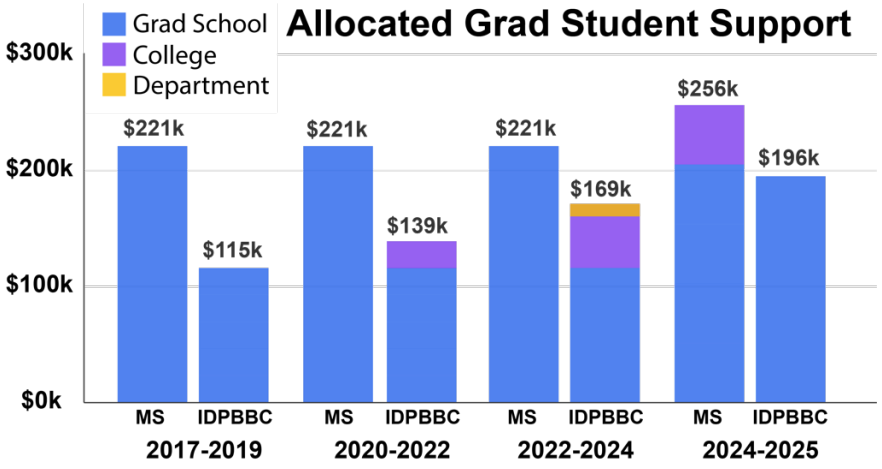
In addition to the Professional Science Masters track within the MS degree, the department recently added a Pharmaceutical Sciences and Technologies (PhaST) Certificate offering. This certificate allows students to take the Good Manufacturing Practice (GMP) and Advanced Methods in Analytical Chemistry courses along with a business-related course to advance their industry employment prospects.

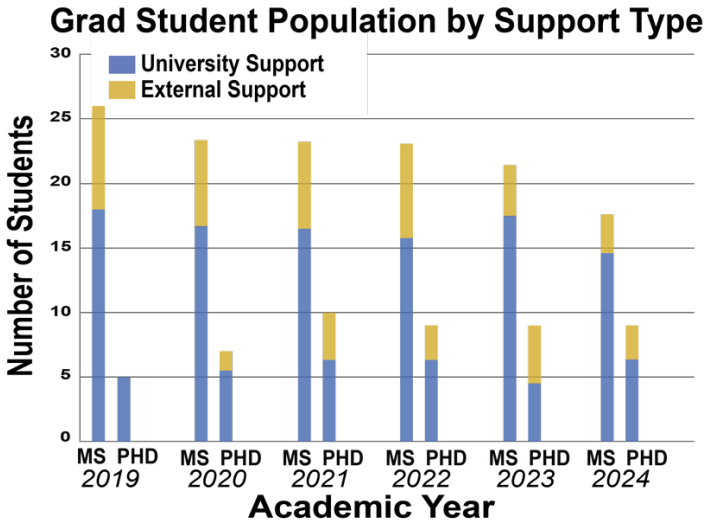
The 'Allocated Student Support' chart below illustrates our graduate student support levels over the review period. While the majority of our student support comes directly from the ECU graduate school, funding has seen some notable changes. Master's program funding remained static through 2024. For our PhD programs, the Thomas Harriot College of Arts and Sciences (THCAS) provided support for an additional student line starting in 2020 and a second in 2022. Furthermore, in 2022, PhD students received a $5k/year stipend increase, funded primarily by THCAS with supplemental support from the department. As of Fall 2024, we received a significant enhancement in our allocated support, which is now wholly provided by the ECU Graduate School and THCAS.

The 'Grad Student Population' chart illustrates the distribution of students across our graduate programs since 2019 and their respective funding sources (enrollment data is also summarized in later sections below). The data show the average number of students covered across each area per academic year as these numbers can vary from semester to semester. For MS students, academic year stipends have increased from $12,500 in 2017 to $16,000 in 2024. We provide additional summer support through

THCAS funds (not reflected in the above plot due to varying allocations based on need), bringing the total yearly MS student compensation to $20,000 starting in the 2024-25 academic year. The new allocation structure supports up to 16 MS positions. Due to ECU Graduate School budget constraints, MS student support is limited to stipends only, with no additional funding for tuition or health benefits. This limitation has broader implications for research funding, as it restricts faculty members' ability to include full MS student support in federal grant proposals. Many federal funding agencies expect institutions to provide comprehensive student support packages, including tuition and benefits, which makes it more challenging to incorporate MS students into grant-funded research projects.

For PhD students in the Chemistry concentration of the IDPBBC, yearly stipends have increased from $23,000 in 2017 to $28,000 in 2022, which is the amount we offer currently. In the duration of the study period, the combination of the ECU Graduate School and THCAS has provided support for five (2017-2020), six (2020-2023) or seven PhD lines (2024). The ECU Graduate School currently provides allocations for 7 positions, which include both full tuition coverage and health insurance benefits.





1.4b. External Factors

As shown in the charts above, there has been a gradual increase of our Graduate Teaching Assistantship budget with a significant increase starting Fall 2024. Starting in Fall of 2020, the College provided funds for an additional PhD assistantship and covered the majority of the raises for these students in Fall of 2022, which was split between the college and the department 75-25%. The 2024 budget maintains the same number of MS student positions for which we've been allocated over the study period while the College has supported a substantial increase in stipend levels. Regarding PhD support, the Graduate School not only assumed the financial responsibility for existing positions but also expanded the program by adding another student line. This demonstrates the College and Graduate School's growing commitment to supporting graduate education in the department.

Also, as mentioned previously, the Bureau of Labor Statistics (BLS) has predicted continued strong growth in job prospects for chemistry graduates, particularly those with the Good Manufacturing Practices (GMP) training and/or internships locally.[3] Quoting from that report:

"Chemists who have laboratory experience outside of a classroom environment, such as through a cooperative program or internship, are likely to meet with better employment prospects after graduation. Chemists and materials scientists with advanced degrees, particularly those with a Ph.D. and work experience, are expected to have better opportunities."

In addition, the 2015 American Chemical Society ChemCensus[4] has revealed a greying of the workforce. Between 1990 and 2015, the percentage of chemists in the workforce aged 50 years of age or older has gone from 27.9% of the workforce to 49.3%. As these older chemists retire, there will be enhanced demand for new employees.

2a. Enrollment, Degrees, and Student Success: BA Chemistry/BS Chemistry

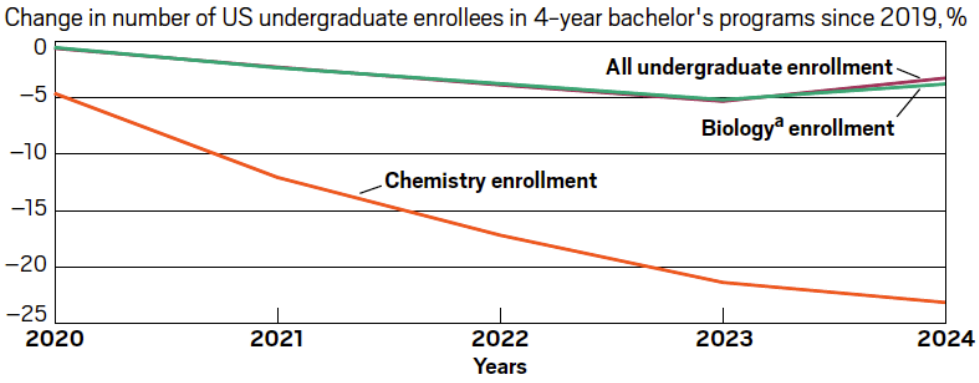
All raw data and charts are available in Appendix A.

Enrollment and Degrees Analysis

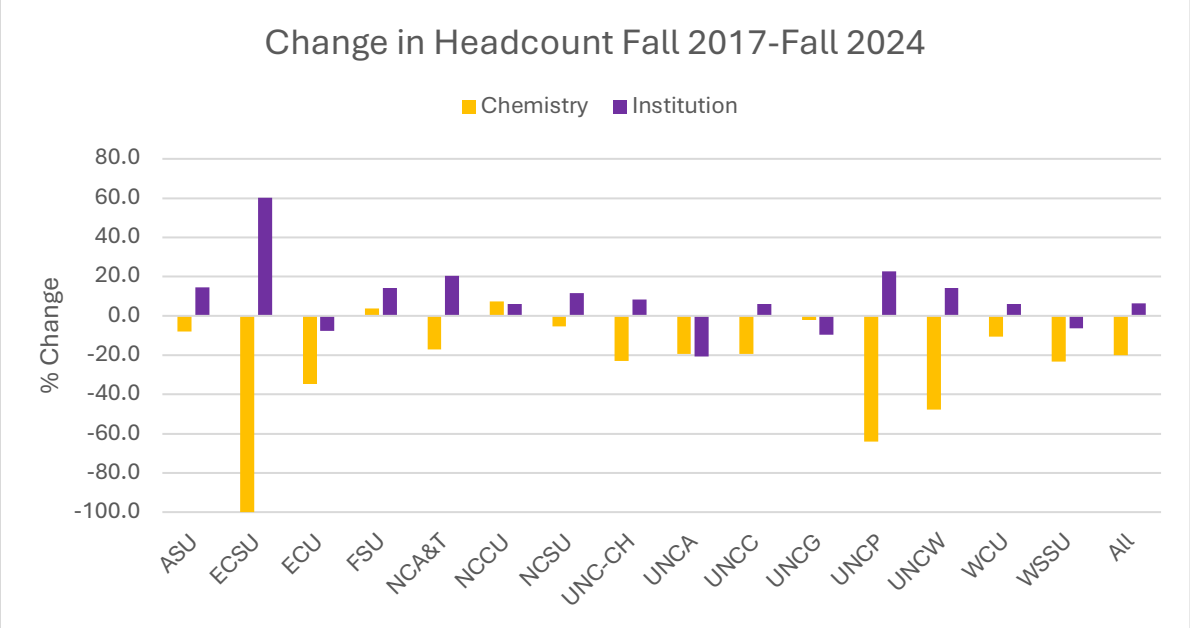
2.1a Enrollment Trends

Discussion of the enrollment trends in Chemistry undergraduate majors first needs to be placed in context with University and National Trends. Total Headcount at ECU peaked in 2020-2021 and has declined 18.5% since. Likewise, the College of Arts and Sciences has declined by 22%. For Chemistry, this downward trend in enrollment at ECU is exacerbated by an additional national trend, in which the average headcount in Chemistry majors has declined by approximately 23% since 2019 (see chart below).[5]

[3] Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook*, Chemists and Materials Scientists, at https://www.bls.gov/ooh/life-physical-and-social-science/chemists-and-materials-scientists.htm
[4] *Chemical & Engineering News Archive* **2015** *93* (17), 40. DOI: 10.1021/cen-09317-ad12
[5] https://cen.acs.org/education/undergraduate-education/undergraduate-chemistry-programs-crisis/102/i33



This trend towards fewer Chemistry majors has held for the institutions in the University of North Carolina System, with only two institutions showing (modest) increases and the rest decreasing (Elizabeth City State discontinued their chemistry program).



BA Chemistry

Inspection of the admissions data in Appendix A (pages 11 and 22) reveals that the BS degree is listed as the intended major about three times as often as the BA major, which is reflected in the number of enrolled intended majors each year. Both degrees gain enrollment as the students progress, with the majority of BA Chemistry majors recruited during the first one or two years of their undergraduate tenure as double majors with BS degrees like Biology and other related degrees. Both degrees will be discussed further below.

Enrollment in the BA Chemistry major peaked in Fall 2018 (187 students) followed by a steady decrease in major headcount through Fall 2023 (70 students), with a promising, albeit small, increase in major count fall 2024 (76 students). Average part-time enrollment over the last seven years is about 11%, with

a maximum of 17% in 2024. Female majors outnumber male majors on average at 60% to 40%. Like many fields, this data mimics the gender demographics of first year (freshman) applicants over the review period. White students comprise most of the students, with the percentage of minority students pursuing the BA Chemistry major decreasing from Fall 2019 (43%) to Fall 2024 (24%). Most students are of traditional college age, individuals aged younger than 25 years, at an average of 93%.

There is a net increase of completed applications from Fall 2018 (25 applications) to Fall 2024 (49 applications), though there is a noticeable decrease aligned with the timing of the pandemic. With an average selectivity rate of 91%, the program has experienced a dramatic decrease in yield with a 100% high in Fall 2018 and a 13% low in Fall 2022. The average weighted high school GPA for enrolled BA Chemistry majors has been relatively steady with a low of 3.74 in 2022-2023 and a high of 3.96 (2018-2019 and 2020-2021). The average for the review period was 3.84. It should be noted that beginning in Fall 2020, ECU did not require applicants to report standardized test scores on their applications, resulting in smaller numbers of reported scores and higher variability. Prior to that change, the average combined SAT score ranged from a 1045 low in Fall 2017 to a 1080 high Fall 2018. The composite ACT score ranged from a 21.5 low in Fall 2018 to a 22.5 in Fall 2017. The undergraduate GPAs of our BA Chemistry students average 3.23.

BS Chemistry

Enrollment in the BS Chemistry major follows the same trend seen with the BA Chemistry major enrollment, peaking Fall 2019 (145 students) and then decreasing through Fall 2023 (64 students) followed by a rebound in Fall 2024 (81 students). As with the BA, the number of majors grows above the initial intended majors enrolled during the admission process (page 22 of Appendix A) due to being a common double major with degrees like the BS in Biochemistry (Chemistry Concentration). Average part-time enrollment is 9%. Over the 7-year period review, female majors just outnumber male majors at 52% to 48% on average. The percentage of minority students in the BS Chemistry major varies from year to year, with a 34% max value in Fall 2018 and a 22% low value in Fall 2023. In this most recent year, the percentage of minority students increased to 33%. Like BA Chemistry students, 93% of BS Chemistry students are of traditional age.

There is a net decrease of completed applications from Fall 2018 (249 applications) to Fall 2024 (176 applications,) though application numbers have rebounded nicely post pandemic. With an average selectivity rate of 94%, yield remains rather low over the program review period at an average of 24%. The weighted high school GPA of enrolled BS Chemistry students has not deviated significantly and averages at 3.92. As noted above, beginning in Fall 2020, ECU did not require applicants to report standardized test scores on their applications, resulting in smaller numbers of reported scores and higher variability. The average combined SAT score ranged from a 1140 low in Fall 2018 with a 1190 high Fall 2019. Performance on the ACT has been consistent over the period review with a composite average of 22. The average undergraduate GPA of our BS Chemistry students is 3.04.

2.2a. Degrees Conferred

As above, with the decline in the number of majors (both statewide and nationally), the number of degrees conferred (pages 9 and 19 of Appendix A) has followed.

BA Chemistry

The number of BA Chemistry degrees conferred has steadily decreased over the 7-year review period with a high of 63 during 2018-2019 and a low of 23 during 2023-2024. The majority of our graduates are female ranging from 49% to 67% of each graduating class. White students make up the bulk of our graduates.

BS Chemistry

There is a net decrease of the number of BS Chemistry degrees conferred, with a high of 26 during 2020-2021 and a low of 12 during 2023-2024. About half of students earning the BS Chemistry degrees have been female from 2017 to 2024. A range of 13%-48% of degree earners were minority students earning BS Chemistry degrees.

2.4a. Student Demand and Enrollment Management

Both undergraduate degrees offered by the Department of Chemistry are primed for growth and expansion. Degree earners are qualified for jobs in STEM, healthcare, and other technologically advanced fields, or to pursue graduate/professional education. Using our pharmaceutical skills laboratory curriculum for its basis, we have designed and launched the Pharmaceutical Methods and Technology Minor to attract pre-pharmacy and other students to the major and engaged in aggressive marketing to pre-health profession students. We have also advertised detailed double major plans with complementary fields like Biology, Physics, Nutrition Science, Public Health, Criminal Justice, and Science Education.

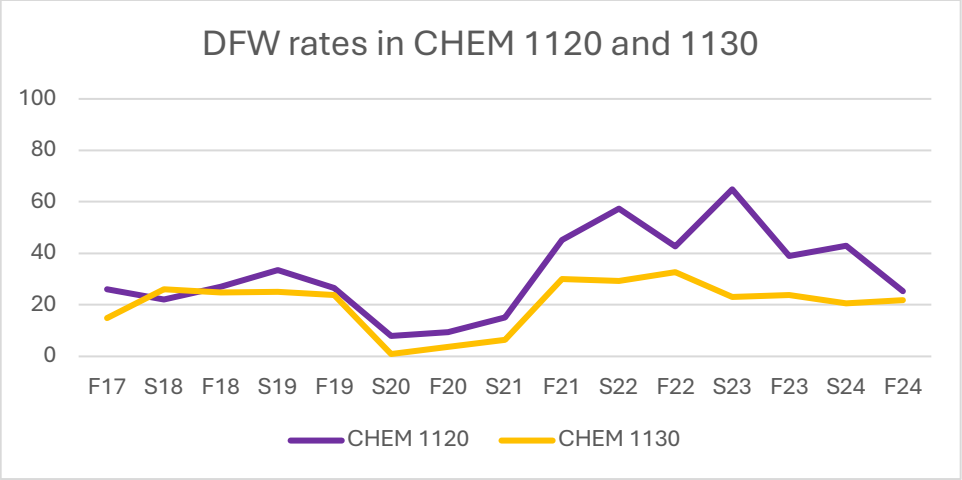
Enrollment management has been a significant focus in our department during the last seven years, requiring careful monitoring in Banner and taking appropriate action to condense underenrolled sections or advise students who have not met prerequisites. The department uses five-year enrollment trends to calculate anticipated enrollments (including growth factor), and success rates in the first of two-semester sequences to predict enrollment in the subsequent courses.

Student Success

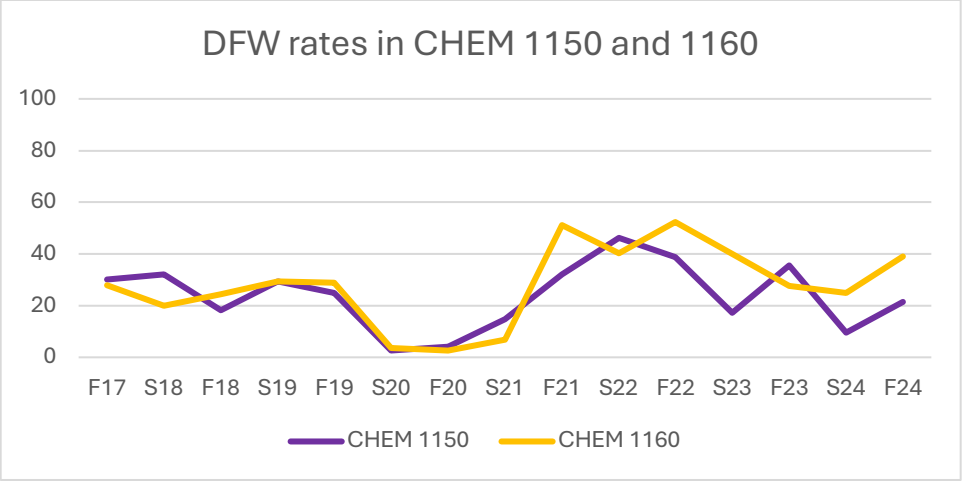
2.5a. DFW Rates & Trends

BA and BS Chemistry majors take the same 1000- and 2000-level courses in Chemistry. In addition, the vast majority of students taking 1000- and 2000-level classes in Chemistry are not intended or declared Chemistry majors, as we serve a large number of majors across the university. For all discussions below, there is a clear disruption in the middle, since due to the pandemic all ECU courses went online in Spring (March) 2020, then remained online in Fall 2020 and Spring 2021 (we made the labs hybrid starting Fall 2020 so the students did as much possible online and just the experimental work in the lab). Students were also able to opt-in to Pass/Fail grades. Following that time period, there were clear post-pandemic issues with success rates that seem to be returning to pre-pandemic levels.

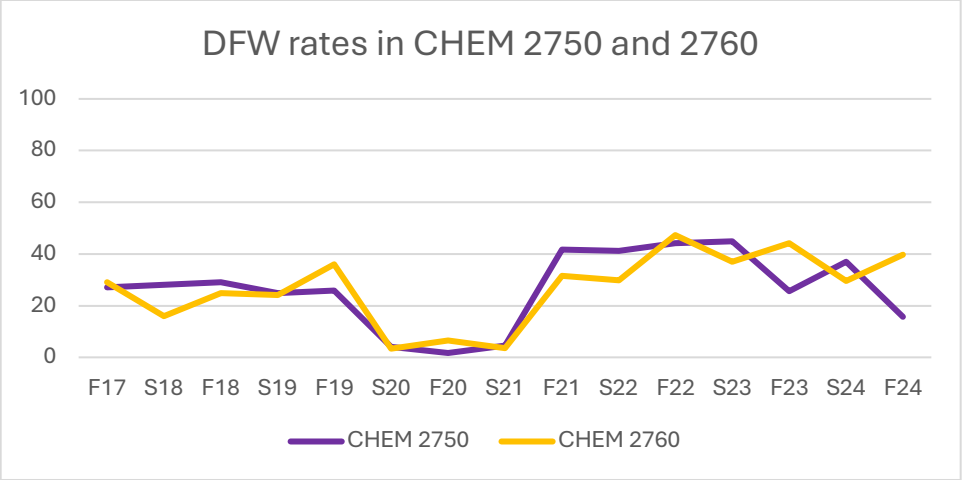
CHEM 1120 and 1130 are the 2-semester sequence of chemistry courses taught to mainly intended nursing majors. In the first course, pre-pandemic the DFW rate averaged 27%, during the pandemic the DFW rate dropped to an average of 11%, then elevated significantly post-pandemic. There has been a slow drop back to pre-pandemic levels. In the second course (CHEM 1130), students have already succeeded in the first course and perform generally better in the second semester course, with pre-pandemic and post-pandemic DFW rates remaining relatively equivalent.



In the traditional General Chemistry sequence (CHEM 1150, 1160, offered to science majors and pre-professional students interested in medical and dental schools), pre-pandemic DFW rates averaged about 27% for the first semester course, and 26% for the second semester course. As for the previously discussed courses, those rates plummeted to 7% and 4% respectively during the online pandemic period, then they jumped back up to significantly higher than pre-pandemic levels (29% and 39% respectively). As will be discussed below in Section 3, the department made a major curriculum change (adopting the Chemistry, Life, the Universe, and Everything (CLUE) curriculum), which has been shown to improve student success.



The two-semester Organic Chemistry sequence (CHEM 2750, 2760) displayed a DFW rate between 26-27% pre-pandemic, and as above those rates were quite low when the coursework was online (3-4%). Post-pandemic, also as above, rates jumped to an average of 36-37%, with a general slow downward trend in CHEM 2750 but the downward trend appears to be reversing in CHEM 2760 and it is unclear if this is a one semester outlier or durable trend requiring additional actions.

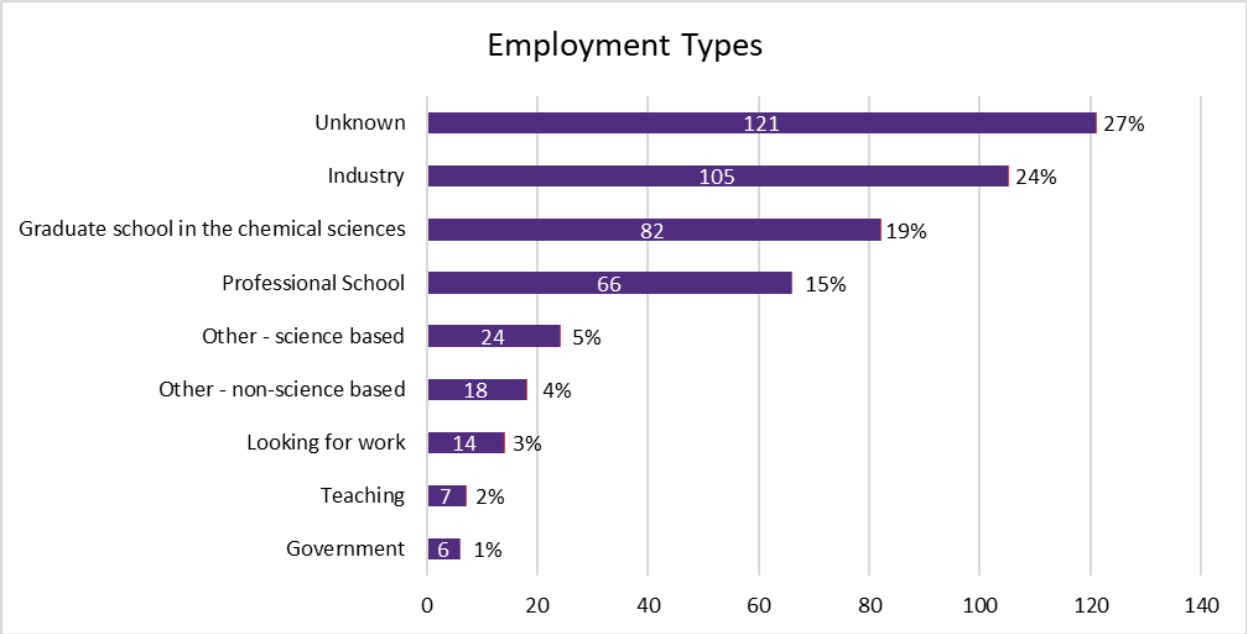


Outside the pandemic period, academic year Chemistry courses are taught exclusively face-to-face except for one general education, non-major course (CHEM 1020), so no comparison of face-to-face and online courses is presented.

The use of early alerts as well as 'forgiveness' opportunities in courses at the 1000- and 2000-level are encouraged among the Chemistry faculty, as well as consistent grading scales and course materials across sections. 'Forgiveness opportunities' vary across sections but include dropping the lowest exam grade, grade replacement of the lowest exam grade with the final, using most frequently missed exam questions on extra credit quizzes, and the use of in-class clicker questions as extra credit opportunities. The use of Learning Assistants (LAs, enabling problem-based learning and group-work approaches even in these large enrollment classes) has been broadened, and those that utilize LAs in their classes have seen better outcomes overall. The undergraduate program committee (which coordinates the 1000 level courses) recently moved to de-emphasize single-point high stakes testing in CHEM 1120, 1130, 1150 and 1160 (i.e. implementing more in-class work, quizzes, homework as part of the grade), which seems to have improved student success overall.

2.6a. Job Placement

Job placement rates are strong based on ECU Chemistry's close ties to regional industry. Students also enjoy success via admission to graduate and professional programs. The faculty are supportive in writing letters of recommendation and acting as professional references. It is difficult to quantify the rates of success, as the Director of Undergraduate Studies relies heavily on social media platforms like LinkedIn, alumni emails, and Facebook, to identify our students' successes. While this method often results in incomplete data, it does provide a valuable snapshot of our students' employment types. As expected, of the known 2017-2024 BA and BS Chemistry graduates (322 students), majority find employment in industry (105 students), followed by graduate school in the chemical sciences (82 students), and professional school (66 students).



ECU's Career Services' access to Steppingblocks,[6] an online career exploration platform, enables users to identify who employs ECU graduates and their geography. This platform is limited, though, as it is programmed to pull publicly available data from online sources, and so if a graduate does not have an online presence, their information is not captured. From the supplied data, it is no surprise that most of the included students remain in North Carolina, residing in the Greenville-Pitt County and Research Triangle areas. Top industrial employers are Pfizer, Catalent, Alcami, Mayne Pharma, and ThermoFisher.

2.7b. Licensure Pass Rate

Not Applicable.

2.8a. Actions Taken

The Department of Chemistry has taken numerous actions to improve student success. We have expanded usage of Learning Assistants in general chemistry and organic chemistry classes and increasing numbers of faculty have adopted some variation of problem-based learning strategies. During the 2020-2021 academic year, a committee made up of members of the Undergraduate Program Committee, Director of Undergraduate Studies (Ms. Bennett), and Dr. Walker examined several alternatives for the general chemistry curriculum that were shown to have improved student learning, retention, and success rates. The selected curriculum, Chemistry, Life, the Universe, and Everything (CLUE), was rolled out over the following 2021-2022 academic year. A comprehensive study comparing 2018-2019 with 2022-2023 data carried by IPAR, working with Dr. Walker, found that it improved success rates among the students from high schools with high Free and Reduced Meal participation (a proxy for socio-economic status) while maintaining the same level of success among those already scoring at the top of the class. Faculty advising records are reviewed semesterly to ensure students are on track to graduate and have access to needed coursework, and faculty facilitate professional development opportunities such as

[6] https://career.ecu.edu/steppingblocks/

internships and other contact with industry and government representatives such as scientists from Catalent and ThermoFisher.

Action Plans

2.9a. Actions Planned and Resources Needed

- Continue to incorporate team-based learning, problem-based learning, argument-driven inquiry (ADI) and related pedagogical approaches into our lectures and labs. We have established that these approaches improve student success as measured via DFW rates and engagement in the material, and on-going research is exploring the impact of these approaches on the peer leaders as well.
- Strengthen, expand, and promote our internship program. Over the last seven years, participation in these opportunities for credit (CHEM 5993) have decreased.
- Use opportunities like extending CURE labs to first year students and increased recruiting in second year courses to expand the pool of internal potential majors. Continue to actively recruit new students through ECU events such as Open House, Pirates Aboard, and Admitted Student Fridays, declining yields indicate additional outreach to admitted students is necessary following admission. Ensure updated and engaging materials are available on the department website.

Needed Resources

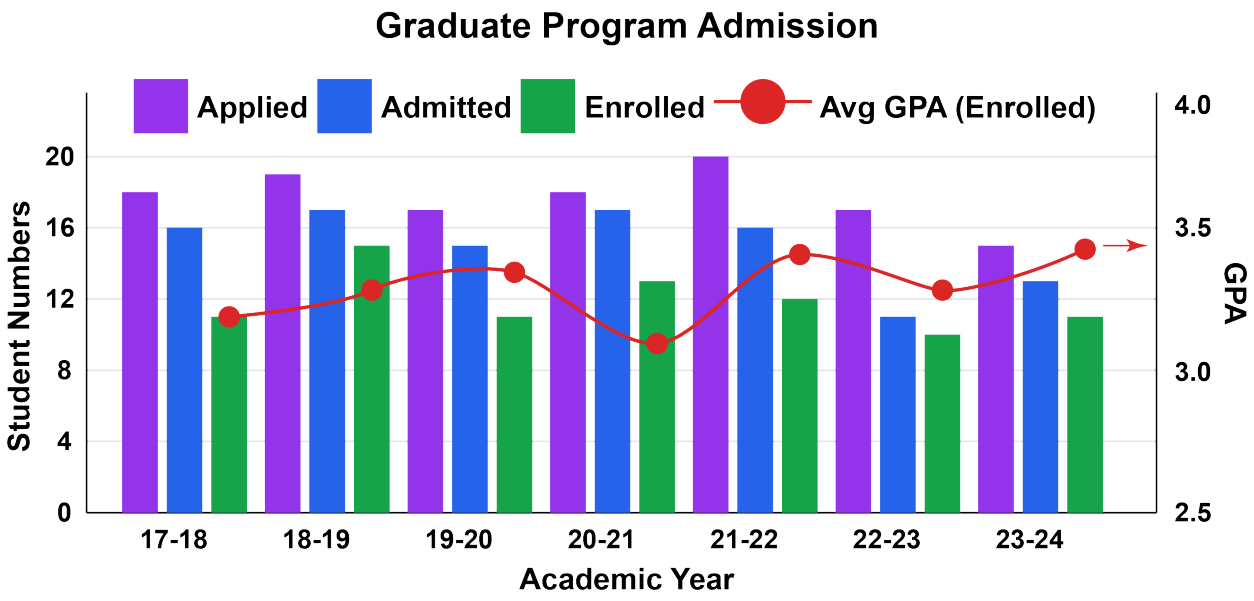
- Appropriate large capacity lecture space (or additional faculty support to utilize lower capacity space which requires more sections) and additional undergraduate learning assistants to support pedagogical approaches. Currently, this program has been supported by the division of Academic Affairs (Provost's Division) or grant/foundation funds. The Department will work with the College and other departments to support fundraising and advancement efforts to expand access to this valuable experience for both the students in the class and the LAs themselves.
- Funds for recruitment and promotional materials, including graphic design assistance to ensure video and other recruiting materials look professional. Consider funding a web advertising campaign.

2b. Enrollment, Degrees and Student Success: MS Chemistry

All raw data and charts are available in Appendix A.

2.1b. Enrollment and Degrees Analysis

Admission trends into the MS program are summarized in the chart below. *Note: some of the requested information might be summarized in consecutive sections.*

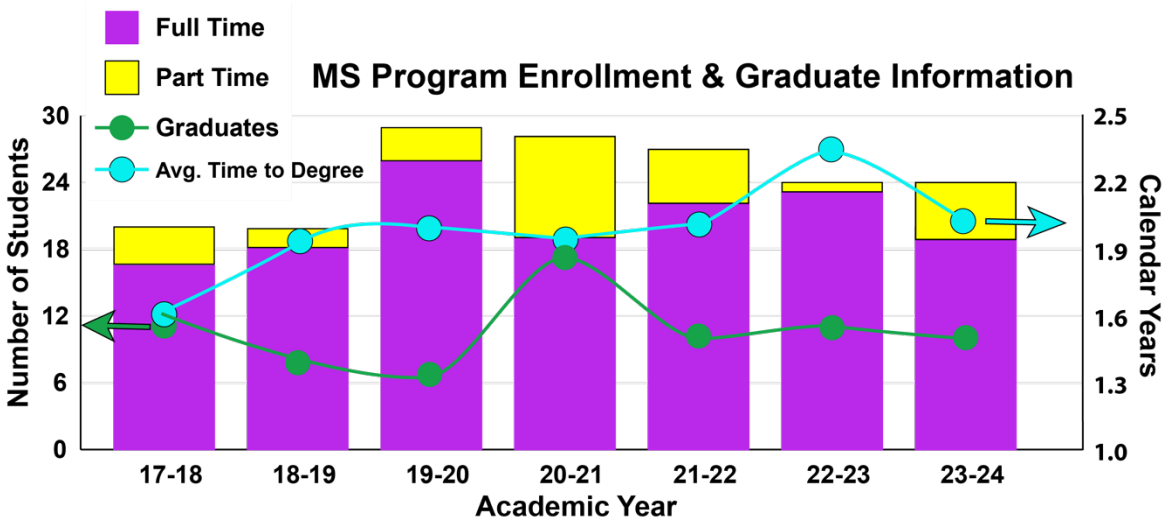


The Graduate Program Admission plot shows that the number of students applying to our program has increased significantly since 2017, and despite some declines in applications since the peak of 2021-22, the number of students admitted to the program has remained steady. The graduate program considers the application packet holistically; therefore, we do not consider entrance exam scores such as the GRE. The GPA for the incoming enrolled students has remained steady between 3.0 and 3.5 during this period (red line in the chart).

Regarding the demographics of our MS students, over this period, the average M/F ratio has been 50% with the racial breakdown ranges as follows: 60-75% white, 10-20% Hispanic or Latino, 5-10% black or African American, 0-20% Asian, and 5-10% nonresident. The percentages reflect the make-up of each yearly enrolled group.

2.2b. Degrees Conferred

The total number of students in the program, their status in the program, and graduation information is summarized in the chart below.



The chart shows that the total enrollment has remained steady over this program review time period. Part time students are those that might need an extra semester to finish their degree, so that number increased after the large incoming class of 2018-19. The number of students graduating with a MS degree yearly has predictably been steady over this period (between 8-12) concomitant with enrollment. A large spike in 2021 graduates resulted from the large 2018 incoming class. Average time to degree in calendar years has remained relatively steady, hovering around 2 years to finish the MS. This is the expected time to finish this advanced degree and reflects our well-constructed curriculum and proper advising by both research mentor and graduate director. The longer time to graduate for 22-23 graduates likely reflects Covid protocols that affected the 2019 and 2020 incoming classes.

While the PhD program is not included in this review, there were nine graduates from the program during the review period, with an average time to degree of 4.9 years. Enrollment has been steady at between 9-10 per year.

2.3b. Trend regarding completion rates and time-to-degree

See "MS Program Enrollment & Graduate Information" chart and discussion above.

2.4b. Program Size

As discussed above in Section 1.4b, BLS and demographic trends, along with expansion of the pharmaceutical industry east of I-95, predicts continued growth in demand for our MS graduates.

The increased federal research funding during the self-study period has enabled us to continue expanding program via Graduate Research Assistantships, as the number of tenure-track faculty continues to decrease this will result in a decrease in size of the program. Alignment with the strategic plan of expanding research-based degrees (Section 1.2) merits further support and expansion of this program.

Maintenance and growth of the PSM, GMP offerings, and internship programs is necessary to expand the base of trained students for regional industry.

While a PhD program is a critical component of growing research productivity, the MS will remain key in the near future for our relationship with local industry and serving the economic needs of eastern NC, and merits continuation at its current size to support local employers. Sacrificing the MS program to populate a PhD program will not address the instructional and research needs discussed in this self-study, and our regional industry consistently values and needs the MS graduates.

Alignment with the strategic plan commitment to preparation of STEM trained educators in eastern NC merits expansion of this program as well to support local community colleges and high school science teachers needing continuing education opportunities.

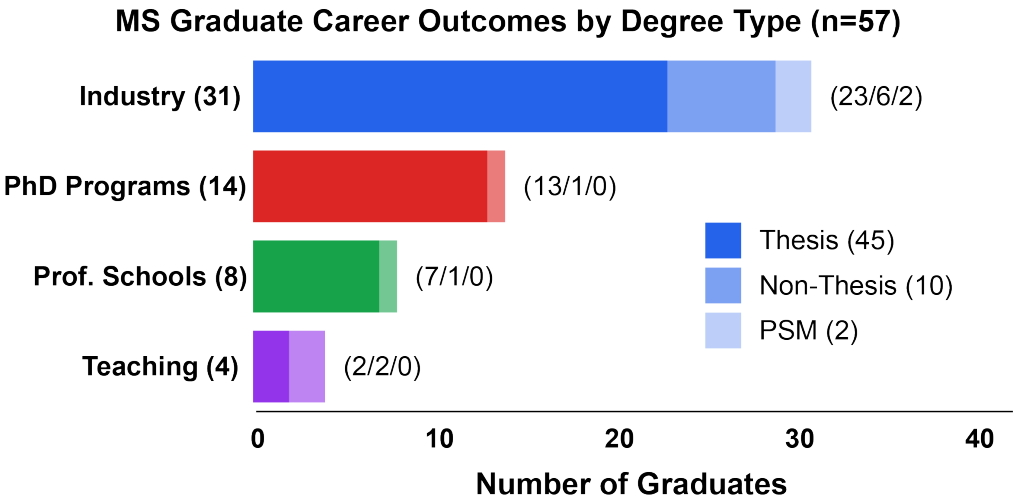
Student Success

2.5b. DFW Rates in 1000 and 2000 level courses

Not Applicable.

2.6b. Job Placement

Career outcomes by MS degree type (thesis, non-thesis, and PSM) for the last 57 graduates from our program are summarized in the chart below. These data were compiled internally via direct outreach with these graduates.



Analysis of our MS Chemistry graduates (n=57) reveals diverse career paths across all degree types. Of the 45 thesis students, the majority (23) entered industry positions, while 13 continued to PhD programs, 7 entered professional schools, and 2 pursued teaching in some capacity. Among the 10 non-thesis graduates, 6 found industry positions, with the remaining evenly distributed across PhD programs (1), professional schools (1), and teaching (2). Both PSM graduates secured industry positions, aligning with that program's professional focus. These outcomes demonstrate successful career placement across all degree tracks, with particularly strong industry placement regardless of degree type.

2.7b. Licensure Pass Rate
Not Applicable.

2.8b. Actions Taken

Enrollment in the MS is primarily driven by the availability of financial support; the recent increases in the stipend amount are designed to ensure students have adequate support to pursue their degrees without external jobs. That is important in keeping the time to degree at a reasonable time period (ca. 2 years). The department has research connections to other departments, particularly those such as Pharmacology and Toxicology, Biochemistry, and other Brody School of Medicine basic sciences departments to increase interdisciplinary experiences and research for the students in the MS program.

Action Plans

2.9b. Actions Planned

- The department is considering applying for an NSF S-STEM grant designed to expand the graduate program and expand the reach and access to the program further out into the region. In addition, we plan to encourage more of our graduate students to apply for federal fellowships.

3a. Curriculum, Learning Outcomes and Student Satisfaction in BA and BS Programs

Curriculum Analysis

The link to degree requirements as published in the Catalog are listed below. See Appendix B for an updated curriculum map from Nuventive Improve that illustrates alignment of student learning outcomes to courses in the curriculum.

BA CHEM: https://catalog.ecu.edu/preview_program.php?catoid=31&poid=8060

BS CHEM: https://catalog.ecu.edu/preview_program.php?catoid=31&poid=8084

3.1a. Curriculum Map and Course Sequences

Consistent with the vast majority of chemistry undergraduate programs, the sequences laid out in the curriculum map reflect the introduction of fundamental concepts (bonding, acidity, thermodynamics and kinetics, research methodology, etc.) beginning in General Chemistry and the labs (CHEM 1150, 1151, 1160, 1161). Various aspects of those concepts are reinforced as appropriate in Organic Chemistry (2750, 2753, 2760, 2763) and Quantitative Analysis (3250; for example, bonding and acidity) while new concepts such as reaction mechanisms and spectroscopy are also introduced. Further reinforcement and mastery (as defined as mastery of a concept at the undergraduate level of understanding) occur in the upper division courses in Biological (CHEM 3770), Inorganic (CHEM 3450, 3451 then optionally 4550 for BS majors) and Physical Chemistry (CHEM 3850, 3851 for BA and CHEM 3950, 3951, 3960 and 3961 for BS majors). BS students also take CHEM 4350 and 4351 (Instrumental Analysis) to master additional spectroscopic and analytical methods. Many of our majors also reinforce and master specific skills (dependent on research project and advisor) in the three undergraduate research classes (CHEM 4515, 4516, 4517).

3.2a. Curriculum

Primary responsibility for the annual program assessment lies with the Chair of the Department, the Assessment Coordinator, and the Undergraduate Program Committee. In addition, the Chair of the Department and the Director of Undergraduate Studies are responsible for ensuring that the curriculum for the BS aligns and meets the American Chemical Society certification standards.

Dr. Joi Walker led the effort and worked closely with Dr. Anne Spuches and Ms. Lisa Bennett to move to a new curriculum for the general chemistry sequence. This curriculum (called CLUE: Chemistry, Life, the Universe & Everything) has been shown to improve outcomes for all students with particularly large impacts for students at the highest risk of dropping out the courses. Dr. Walker developed the pacing for those courses and aligned them with the labs (also developing new labs for better alignment with the lecture curriculum). Working with Institutional Planning, Assessment and Research (IPAR), we were able to demonstrate that this improvement in student success previously observed was true for our students as well, with students from low wealth school districts and URM showing significant improvements in student success while the top scorers continued to perform well. Working with Dr. Walker, Dr. Colin Burns has implemented the Argument Driven Inquiry curriculum into the organic labs (CHEM 2753 and 2763).

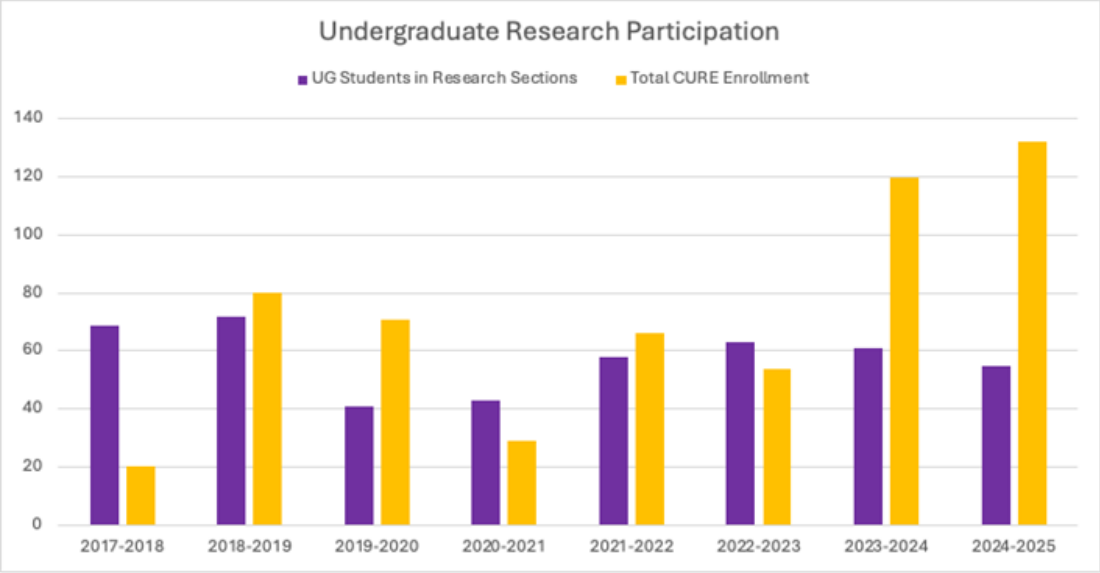
Dr. Walker also was the PI of two NSF grant funded efforts to introduce and enhance Course-based Undergraduate Research Experience labs (CUREs) offered by the Departments of Chemistry, Biology,

Geology, Physics, and Engineering, while studying team science.[7] Course-Based Undergraduate Research Experiences are a type of course that allows students to enhance their research/technical skills by engaging groups of students in research projects that require students to identify problems that need to be addressed in science, identify a way to answer them and then conduct the research and report on their findings. In the past, students have traditionally received such training through independent study courses but CUREs offer the opportunity to provide a greater number of students with such intense research experiences that they would not ordinarily be able to obtain in a typical lab class (see the introductory video on our CUREs here: https://www.youtube.com/watch?v=pGBQJh_hy4c). There is strong evidence both externally[8] and in our own results[9] that these types of experiences result in higher levels of student engagement, enhanced technical skills, stronger presentation skills (students write a research report and create an oral presentation as a capstone) and just as critically a higher retention rate in the field and university. These courses are very popular with the students, serving as an important recruiting tool for majors and research students into faculty labs (for example, four CURE students in a recent CHEM 2763 section began independent study in their instructor's laboratory the following semester). Most of these students went on to apply for & receive either URCA or PURC funding. Although it is unclear whether CUREs result in a net increase in undergraduate independent study participation versus pre-pandemic years, these courses definitely increase the number of students who are receiving independent research-based experiences in our department (chart below). It is notable that the number of research sections has not decreased in lockstep with the number of majors, suggesting that CUREs may be an excellent recruiting tool to the department's research labs.

[7] https://news.ecu.edu/2020/06/17/supporting-team-science/
https://news.ecu.edu/2021/01/13/the-road-to-discovery/
https://rede.ecu.edu/undergraduate/cures/

[8] https://www.ourcurescommunity.com/?fbclid=IwAR3gF5c1OqYDq_teZ3Wtz1IDsAy6-Y8Wn1o3xbxNx75YlGu3RYqo-SS4_1E

[9] a.) Wurz, A.I., Andersen, C. Walker, J.P, and Hughes, R.M. (2024). Evolution of a Biocatalysis CURE for Organic Chemistry Students. Journal of Chemical Education, 101(8), 3163-3170. b.) Vance-Chalcraft, H, Etheridge, R., O'Driscoll, M., Peralta, A., Andersen, C., Freeland, F., and Walker J. (2024). Embedding Team Science in Three Linked CUREs. Scholarship and Practice in Undergraduate Research, 7(2), 53-64 c.) Walker, J.P, Allen, W.E., Kennedy, A.M. Hosbein, K.N., Clevenger, L. Vance-Chalcraft, H. Whiting, B. (2023). Course-Based Undergraduate Research Experiences as a Community of Practice (CoP). Journal of Chemical Education, 100(7), 2520-2528, DOI: 10.1021/acs.jchemed.2c00844



The Department's offerings under her leadership have now expanded to include two (two-semester sequences) in the Organic labs (CHEM 2753 and 2763), Quantitative Analysis (CHEM 3250), Inorganic Chemistry (CHEM 3450), and Chemical Biology (CHEM 3771). Instrumental Analysis (CHEM 4351) and the Physical Chemistry labs (CHEM 3951 and 3961) include elements of the CUREs and Inquiry-based lab work. During the 2024-2025 year, we have offered two CURE sections of CHEM 2753 (out of 23), two CURE sections of CHEM 2763 (out of 19), one of CHEM 3251 (out of six), one of one for CHEM 3771, one CURE out of two each for CHEM 3951 and 3961, and both sections of CHEM 4351 were CUREs.

Student Learning Outcomes Assessment

3.3a. Identified Strengths and Weaknesses in Student Learning Outcomes

The department assesses (as reflected in the curriculum map and chart in Appendix B) subject knowledge in the five major disciplines of chemistry (analytical, biochemistry, inorganic, organic and physical) and research methodology.

Since 2022, our graduates have consistently met the criteria for success in the assessments in the General Chemistry (CHEM 1151 and 1161 lab practical results) for research methodology following the transition to the Argument-Driven Inquiry (ADI) approach in the General Chemistry labs.[10] Clearly, the ADI approach has directly addressed the desired outcomes, prompting the department to transition the organic (CHEM 2753 and 2763) to the ADI approach, and we are discussing moving the assessment to those labs, where assessment outcomes will allow us to address any identified deficiencies.

We assessed our students using the ACS DUCK (Diagnostic exam for Undergraduate Chemical Knowledge) exam for their subject knowledge in Inorganic Chemistry and Physical Chemistry, via

[10] a.) *Hosbein, K.N., Lower, M., Walker, J.P. (2021). Tracking student argumentation skills across General Chemistry through Argument-Driven Inquiry using the Assessment of Scientific Argumentation in the Classroom observation protocol. Journal of Chemical Education. 98(6), 1875-1887. b.) Hosbein, K. N., Alvarez-Bell, R., Callis-Duehl, K. L., Sampson, V., Wolf, S. F., Walker, J.P. (2021). Development of the Investigation Design, Explanation, and Argument Assessment for General Chemistry I Laboratory. Journal of Chemical Education. 98(2), 293-306.*

common test items in Organic Chemistry and Biological Chemistry, and via the written final lab report in quantitative analysis to assess their knowledge of analytical chemistry. Students in Analytical Chemistry courses consistently met the criterion for success. Students in Biological Chemistry met the criteria in the only non-COVID year of this cycle, while students in Organic Chemistry did not (continued work in organic chemistry on mechanistic based understanding of reactions is necessary). Students in Inorganic and Physical Chemistry consistently did not meet the criteria, the department is currently considering if the DUCK exam is the appropriate Means of Assessment or whether we should move to common test items involving a pre- and post-test assessment, particularly for Physical Chemistry where there is a temporal disconnect with the class timing in the curriculum and the assessment.

3.4a. Where applicable, are there any significant differences in student outcomes in face-to-face and online programs?

We have no online programs at the undergraduate level, but there are some courses offered online including CHEM 1020 (our 4-credit general education for non-science majors) during the academic year, which has followed the same pattern as our other large service courses with a dip in the DFW rate during the pandemic followed by higher than normal rates. Our major online offerings are in the summer, which have been online lectures since the pandemic. Online, CHEM 1120, 1130, and 1160 all have lower DFW rates than the traditional face-to-face lectures during the academic year, while CHEM 1150, 2750, and 2760 are all higher DFW rates while online in the summer. It is difficult to differentiate between mode of delivery and the compressed time frame to draw any conclusions at this time.

3.5a. Decisions Made and Changes Instituted Based on Assessment

Lack of progress made by the students in the assessments of subject knowledge and research methodology prompted the department to start the process of reconsidering the means of assessment to ensure that we are assessing the skills we are attempting to improve. We have also made the change in the undergraduate Organic Chemistry lab classes to incorporate the ADI approach. Other changes include expanding CUREs to include two (two-semester sequences) in the Organic labs (CHEM 2753 and 2763), Quantitative Analysis (CHEM 3250), Inorganic Chemistry (CHEM 3450), and Chemical Biology (CHEM 3771). Instrumental Analysis (CHEM 4351) and the Physical Chemistry labs (CHEM 3951 and 3961) include elements of the CUREs and Inquiry-based lab work.

3.6a. Effectiveness of the Changes

Feedback and assessment results strongly support the move to expand the ADI labs (see Section 3.3a), and the CURE labs because they have received positive feedback and increased participation in research experiences in the department (see Section 3.2a). The adoption of the CLUE curriculum appears to have also had a positive impact on student success, as discussed in more detail above in Section 2.8a and 3.2a.

Student Satisfaction

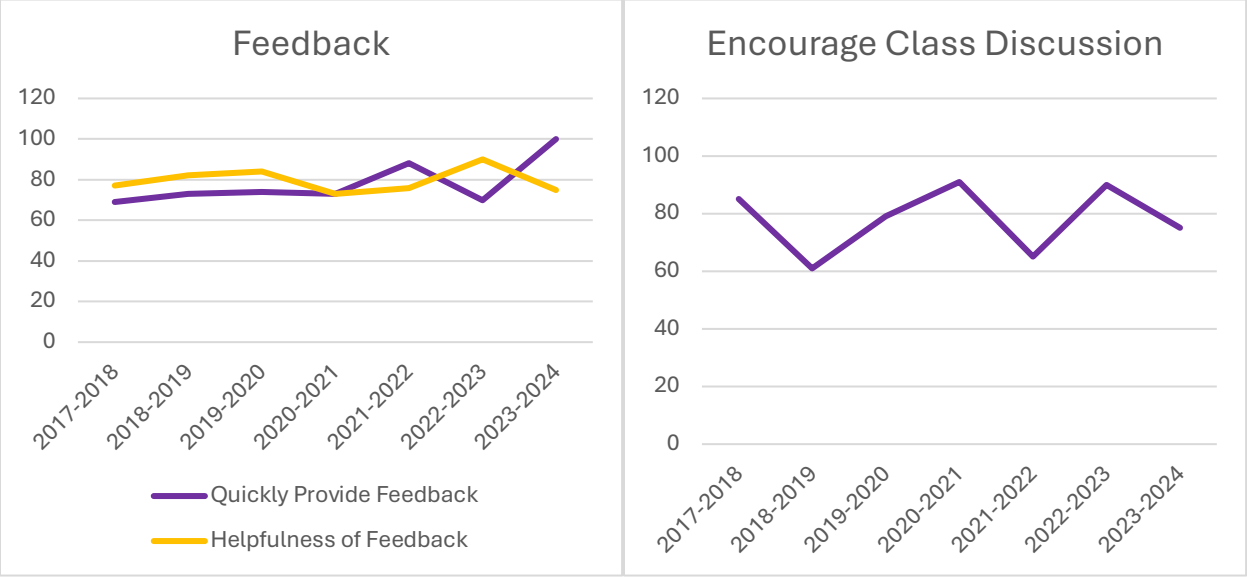
3.7a. Student Satisfaction

Based on the data (2017-2024) available to us via the Graduating Student Survey, which has a 24% response rate, we can see the following trends:

Overall satisfaction with the department's instructors has remained essentially flat with a slight upward trend (ratings in 2020-2021 and 2021-2022 are universally lower, likely due to the pandemic), with an average of 88% of the graduates giving ratings of satisfied or very satisfied (94% excluding the post

pandemic years). Ratings for effectiveness of use of instructional technology is similarly high and follows the same pattern, not unsurprisingly, as the department has never had online courses in the curriculum and was required by the pandemic to pivot in a matter of weeks to online coursework.

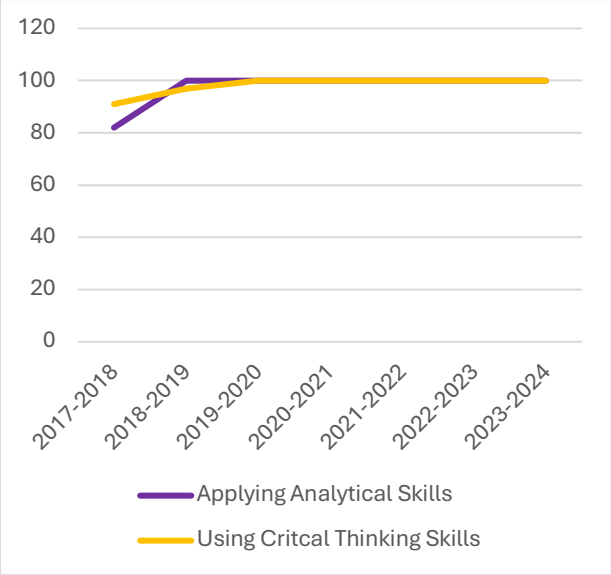
Students' satisfaction with the feedback received (both timeliness and helpfulness) was also mostly flat with a slight upward trend, while a similar pattern (while noisier) is reflected in the Encouragement of Class Discussion. These slight upward trends may be due to increased utilization of Learning Assistants in general and organic chemistry classes, but that relatively recent move may not yet be reflected in the data.

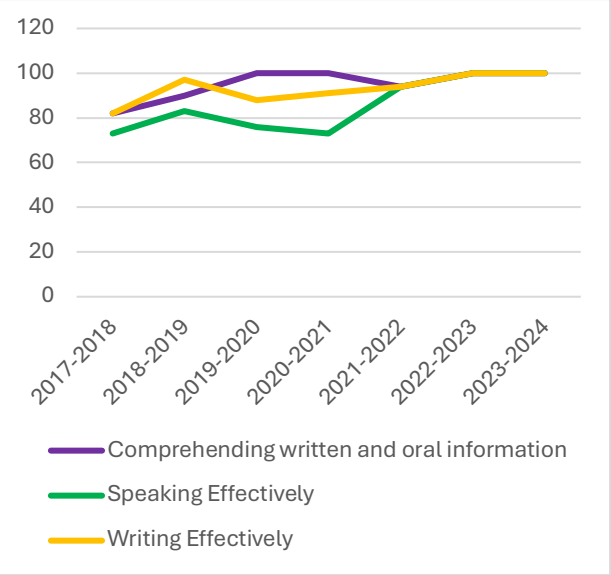


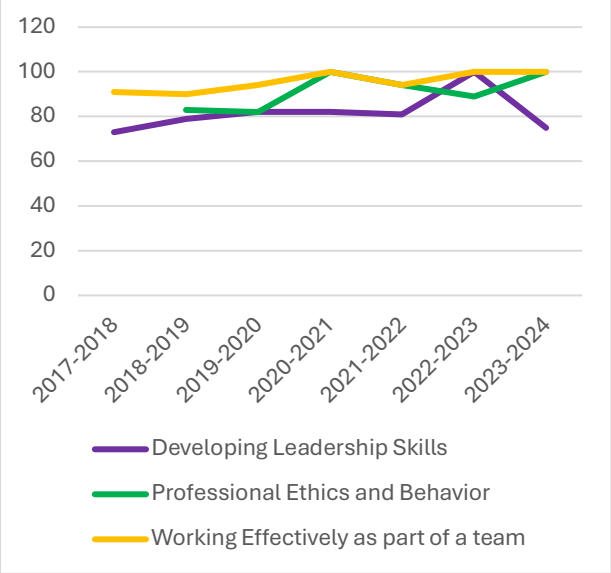
3.8a Graduate Evaluation of Skills Gained

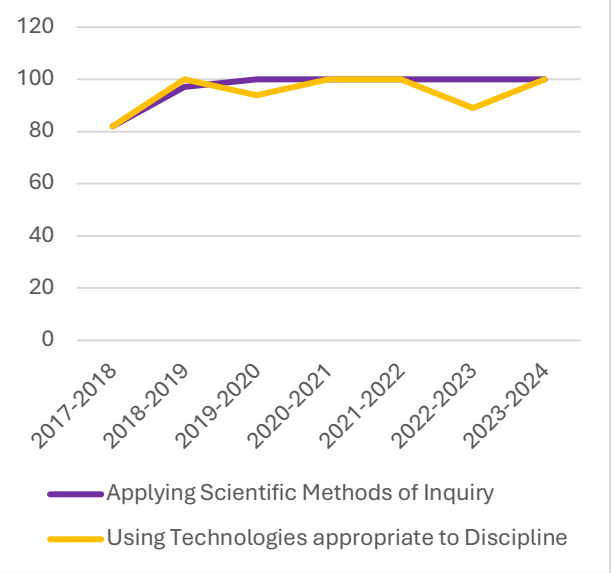
Our graduates give the department high marks (percentage ranking their skills as somewhat or very much improved is shown in the charts below) on their experience and mastery of new skills. There are no clearly discernable trends, although the slight upward trend in working effectively as a team and speaking

effectively skills may reflect our students' experiences as undergraduate teaching and learning assistants and the additional incorporation of student presentations in many of our upper division courses.









3.9a. Employer Feedback

While we do not formally survey our local employers, Dr. Jack Pender (Director of Pharmaceutical Training and Development) is in constant communication with them. They provide positive feedback, continue to hire the majority of our students interested in entering the pharmaceutical industry, which indicates continuous satisfaction. In the CHEM 4522 (GMP) class, employees of the local companies volunteer to serve on expert panels and work in the lab with the students to give them excellent mentoring and build connections to prospective employers. As discussed further in Section 5.1, Dr. Pender's work with the Eastern Regional Pharmaceutical Center, North Carolina Biotechnology Center, and the BioPharma Crescent strengthens the department's connections with the local industry, to the benefit of all.

3.10a. Improving Student Satisfaction

The department has, under the leadership of Ms. Lisa Bennett, continued to ensure that student advising by faculty in the department is consistent and correct. We utilize the SharePoint web portal to keep accurate advising notes and records, use student data to guide advising, and carefully monitor progress. The university has a mandatory peer evaluation process in which every faculty member is regularly evaluated by colleagues on not just lecture delivery, but quizzes, exams, and other content to ensure best practices.

Action Plans

3.11a. Actions Planned: Pedagogical Changes in Next Seven Years

- Assess ADI approach in Organic Labs.
- Incorporate Learning Assistants into more lecture courses as funding allows to facilitate more team-based learning approaches and group work.

3.12a. Actions Planned to Improve Student Education Experience

- Expand our internship (done while taking coursework) and Co-Op (intensive full-time semester or summer long opportunities).
- Expand Course based Undergraduate Research Experiences to additional sections of each level of labs, including general chemistry.

3.13a. Additional Resources Needed

- Large classroom (120+ student) instructional space appropriate for problem-based learning or additional staffing to support smaller courses that can utilize currently available space for such pedagogy.
- Additional support for learning assistants and graduate teaching assistants to support teaching activities and student success.

3b. Curriculum, Learning Outcomes and Student Satisfaction in MS Program

Curriculum Analysis

The link to degree requirements as published in the Catalog is listed below. See Appendix C for an updated curriculum map from Nuventive Improve that illustrates alignment of student learning outcomes to courses in the curriculum.

https://catalog.ecu.edu/preview_program.php?catoid=30&poid=7821&returnto=2675

3.1b. Curriculum Map and Course Sequences

Students in the MS program are required to take two of four core courses, CHEM 6210, CHEM 6220, CHEM 6230, and CHEM 6240, in which, building upon their undergraduate knowledge, their subject knowledge of the broader field is reinforced and expanded. They also take two electives, at least one of which must be in their selected area. The primary reinforcement and mastery of their chosen sub-

discipline occurs in their research (i.e. CHEM 650x, Research) and the defense of their major products (i.e. research proposal, major research paper or thesis). Reflecting this flexibility of curriculum sequence and the variation in research programs, assessments are carried out in the required seminar (CHEM 6103) and the proposal and thesis defense.

3.2b. Curriculum

Primary responsibility for the annual program assessment and leadership of curriculum changes lies with the Chair of the Department, the Assessment Coordinator, and the Graduate Program Committee.

Student Learning Outcomes Assessment

3.3b. Identified Strengths and Weaknesses in Student Learning Outcomes

The MS program assesses students in communication skills, both oral and written, mastery of concepts, research skills in literature and laboratory, analysis and instrumentation (see rubrics for the proposal and thesis defense in Appendix C).

Our students typically meet the criteria for success in laboratory skills and instrumentation. The criteria are less often met for mastery of concepts, research skills in literature (i.e. finding and citing sources), and analysis (based on rubric scores rating ability to answer questions during seminars and defense). Communication skills ratings have varied, with oral presentations consistently meeting the criteria, while professional and technical writing has continued to be an issue for some students. On the written communications rubric, the lowest average scores continued to be on 'Discussion of Results' section. Note that these outcomes appear to be at least somewhat correlated (i.e. individual students will often have low scores on the multiple items).

3.4b. Differences in student outcomes in face-to-face and online programs

We have no online programs at the graduate level

3.5b. Decisions Made and Changes Instituted Based on Assessment

The department has added two courses to the curriculum, CHEM 6240 (Research Methods for Chemistry Education) and CHEM 6529 (Metals in Biology), to expand students' abilities to meet the criteria for mastery of concepts, research skills in literature, analysis, and written communication skills.

3.6b. Effectiveness of the Changes

The curriculum revision appears to have had a positive influence, overall. Even though the students have still not consistently met the criterion for success on mastery of concepts, average scores on the rubrics have improved for research skills in literature, analysis, and written communication skills.

Student Satisfaction

3.7b. Graduate Student Satisfaction with Program

The number of responses to the Graduate School's Graduate Student Exit Survey is small (15/69 or 22%), but positive. The department will emphasize to the graduate students that they should provide us this valuable feedback. The data is summarized in this and the following table:

Satisfaction Ratings:	Positive	Neutral	Negative
Academic Experience	88%	12%	
Overall Instruction	80%	20%	
Overall Experience	88%	6%	6%
Well Prepared for Practice in Discipline	82%	18%	

3.8b. Graduate Evaluation of Skills Gained

The vast majority of students rated their gain in skill and content positively, as summarized below.

Contribution to:	Somewhat and Very Much	Not at All or Very Little
Communication Skills	93%	7%
Knowledge of Field	93%	7%
Leadership Skills	87%	13%
Personal Development	87%	13%
Problem Solving	80%	20%
Technical Skills	93%	7%

3.9b. Employer Feedback

As mentioned above, while we do not formally survey our local employers, Dr. Jack Pender (Director of Pharmaceutical Training and Development) is in constant communication with them. They provide positive feedback, continue to hire the majority of our students interested in entering the pharmaceutical industry, which indicates continuous satisfaction. In the CHEM 6622 (GMP) class, employees of the local companies volunteer to serve of expert panels and work in the lab with the students to give them excellent mentoring and build connections to prospective employers. As discussed further in Section 5.1, Dr. Pender's work with the Eastern Regional Pharmaceutical Center, North Carolina Biotechnology Center, and the BioPharma Crescent strengthens the department's connections with the local industry, to the benefit of all.

3.10b. Improving Student Satisfaction

The department's increase in stipend in 2022 and 2024 was partially in response to student concerns over ability of stipend, once tuition and fees were paid, to provide a level of support required to live in Greenville.

Action Plans

3.11b. Actions Planned: Pedagogical Changes in Next Seven Years

The department is currently looking at the Means of Assessment to more directly tie curriculum changes to the outcomes (i.e. exam items in each class) to facilitate improvements in the mastery of concepts and analysis. As all indicators (time to degree, employability of our graduates, satisfaction surveys of the graduates) have strong evidence the program is well received, we will concentrate our attention on curricular changes.

3.12b. Actions Planned to Improve Student Education Experience

- Several faculty at ECU (including Chemistry's Anne Spuches) have completed Center for the Improvement of Mentored Experiences in Research (CIMER)[11] training and serve as facilitators for sessions through the Office for Faculty Excellence here at ECU. The department would target having at least two or three additional faculty members enroll and complete this training.

3.13b. Additional Resources Needed

- Any required funding to cover participation.

4. Strength of Faculty: Teaching, Research and Scholarship

Faculty Resources

4.1. Faculty Profile

For 2024-2025, we have 16 Full-Time Faculty members tenured or tenure track (including the Chair Andrew Morehead and Associate Professor Joi Walker who has been named the Kinnear Chair, Distinguished Visiting Professor at the US Naval Academy and will be on unpaid leave started Spring 2025), and 10 Full-Time Fixed Term Faculty members. In addition, we will also have 3 Part-Time Fixed Term Faculty members teaching an average of one course per semester. These data are summarized in the table on the next page. Faculty biosketches are available in Appendix D.

There are several trends evident in the data collected here. The first is that the size of the department has decreased slightly (by two faculty members considering that two current faculty members are half-time instructional faculty and half-time staff (stockroom manager and lab manager). The second is the distribution of ranks and titles: the department has been quite successful at promoting faculty and the number of faculty at the highest ranks/titles are all significantly increased, which speaks positively to the department's support of its faculty. However, over the time period of this review the department has only been allocated one tenure-track faculty position while losing five tenured faculty members during that time. While the additional two fixed term faculty members will help cover the teaching obligations, loss of research capacity has been noticeable (see Sections 4.8-4.10 below).

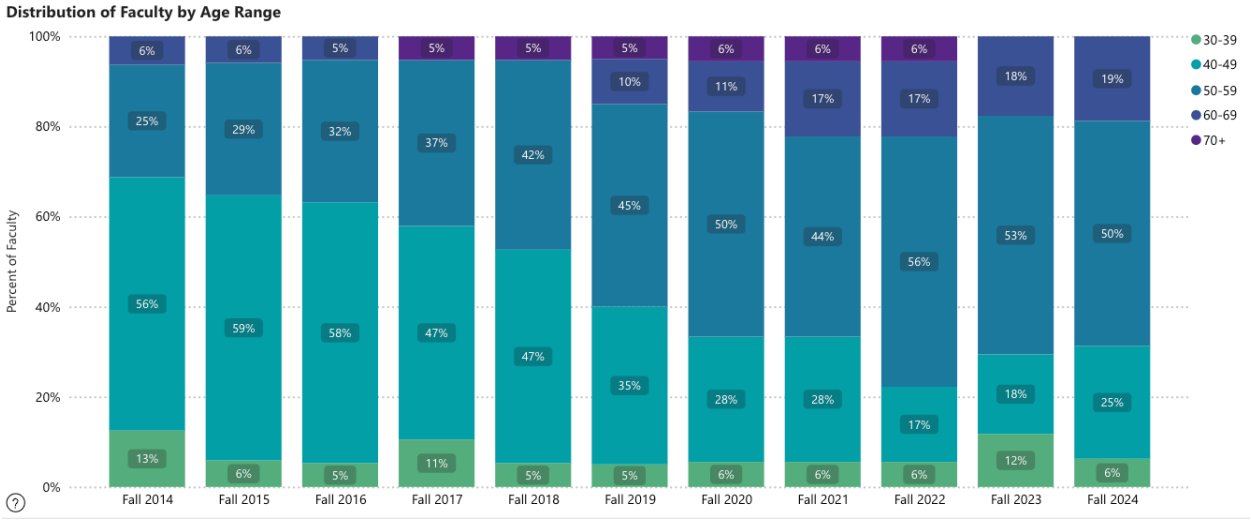
To put this in University and College contexts (which have seen enrollment declines discussed in Section 2.1a above), during the review period the total permanent faculty headcount at ECU has declined 4.1% and the College has declined 10.1%. In addition, as in the Department (down 20% in tenure-track faculty), both the university (13.8% fewer tenure-track faculty) and the College (18.3% fewer tenure-track

[11] https://cimerproject.org/

faculty) are increasingly reliant on fixed-term and temporary faculty. The NC General Assembly recently implemented a Faculty Realignment Incentive Program designed to incentivize early retirement for senior tenure-track faculty to reduce the size of the faculty. Dr. Yang passed away before participating but the Department has had no other retirements during the two-year period that program was active.

Rank/Title	Number	Tenure Status	Full/Part Time	Highest Degree	Δ 2018-2024	Demographics	
						Male/Female	Race/Ethnicity
Professor	8	Tenured	Full	PhD	+4	6 Males, 2 Female	5 White, 3 Asian
Assoc. Professor	7	Tenured	Full	PhD	-5	6 Males, 1 Female	7 White
Assist. Professor	1	Untenured	Full	PhD	-2	1 Female	1 Asian
Teaching Professor	2	Not Eligible	Full	PhD	+2	1 Male, 1 Female	1 Asian, 1 Hispanic
Teaching Assoc. Professor	3		Full	PhD	+3	3 Males	2 White, 1 Asian
Teaching Assist. Professor	3		Full	PhD	-4	2 Males, 1 Female	3 White
	1		Part	PhD	0	1 Male	White
Senior Teaching Instructor	1		Full	MS	+1	1 Female	White
Instructor	1		Full	MS	0	1 Female	White
	2		Part	MS	0	2 Female	1 White, 1 Black
Total	26 FT 3 PT	16 TT 10 FT	26 FT 3 PT	25 PhD 3 MS	-1	19 Male,10 Female	21 White,6 Asian,1 Hispanic,1 Black

Related to the few tenure-track hires over the review period, the current faculty are aging, as can best be seen in the graphic below. New and sustained hiring on the tenure-track will be necessary for the ongoing success of the department.



4.2. Faculty Resources:

The Department of Chemistry continues to perform well for the level of funding it is allocated, as the department is significantly below the institutionally identified peers in the amount of resources provided by the university, as summarized in the table below. Graduate teaching assistant, departmental staff, and scientific staff positions continue to lag our peers, ranking us 8 or 9/12 among the official institutional peers and 5/5 among the in-state peers. Despite that, the department ranks around the median in research expenditures. The department was the first in the university to launch a very successful Undergraduate Teaching Assistant program, and in a typical academic year the UTA's teach (under the supervision of a SACS credentialed instructor) between 20 and 25 sections of laboratories. This has allowed the department to keep lecture sizes to between 120-250 students, relatively manageable by the faculty without support for grading, recitation sections, and other sources of faculty assistance provided by GTA's.

The current distribution of teaching specializations is adequate for covering the departmental needs. Indeed, the department has not concerned itself with teaching specialization for the last four hires going back to 2014, preferring to concentrate on building research expertise. The departure (Spring 2025) of one senior faculty member and the death of a senior member of the analytical division may require hiring for specific teaching needs in chemical education and analytical chemistry.

Per 10K students in the institution						In $1K 2022
	Tenure Track Faculty	Total Faculty	Staff	Scientific Staff	Est. GTA	HERD/TT Faculty
Peer Median	8.7	10.3	2	1.5	10.0	75
In-state[a] Peer Median	9.9	12.7	2.8	2.8	20.0	90
ECU	7.4	12.0	1.4	0.9	8.1	79
% of Peer Median	85	117	70	63	81	105
Rank in Peers	6/12	5/12	8/12	9/12	8/12	6/12
Rank In-state Peers	4/5	4/5	4/5	5/5	5/5	3/5

[a] In state peers are the four public Carnegie R2 institutions: UNC-Wilmington, UNC-Greensboro, UNC-Wilmington, and NC A&T.

4.3. What actions has the program administrator taken to recruit, retain, and advance highly qualified, diverse faculty?

State allocations for higher education in NC have been flat or declining over the period of this self-study, although there has been some support for enrollment growth funding. Thus, institutional declines in enrollment (29,131 total students in Fall 2017 to 26,940 in Fall 2024, ca. 7.5%) have been the primary contributor to the shrinking of the department (the department peaked at 29 faculty members in 2019 and currently has 27, including the two hybrid positions).

As discussed above, since the last self-study in 2017-2018, the department has hired one tenure-track, two senior tenured faculty members in support of other departments, and four full-time fixed term faculty. Working closely with the (now discontinued) Office for Equity and Diversity, the department has advertised through multiple avenues, many of which are targeted at improving the number of members of under-represented groups in the pool. We have made diversity in the pool of on-campus interview invitees a priority as well. These efforts have been less successful than desired and diversifying the faculty will remain a concern. The Assistant Professor hire was female and Asian, the other tenured faculty were male (one white and one Asian, note that both have since departed). Among the fixed-term faculty, two of the hires are female and two are male (all of whom are white). The scientific staff consist of two males, one of Asian descent.

There has been significant turnover in the last seven years. Two senior tenured hires (one spousal hire at the Professor rank and one targeted at collaborative research in the East Carolina Diabetes and Obesity Institute at the Associate Professor rank) both departed, the former after one year (returning to his

previous institution) and the latter after five years (leaving for another university). Professors Bartolotti and Rodriguez retired, and Professor Yang passed away. Fixed term faculty members Holmes retired and White left to join a medical school faculty. Professor Danell has served as Dean of the College of Arts and Sciences since 2020. That turnover includes two staff members (stockroom manager and lab manager) being replaced with two faculty members (each of whom is half time stockroom or lab manager), for a net gain of one instructional FTE and the net loss of one staff position.

The lack of tenure-track hires means the department has made only a little progress on diversifying the faculty at the Assistant Professor rank. The previous program reviews had noted that the diversity in the Professor rank is a particular concern, with all four Professors at that time in the department being male (three white and one of Asian descent), and that the department had a significant number of "stalled" Associate Professors. The Department has made significant progress on that front, with eight faculty members promoted to Professor (all three female faculty members and five males) with a fourth female faculty member promoted to Associate Professor and in the promotion process currently for Professor. Two other Assistant Professors were also promoted to Associate Professor. In the fixed-term ranks, nine faculty advanced in title, including one female faculty member twice.

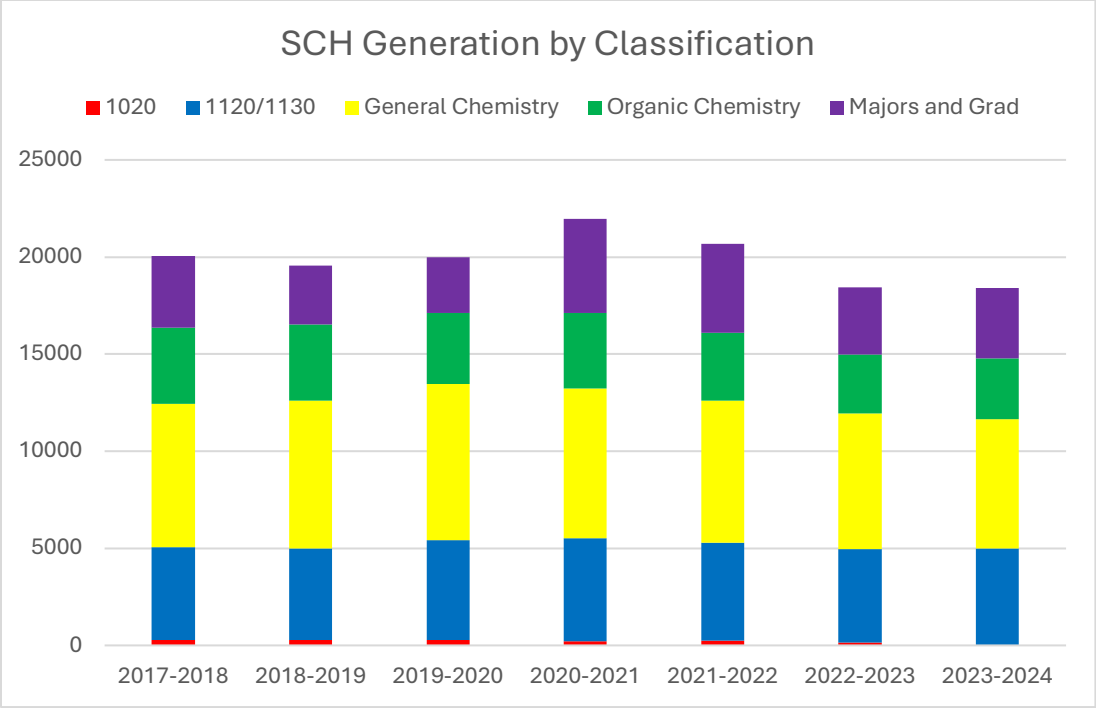
The promotions and advancement in title, a pre-emptive retention offer to a highly research active faculty member, and targeted salary increases based on market data have all assisted in retaining the faculty.

Analysis of Teaching Productivity

4.4. Program Instructional Trends

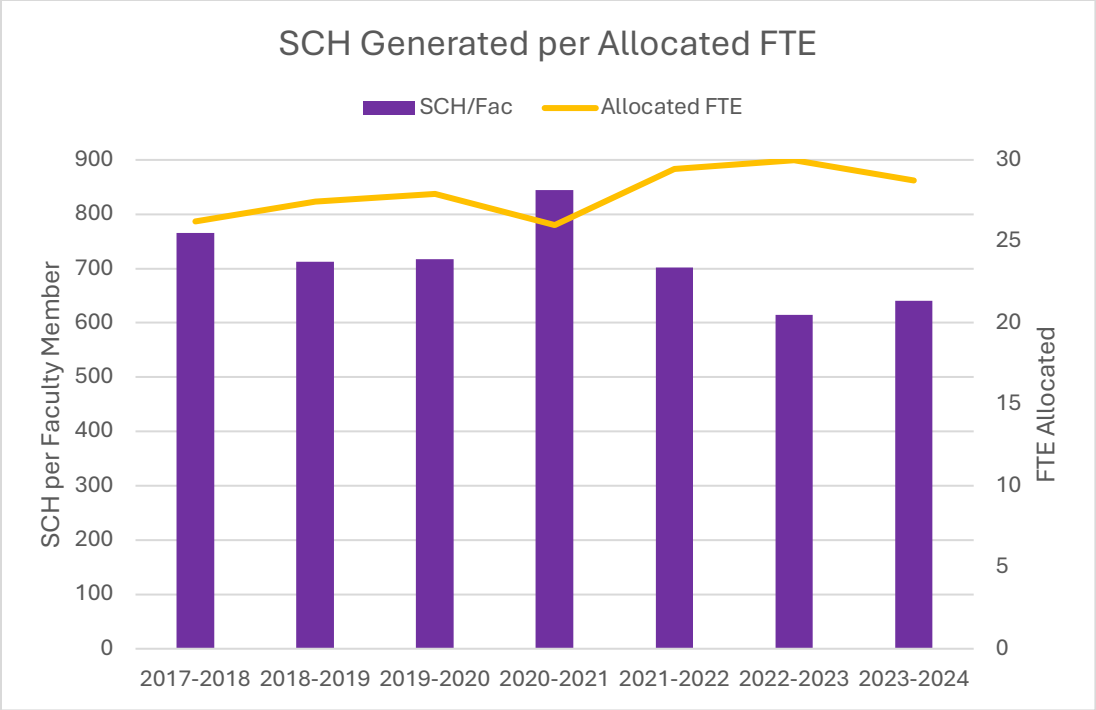
Data for this section may be found in Appendix A.

As can be seen in the first figure below, the overall trend in student credit hour (SCH) production has been trending downwards since 2020. The vast majority of SCH generation occurs at the undergraduate level, almost entirely face to face. The only courses we teach online are CHEM 1020 (the foundations course for non-majors) and all our summer school courses are online lectures (CHEM 1120, 1130, 1150, 1160, 2750, 2760, 3770) with any associated labs in person. At the upper division, the majority of the SCH generation is from the BA and BS students. The MS students generate most of the graduate SCH, with the PhD students from the Interdisciplinary PhD in Biology, Biomedicine, and Chemistry accounting for the rest (note that some of our MS students also take the 7000 level PhD courses).



As one would expect for a department with ca. 180 undergraduate majors and ca. 30 graduate students, the largest SCH production comes from the general education (CHEM 1020), nursing chemistry (CHEM 1120 and 1130) and general chemistry I and II (CHEM 1150 and 1160), all of which fulfill the natural sciences foundation requirement, and organic chemistry (CHEM 2750 and 2760). As an institution with a medical school, dental school, and allied health programs, pre-professional class enrollment is a major driver of SCH generation, and this is illustrated above. For example, in 2023-2024, these courses accounted for 80% of the SCH generation in the department.

As shown in the following plot, SCH production per allocated faculty FTE has trended mostly down from 2017-2024 (as SCH production has gone down and FTE allocated has mostly increased), a trend that started reversing in the last few years. Note that having faculty teach labs (most faculty teach one lecture and the rest labs each semester, about a third of our general and organic chemistry labs are taught by faculty) is an inefficient way to generate SCH. An increased allocation of graduate assistantships would greatly facilitate maintenance of this high level of productivity while improving research productivity. One strategy would be to add one or two PhD assistantships when a new tenure-track faculty member is hired, providing instructional and research support for those new faculty members, which is complicated by the Graduate School's current two year-cycle of re-allocation of assistantships. Another would be to commit to a regular increase each cycle of one additional assistantship. In addition, we have found that our problem-based learning classes have had lower DFW rates, and additional support in terms of large capacity classroom space or additional faculty to reduce section capacities, learning assistants and/or graduate assistants are necessary to expand these offerings either way.



4.5. Teaching Load

Teaching loads for department faculty:

	17-18	18-19	19-20	20-21	21-22	22-23	23-24	24-25
Tenure-Track Faculty[a]	4.2	4.2	3.4	3.8	4.3	4.1	4.4	4.6
Fixed Term faculty[a]	6.9	6.9	7.3	7.5	7.4	7.0	7.0	7.0

[a] Not including those sections in which a faculty member supervised a GTA or UTA; including reassigned time for Program Directorships and Lab Coordination

The typical teaching load for a research active tenure-track faculty member at ECU is expected to average 5 courses/AY. Release time is allocated to faculty for duties including Chair of the department, the two Directors of Undergraduate and Graduate Studies, and lab coordination. The department has had unbalanced teaching loads for tenured/tenure track faculty since 2006, in which research productivity merits fewer courses assigned per year, while faculty who are less productive in terms of research publications and grants will teach more than 5 courses/AY. In addition, new Assistant Professors will receive lower loads to facilitate the development of their research agendas. The department's long time unbalanced instructional workload practice discussed above has been formalized by the new workplan/workload policy from the UNC system, implemented this fall, which explicitly ties reassigned time to instructional, research, and service productivity.

4.6. Graduate Teaching Assistants

	17-18	18-19	19-20	20-21	21-22	22-23	23-24
GTAs provided*	21	21	21	22	22	22	22
Sections taught	42	65	66	59	59	54	48
*- Number represents combination of MS and PhD lines provided to the department from the ECU Graduate School and THCAS							

Graduate teaching assistantships (GTA) are provided by the Graduate School (with supplemental funding from the College and occasionally the Department), and consist of a stipend for MS students, and a limited number of out-of-state tuition waivers. The MS students pay approximately $4800 in in-state tuition and $2800 in fees out of that stipend annually. Per University of North Carolina system policy, ECU cannot discount tuition, so any form of tuition waiver would require a funding source. A University-wide issue is that we are not able to budget MS tuition waivers in grant proposals. We do supplement the stipend with summer funding provided from THCAS based on summer teaching needs. MS students are expected to perform research over the summer months for this additional support. The department also has a limited number of GTA positions (seven) associated with the Interdisciplinary PhD program in Biology, Biomedicine, and Chemistry (IDPBBC). These students receive a stipend, in- and out-of-state tuition waivers, and health insurance. We have summarized our graduate student support in earlier sections, but from these allocations we have averaged 16.5 and 6 GTA funded MS and PhD students, respectively, from 2019-2024. Graduate teaching assistants generally serve as primary instructors for one or two laboratory sections per semester. Those with lower loads reflect assignment to other duties including laboratory prep, instrument room support, and related needs. All GTA's serve as proctors, some semesters we can offer grading assistance to one or two faculty members with large sections.

4.7. Major Achievements and Department Support for Teaching

Over the last seven years, numerous department faculty have been recognized for their strong teaching abilities. Highlights include:

- Toby Allen (2020) and Anne Spuches (2024) received the University's highest honor for teaching, the UNC Board of Governors Award for Excellence in Teaching.
- Four faculty members have received the Board of Governors Distinguished Professor for Teaching: Allison Danell (2018), Anthony Kennedy (2019), Andy Sargent (2020), and Lisa Bennett (2023).
- Two faculty members have received the Harriot College Fixed-Term Faculty Award for Excellence: Subodh Dutta (2019) and Lisa Bennett (2020).
- One Faculty Member has received the Max Ray Joyner Award for Outstanding Teaching in Distance Education: Subodh Dutta (2022).
- One Faculty member has received the Robert L. Jones Teaching Award: Lisa Bennett (2022).
- Two faculty members have received recognition for the integration of their teaching and research, the Scholar-Teacher Award: Adam Offenbacher (2023) and Robert Hughes (2024)

- One faculty member has received the Outstanding Faculty Advisor Award: Lisa Bennett (2020).
- Joi Walker is Principal Investigator on about $2.6 million in NSF grants supporting three projects: "Team Experiences and Mentoring Strategies for Undergraduate Research (TEaMS-UR)," "Increased access to authentic research for undergraduate Chemistry students through Course-based Undergraduate Research Experiences (ChemCUREs)," and "XLabs: Cross-Disciplinary Practice Focused Undergraduate Laboratory Transformation"[12]

The department's undergraduate program committee has coordinated the general chemistry courses for most of the self-study period, with an eye towards sharing best practices, consistent feedback to the students and the selection of texts and ancillary materials. Informal mentoring by experienced instructors is expected and the department has a well-established peer review process in which all the faculty are required to participate. Laboratory course instructors are required to attend training sessions regularly. Several of our faculty are recognized campus-wide for their outstanding teaching and have led workshops through the Office for Faculty Excellence.

Analysis of Research, Scholarship and Creative Activities

4.8. Major Achievements

A major highlight of the last seven years was the recognition of Professor Yu "Frank" Yang with the ECU Lifetime Research and Creative Activity Award in 2022-2023,[13] with additional recognition that same year with the International Research Award. Associate Professor Joi Walker and Associate Professor Adam Offenbacher were both recipients of the Harriot College Dean's Early Career Award, and Associate Professors Offenbacher and Robert Hughes were recognized with the Scholar-Teacher Award.

Another highlight was the selection of Professor Anne Spuches as the Thomas Harriot College of Arts and Sciences Distinguished Professor in the Natural Sciences and Mathematics.

In addition to the significant NSF support listed above, obtained by Associate Professor Joi Walker, the department has obtained a wide variety of funding not just from the NSF and NIH, but other funding sources as well.

National Science Foundation: Adam Offenbacher (2 grants for $690K), Anne Spuches (2 grants for $564K), Shouquan Huo and Yumin Li ($338K research and $352K for the REU).

National Institutes of Health: Robert Hughes ($453K), Hun Lim (two grants for $1,427K), Colin Burns ($398K), Adam Offenbacher (2 grants for $519K), Yumin Li ($416K).

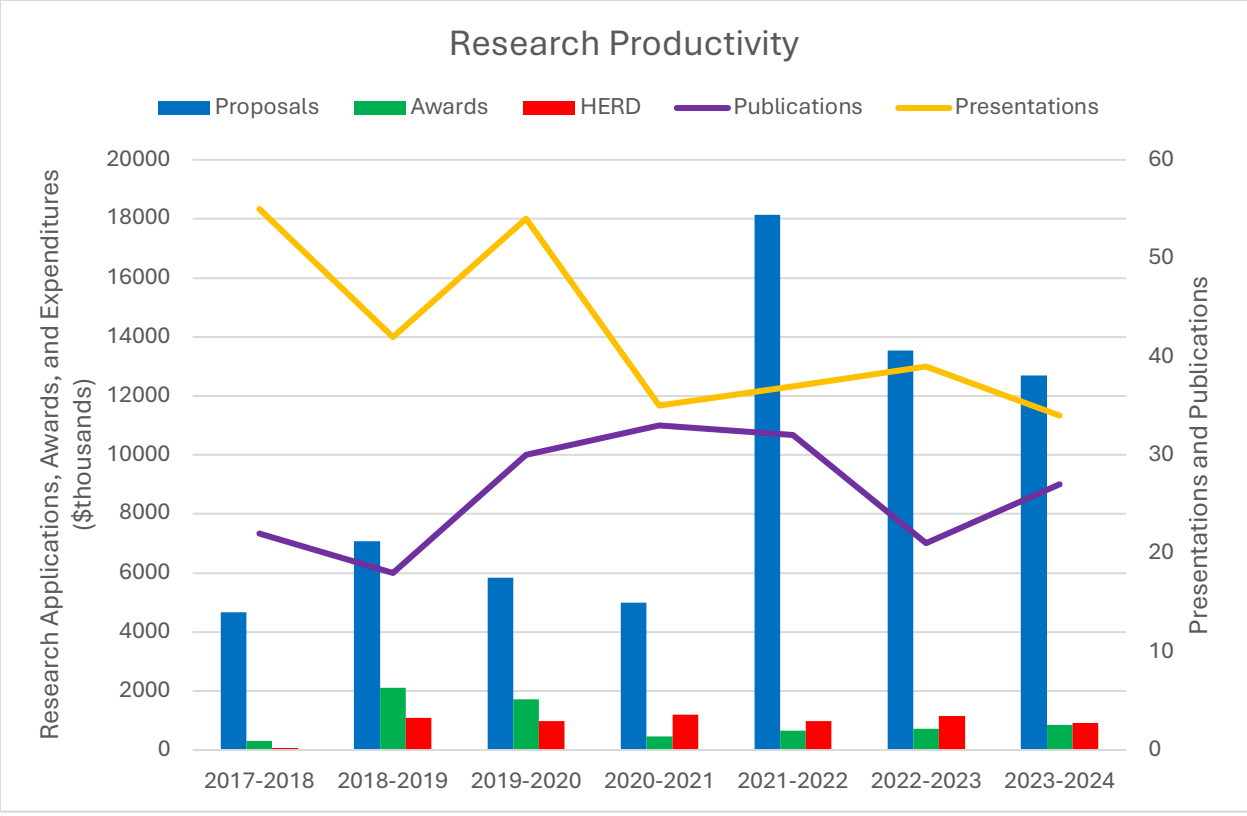
Others: Pingping Meng (North Carolina Policy Collaboratory, 2 grants for $485K), Adam Offenbacher (Toyota Motor Engineering & Manufacturing, $167K), Colin Burns (NCInnovation, $974K), Anthony Kennedy (Civilian Military Innovation Institute, $212K), Eli Hvastkovs (UNC-Research Innovation, $1,200K), Colin Burns (NC Biotechnology Center, $110K), Robert Hughes (American Chemical Society-Petroleum Research Foundation, $110K)

[12] https://east.ecu.edu/2019/10/01/f19-x-marks-the-lab/
[13] https://news.ecu.edu/2023/04/06/lifetime-of-caring/

4.9. Research Productivity

The Department of Chemistry's research funding, presentations and publications is summarized in the table and chart below. Successful hires at the Assistant Professor level (one per year between 2015-2017, all now promoted) are all externally funded and have built national and international reputations, along with funding by the senior faculty resulted in HERD expenditures averaging around $1,000,000 annually over the last six years. By comparison, during the period covered by the previous seven-year review, HERD expenditures averaged $133,000, demonstrating the return on investment of those new hires and a small expansion in the number of GTA positions available. As discussed above, the decrease in the number of research active tenured faculty, coupled with only one new hire in the last seven years, may be beginning a downward trend in funding.

	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
HERD ($1000)	75	1094	979	1193	979	1158	926
Proposals ($1000)	4676	7077	5835	4998	18144	13547	12703
Awards ($1000)	299	2112	1710	471	658	721	848
Publications	22	18	30	33	32	21	27
Presentations	55	42	54	35	37	39	34



Over the period of the self-study (2017-2024) the Department of Chemistry faculty have been featured on approximately 185 journal articles or book chapters, featuring approximately 140 unique student co-author designations (i.e.-not double counting on collaborative efforts).

4.10. Program Support

Out of a departmental operating budget of $236K, we typically spend ca. $60K for materials and supplies, $15-20K for travel, and around $90K on instrument maintenance and related items. The University provides approximately $65K in student fee money to support consumables, teaching technology, and equipment maintenance (note that we are not allowed to have an additional lab fee). It is expected that all faculty will seek matching funds, college and university travel and research grants to assist in extending the departmental support as far as practicable.

All new tenure-track faculty receive startup funds, with the majority coming from the Research, Economic Development, and Engagement division. The College and Department are expected to contribute a minimum of 30% for the total package. Those packages typically include needed equipment, supplies and consumables, typically graduate student support for one or two students, and the reassigned time for research as buyouts. The department contributed about $210,000 to the most recent hire's startup, the majority of that for needed lab renovations (from accumulated indirect cost funds) and student support (usually reallocated GA funds).

The critical role GTA positions play in instructional support is already covered above, but that support is also critical to the success of the research productivity of the department. The research carried out by the graduate students is the backbone of all publications and preliminary results for grant applications. Per the American Chemical Society Committee on Professional Training, small PhD programs (>40 students enrolled) should expect to support 30% of their graduate students on non-institutional funds, something we have succeeded in doing over the last seven years (see section 1.3b).[14]

As mentioned above in Section 4.5, the department has unbalanced teaching loads for tenured/tenure track faculty based on research productivity, the Chair and faculty members may also negotiate reassigned time for research-oriented tasks like submitting a federal grant.

Analysis of Service and Outreach activities

4.11 . Major Service and Outreach Activities

The department recently concluded an NSF-REU summer research program. This program ran from 2019 – 2023 and brought students from around the country to ECU for a research-intensive experience. Many of these students presented at local, regional, and national conferences, were co-authors on manuscripts from our department, and are now attending graduate programs in the chemical sciences.

The department's annual Homecoming event also welcomes returning alumni and department supporters back to campus each October. A poster session featuring student research projects held during this event keeps them informed of ongoing research and educational activities in the department.

[14] https://www.acs.org/content/dam/acsorg/about/governance/committees/training/reports/cptreports/phd-programs-in-chemistry-survey-report-2008.pdf

Our faculty serve many leadership roles campus-wide, including:

- Numerous roles on Faculty Senate Committees including Research and Creative Activities, Faculty Welfare, Teaching Grants, Admissions and Retention, and Curriculum.
- As members and leaders of the Chancellor's Military Advisory Commission, Student Conduct, Health Professions, Finish in Four, Predictive Analytics, Allies and Advocates, and many others.
- Playing critical roles in economic development via the Pharmaceutical Development Center, ECU Patent Committee, and the Innovation Hub.

Professional Service Activities include:

- Over 250 articles reviewed over the last seven years for leading journals in the field.
- Serving as ad hoc and panel reviewers for the NSF, NIH, American Chemical Society, Alzheimer's Association, American Heart Association, and others.
- Organizing events such as the Environmental Health and Safety of Emerging Chemicals and Technologies Symposium, the ECU Biophysics Symposium, and the LaserTAG Imaging Competition and Research and Creative Activity Week visiting speaker.
- Several faculty members have served as Chair, Chair-Elect and Councilors for the ACS Local Section.
- Multiple faculty have served as outside reviewers for tenure and promotion decisions at other universities.

The department has also been engaged in outreach activities geared towards students in Pitt County schools, including mentoring and judging Science Olympiad events, participating in Meet the Scientist events through NC Museum of Natural Sciences – Greenville and Contentnea Creek (also known as *A Time for Science*), and through hosting visiting student groups from the Third Street School, a local charter school.

Action Plans:

4.12. Action Plans

- In order to support the teaching, research, and service activities of the faculty, the department plans to:
- Continue to request tenure-track hires at the Assistant Professor rank, particularly in Chemical Education but there are also current or pending needs in the Analytical, Physical, and Inorganic fields.
- Addressing aging research infrastructure is a priority. The department's workhorse 400 MHz NMR is at end-of-life with Bruker, which means they will no longer provide a service contract and are no longer making parts to repair the console. The department had two NSF-MRI applications this year, one for a replacement 400 MHz NMR and a second for a 700 MHz NMR needed for macromolecule work in Chemistry and with collaborators in the departments of the Brody School of Medicine. Following replacement of the 400 MHz NMR, next we will seek to replace the Waters Q-TOF mass spectrometer, which is defunct, and the SciEx triple quad mass spectrometer, which has also reached end of life.
- Continue to advocate for a concomitant increase in the number of graduate teaching assistantships at the PhD level required to improve publication rates and funded research grants, as continued successful participation in the interdisciplinary degree will support an eventual application for a

standalone PhD program in Chemistry. That investment in enhanced research capacity is consistent with ECU's move to and maintenance of Carnegie R1 status. It is important to note that the UNC system carefully considers program redundancy and ECU needs to be prudent and strategic with any investment, making continued success in the interdisciplinary PhD program the strongest argument for addition of a new PhD program in Chemistry in the system.

- Continue to advocate for upgraded instructional space appropriate for team-based learning and CURE labs.
- Continue to advocate for and help seek external sources for additional support for learning assistants and graduate teaching assistants to support teaching activities and student success.
- Continue to actively seek external resources in support of research programs.

Resources Needed:

- Graduate teaching assistantships are required to expand the MS program, expand participation in the Interdisciplinary PhD and eventually potentially launch a stand-alone PhD. This will lower teaching loads on research active faculty, provide more research productivity from the graduate students, and support student success activities and external service. While launching a PhD program will slightly increase the number of MS graduates (this is a common off-ramp for students that don't successfully pass candidacy), simply allocating MS lines to support new PhD students will reduce the instructional capacity (approx. 2 MS student lines are required to fund one PhD) and close off a vital employee pipeline for local industry.
- Additional support for learning assistants in lecture classes.

5. Regional Transformation – Economic Development/Public Service

5.1. Major Activities

The Pharmaceutical Development Center[15] was created by a grant awarded to Professor Allison Danell (now Dean of the Harriot College of Arts and Sciences) in 2014, and now is part of the Eastern Region Pharma Center (which includes the Department of Engineering and the Department of Biology). This center is an outgrowth of the strong, ongoing relationship the department has built with regional industry, including the creation and on-going support of the GMP class mentioned previously. The Pharmaceutical Center continues to make strides in connecting ECU with the growing pharmaceutical industry in our region. In particular, Dr. Jack Pender organizes an annual Pharmaceutical Conference that attracts local industry professionals for two days of mini-courses in industry-related topics and an outstanding vendor show. Many of our own students use this conference as an opportunity to network with local industry and make critical contacts with recruiters. This event continues to grow from year to year, and last year's conference (Spring 2024) was the largest one to date. The center also routinely offers short courses in HPLC method development and other custom trainings as needed.

The mission of the center is:

> The Pharmaceutical Development Center is a laboratory-based education and training center providing research and innovation expertise to internal and external constituents. With a focus on workforce and professional development, the center offers opportunities for students to receive industry-specific training to shorten new workers' time to productivity and welcomes

[15] https://chemistry.ecu.edu/pharm-center/

incumbent workers seeking career progression opportunities in areas such as regulatory affairs and clinical trials. The modern laboratory instrumentation and scientific expertise of our personnel fuel innovation and enhance the competitiveness of our collaborators in industry and academic research and development activities. We strive to impact the region through economic, educational, and innovative development in the pharmaceutical sciences sector.

5.2. Action Plans and Resource Needs

The department is fully committed to expansion of these critical components of regional economic development and transformation. Addition of upgraded NMR capabilities and additional mass spectrometry and other analytical capabilities are critical for both internal and external stakeholders. Personnel needs will include technicians and graduate research assistants to help run routine samples and maintain the instrumentation. Much of these costs should be offset with the development of grant and external revenue streams.

6. Resources

6.1. Adequacy of Resources

Our primary source of operating funding is the state allocation, which is transferred to us via the College. The current operating budget has been flat for the review period, and inflation has eroded its purchasing power. Service contracts for equipment continue to be a significant burden. The very successful CURE labs courses supported up to this year by Dr. Walker's NSF grants will now need to be supported by state provided funding. The student fee-based funding is a potential source for those additional consumable costs, but additional TA help will need to be identified. Utilization of Foundation funds (i.e. the undergraduate research support funds, Catalent Undergraduate Teaching Assistant funds, general use fund) have allowed us to support additional research and instructional needs, but those funds are limited.

Indirect cost return (F&A) funds have been used for a variety of research-oriented items. That includes lab renovations, equipment repairs, and service contracts. The ability to accumulate the department's share (10% of the F&A is returned to the department, and 10% to the faculty member) paid off in the needed lab renovations, which cost approximately four years total of accumulated funds, and serves as a hedge for emergency needs.

As discussed above (Section 4.2), state personnel funding (faculty lines, scientific staff, and particularly GTAs) is well short of our institutional peers.

6.2. Space Needs

- Lab renovations and office space for any new hires; the department is currently occupying all but one of the allocated offices and has one vacant laboratory space in the Science and Technology Building. The eventual move of the molecular biology faculty (of the Biology Department) to the new Life Sciences Building should help address this issue and presents an opportunity for additional tenure-track faculty in support of the PhD program.
- Appropriate space will need to be prepared for a high field NMR, once obtained. This vital piece of core instrumentation will require a dedicated staff. A high field NMR would ideally be on the ground floor with the appropriate shielding, although we are also evaluating a potential site on the fifth floor of the Science and Technology Building as well.

- Additional dedicated space for research analytical instrumentation (and the support staff if possible). As above, the department is currently at capacity in the allocated instrumental space of the Science and Technology Building, which is also mixed instructional/research space. It would be much preferred to keep research instrumentation in dedicated space for research.
- As mentioned above, the university needs additional, appropriate space for team-based learning.
- The current lab space for CUREs needs to be expanded, the simplest way to do so would be to upfit appropriate space for the Department of Criminal Justice and Criminology in another location, opening a lab space next door to the current lab. Additional TA support in the lab is also critical for successful CURE experiences for students.

7. Other Operational or Programmatic Outcomes

7.1 Other Operational or Programmatic Outcomes

Major recommendations from prior seven-year review:

- Update faculty websites and ensure easy searches by research interest and will designate a responsible individual to coordinate undergraduate research.
    - Ongoing. Chair reviews and recommends updates to websites regularly. Ms. Bennett has been coordinating undergraduate research, while Dr. Walker has been coordinating Course-based Undergraduate Research Experiences (CUREs).
- Hire of a full-time mass spectrometry (MS) staff person/instrument specialist.
    - Completed. Currently Dr. Ninad Doctor.
- Increased instructional support to facilitate faculty research time.
    - Two additional PhD lines were funded initially by the college, now by the Graduate School.

7.2. Action Plans:

As discussed above, the pandemic had a clear impact on student success, and possibly on the number of students seeking to major in chemistry. With the potential for continued enrollment declines based on demographics, providing the needed instructional support for the students who do matriculate so they are successful is going to be critical, mandating investment in instructional support like learning and teaching assistants.

The department does not anticipate a Chair transition in the immediate future, but putting potential candidates in leadership roles (Directors of Graduate and Undergraduate Studies, Chairs of Executive, Undergraduate, and Graduate Program Committees) is an important part of succession planning. A new Associate Chair role has also been created to assist with departmental administration.

Front office staff morale is currently good, primarily due to hard work by the lead administrator and good rapport among the staff. Retention of these good staff requires the state to make processes and support available to facilitate concerted efforts by the administration to use market rate adjustments, reclassifications, and raises and bonuses to reward good work. The Chair worked with the support of the college to reclassify one of the three front office staff positions to better reflect her current job duties, which also resulted in a market-based increase in salary.

As mentioned above, the department converted two staff positions into two faculty positions with duties as Stockroom Manager and Lab Manager (functionally converting two staff positions into one faculty FTE and one staff member). While that did add capacity of one additional faculty FTE (with the loss of one staff FTE), it is quite unfortunate that the university counts that as two faculty FTE, making it harder to make a case for additional faculty hires. Advantages include being able to hire someone with additional capacities. For example, the Lab Manager staff position was formerly at the bachelor's level, and being able to hire a PhD into that new position means that individual can participate in curricular revisions and discussions, and they are heavily involved in training TAs. In addition, turning the bachelor's level Stockroom Manager replaced with a master's level faculty member with pharmaceutical industry experience fills a departmental need by teaching in the GMP classes. Having the Stockroom Manager as a half-time management position does shift costs to the operating budget to cover the stockroom with student workers while they are teaching and doing their faculty duties. It may be worth considering if this is a viable model for both positions moving forward.