Monmouth College Chemistry Program Review Self-Study
March 13, 2019

Department Background

The Chemistry Department at Monmouth College has four full-time faculty members (Tables 1 and 2) in the subdisciplines of Analytical, Biochemistry, Organic, and Physical, as well as a full-time lab supervisor. The department became an American Chemical Society (ACS) approved department in 2009. This accreditation requires the department to submit an annual report indicating the number of graduating majors. Those students earning an ACS accredited degree are required to take specific courses and to submit an approved research paper (first two pages of ACS reports in evidence files). The curriculum that the department offers is also dictated by the ACS requirements. Over the last 7 years, 30 chemistry/biochemistry majors earned ACS accreditation while the total number of majors for those years was 82 (Table 3).

Research is an important component of our curriculum and the experiences that we are able to give our students are invaluable. We have many students who enroll each semester in the research course (Table 4 - numbers listed as Fall/Spring enrollment), and that number has significantly increased since 2011. While completion of a senior research project is a graduation requirement for all science majors at Monmouth College, it is obvious from comparing our numbers of graduates each year (Table 3) to our enrollment in the research course (Table 4) that our students do not wait until senior year to begin research. In fact, students sometimes begin a research project as early as the spring semester of their freshman year. In addition to research courses during the semester, the Kieft Summer Research Program (application and example programs in evidence files), which is part of the Kieft Endowment (discussed later in the report), has supported 63 students since 2011 for an 8-week research experience (Table 5). This endowment also allows us to take many of our students to national conferences to present their work. We attribute the success that our students have seen later in graduate school, professional school or at jobs in industry, where the majority of our graduates continue with their studies as seen in Figure 1 (data taken out of 116 graduates), to our department's emphasis on research.

Table 1: Department Members (2011-2012)

	Highest Degree	Rank at College	Years at College	Area of Chemistry	Publications at MC since hired
Laura Moore	PhD	Tenured/Associate	6	Biochemistry	1
Audra Sostarecz	PhD	Tenured/Associate	6	Analytical Chemistry	2
Brad E. Sturgeon	PhD	Tenured/Assistant	5	Physical Chemistry	2
Eric Todd*	PhD	Assistant	3	Organic Chemistry	0

Table 2: Current Department Members (March 2019)
***for a more detailed history and FTE information, see the excel file on department members**

	Highest Degree	Rank at College	Years at College	Area of Chemistry	Publications at MC since 2011-2012
Laura Moore	PhD	Tenured/Full	13	Biochemistry	2
Audra Sostarecz	PhD	Tenured/Full	13	Analytical Chemistry	2
Brad E. Sturgeon	PhD	Tenured/Associate	12	Physical Chemistry	2
Michael Prinsell*	PhD	Assistant	4	Organic Chemistry	0
Steve Distin	BA Bio	Lab Manager	10 (7 PT, 3 FT)		

Table 3: Total Chemistry and Biochemistry Graduates per Year

2011-2012	**2012-2013**	**2013-2014**	**2014-2015**	**2015-2016**	**2016-2017**	**2017-2018**	**2018-2019**
13	7	7	12	12	18	13	≤ 13

Table 4: Research Course Enrollment per Semester

2011-2012	**2012-2013**	**2013-2014**	**2014-2015**	**2015-2016**	**2016-2017**	**2017-2018**	**2018-2019**
15/22	16/16	14/12	13/15	24/26	30/35	22/28	26/26

Table 5: Doc Kieft Summer Research Students

2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
4	4	8	8	10	8	10	11

As can be seen in Table 1 and Table 2, three of the four faculty members in the department have been teaching at Monmouth College for over 10 years. The consistency of faculty is very important to our alumni involvement (see sections on Advising and also the alumni survey data in the evidence files) and to our research program (see section on Professional Development) and curricular cohesiveness (see section on Curricular Changes). The organic chemistry position has been the only position in which that faculty member has changed since 2011; Dr. Eric Todd left his position at the college after he completed the spring 2013 semester. For the 2013-2014 year, Dr. Safiyyah Forbes was hired as a tenure-track Organic Chemist. Unfortunately, she left the position after one year. For 2014-2015 the academic year, the organic chemistry position was filled by a visiting professor and Dr. Michael Prinsell was hired starting the 2015-2016 academic year.

Learning Objectives

The learning objectives for our majors (Chemistry and Biochemistry), which were defined prior to 2011, are used to guide the curriculum and other activities in our department. We will discuss them in context with the information we have obtained for this report. The learning objectives are as follows:

1. Sharpen students' quantitative skills
2. Encourage critical thinking
3. *(*Biochemistry*) Demonstrate the cumulative aspect of chemistry principles and how they relate to biological systems.
   (*Chemistry*) Demonstrate the cumulative aspect of chemistry principles.
4. Develop students' analytical skills by using inquiry-based learning in class
5. Strengthen students' scientific writing and presentation skills

*Note that #3 differs between chemistry major and biochemistry major. The department sees this as the learning objective that deals with content.

Alumni Survey Data

The department, along with the assistance of the institutional researcher, sent a survey to our alumni from 2009-2018. We received responses from only 32% of alumni; we have found through contact with our alumni that many of them did not receive the survey. Overall, the survey data demonstrates that the continuation/presence of faculty in the main subdisciplines of chemistry is critical to student continuation or mastery of that subdispline. The department hopes to see more graduating students entering the field of organic chemistry now that we have a continuing organic chemist in the department. Additionally, the Kieft Summer Research Program and travel to national conferences had

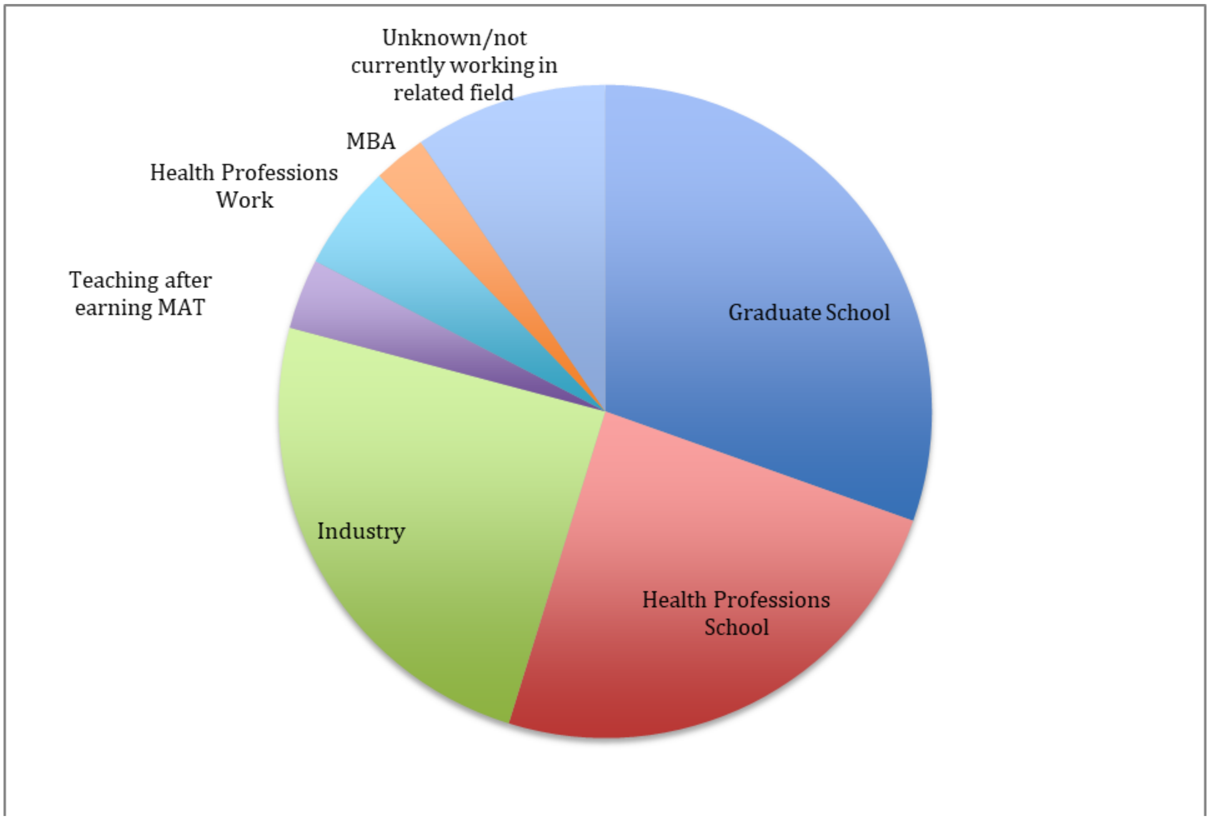


Figure 1: Employment of Monmouth College Chemistry and Biochemistry Graduates (2008-2018). *Early career trajectory of our graduates (1-4 years out). About 30% attend graduate school in chemistry, biochemistry or a related discipline. About 25% of our graduates attend a professional school for a health career (medical school, dental school, physician assistant school, pharmacy school, and nursing school (MSN)). More recent graduates who aspire to go to medical school or physician assistant school often work in a health career (such as medical scribe) for a few years to enhance their applications to the professional school and this category (currently about 5%) is growing. About 25% of our graduates enter a career in the chemical or pharmaceutical industry soon after they graduate. A few decide to earn an MBA and a few go into a graduate program to earn a MAT to be able to teach high school. Approximately 10% of our graduates have not confirmed what they are doing or are not working in a chemistry related field; most of these are our most recent graduates (2017 and 2018) who have not settled into a job yet.*

a large impact on student success at Monmouth and after. The main outcomes of the survey are the following:

1. Inorganic and Organic were the areas that alumni were least prepared for in their post graduate work. These were also the subdisciplines in which alumni were doing the least amount of research. *As already mentioned, we have had a rotating Organic Chemist and we do not currently have an Inorganic Chemist.*
2. Biochemistry and Analytical were the areas that alumni were most prepared for in their post graduate work. *The Biochemist and Analytical Chemist have been members of the department the longest and the Physical Chemist also does research of biological systems.*
3. Engineering, Inorganic, Neuroscience, and science writing were mentioned as areas that alumni would have enjoyed taking if offered at Monmouth when they were a student. *You will see later in the report that we are beginning engineering and neuroscience majors at Monmouth College pending external approval; that Inorganic has been added to the*

curriculum as of spring 2014; and the department would like advice on incorporating science writing into the curriculum in a more deliberate way.

4. Having a Bachelor of Arts (BA) degree as opposed to the Bachelor of Science (BS) in chemistry or biochemistry was seen as a concern among employers of 14% of our alumni. *We recently had the BS in chemistry and biochemistry approved by the faculty and these new degrees will go into effect in the fall 2019 semester if externally approved by the Higher Learning Commission.*
5. The majority of the alumni surveyed did research for 3-4 semesters and also participated in a summer research program, with a similar amount of alumni participating in the Doc Kieft summer program and an off-campus REU. *We are very proud of our research efforts. Sample programs of the Kieft summer research projects are in evidence files.*
6. More than half of the alumni surveyed presented research at a National Conference while at Monmouth. *Again, this is attributed to the Kieft endowment.*
7. Three quarters of the alumni surveyed were a TA while at Monmouth while about one third were an SI leader. *Teaching through critical thinking and problem-based learning, as are our learning objectives, make our students excellent TAs and SI leaders.*

Advising

The chemistry department has always taken a holistic approach to advising. We spend a lot of time with the students discussing their reasons for studying chemistry or biochemistry and we help them find summer research programs. We also ask them to evaluate how they are best spending their time in college which becomes increasingly important if they are not doing well. Laura Moore, along with Kevin Baldwin in the biology department, are the pre-med advisors and tend to advise most pre-professional students. The other chemistry department faculty split advisees normally based on who is in their research group. Over the years, the department has invited alumni back to campus with the assistance of the Wackerle Career and Leadership Center. We have been fortunate to bring in a broad range of alumni in terms of years since graduation, areas of study, and types of careers. For example, Kortney Rupp ('13) who has a Masters in chemistry and a Masters in library science and is currently a Science Librarian at U. C. Berkeley, talked to our students about other jobs in the chemistry field that they can consider. When alumni come back, they typically speak casually in classes with students, give a talk at Science Seminar, and also have lunch with students. A list of these alumni visits can be found in the evidence files.

Curricular Changes (syllabi and schedules for all courses are in the evidence files)

Sequencing of First and Second Year Courses

When Laura Moore and Audra Sostarecz began teaching in the chemistry department at the college in fall 2006, the first course in the chemistry major sequence was Organic Chemistry I (Table 7). The students then took General Chemistry in the spring, Analytical Chemistry and Organic Chemistry II in the fall and spring semesters, respectively, of their sophomore year. The department realized that our graduates were not prepared for organic chemistry topics on standardized tests such as the MCAT or for graduate school work (see alumni survey data in evidence files). As a result, the sequence of courses was changed to General Chemistry in the first semester and Analytical Chemistry in the second semester in 2008-2009. In this regard, Analytical Chemistry served as the General Chemistry II class that is taught at many schools. However, not all the topics that are covered in General Chemistry II are appropriate for an Analytical course. Adding a sophomore level Inorganic Chemistry course to the curriculum in spring 2014 was a way to try and rectify this issue. When Inorganic was added, students had the option of taking it in the spring semester of their sophomore or junior year.

Table 7: Reordering of Organic Chemistry I, General Chemistry, and Analytical Chemistry

	Fall 2006	**Spring 2006**
Freshman	Organic I	General Chemistry
Sophomore	Analytical	Organic II
	Fall 2008	**Spring 2009**
Freshman	General Chemistry	Analytical Chemistry
Sophomore	Organic I	Organic II
Common Option	**Fall 2013**	**Spring 2014**
Freshman	General Chemistry	Analytical Chemistry
Sophomore	Organic I	Organic II
Junior		Inorganic
Advanced Student Option	**Fall 2017**	**Spring 2018**
Freshman	Analytical Chemistry	Inorganic
Sophomore	Organic I	Organic II
Late Major/Dropped General Chemistry in the fall Option	**Fall 2017**	**Spring 2018**
Freshman		General Chemistry *first offered in spring 2013
Sophomore	Analytical Chemistry/Organic I	Organic II
Junior		Inorganic

In spring 2013, we decided to offer a trailing section of General Chemistry. This section often attracts students in majors that require only one semester of chemistry (such as Biology and Biopsychology), students who come to college with a weaker science and math background, or students who decide to come to the major late. More recently, we have moved to offering an Analytical Chemistry section in both the fall and spring semesters. This offering allows students who have a good background from high school (such as AP Chemistry) or as a transfer student to take a chemistry course in their first semester. The department determined that this enabled us to reach out to those high achieving students earlier since they would not otherwise be enrolled in a chemistry course their first semester.

This schedule may have helped us address some of the retention problems that are often seen in the first two courses in chemistry. From looking at the data in Table 8 which lists the percentage of D, F, and W grades in General Chemistry and Analytical Chemistry, you can see that, in general, there is a lower percentage of D, F and W in recent semesters. This data is hard to attribute entirely to our department since the student population does change each academic year and the college has been moving towards accepting higher achieving students. However, we do believe that the changes to the curriculum have affected the percentage of D, F and W positively; and, from Table 9, you can see that the enrollment in the courses has remained fairly steady, if not increased slightly, even though the admissions representatives claim they were more selective and the overall class size decreased. The Inorganic class is not as populated as the lower level courses as this course is only required for Chemistry majors.

One issue that we are seeing is that this fall semester offering of Analytical Chemistry is taken by both our more prepared students and students beginning the chemistry sequence late (these students are often not the strongest students). This sometimes leads to a bimodal distribution of student abilities. However, we believe that offering this "trailing" section in the fall has been a success because it has allowed us to connect with some of the better students early. This type of scheduling will also be beneficial to those students majoring in chemical engineering (pending internal and external approval) which will come online in Fall 2020 (this is discussed later in the document); the draft schedule of this major has these students taking general chemistry in the spring of their first year and analytical in the fall of their second year.

Table 8: Percentage of D, F and W Grades in Selected Courses

Course	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
General Chemistry Fall	39	39	36.5	38	24.5	17	23.5	14.5
General Chemistry Spring		35	34	16	38	21	11	
Analytical Fall							25	27
Analytical Spring	35.5	49	13	31	48	25	18	

Table 9: Percent Enrollment in Selected Courses (% based on total institutional enrollment)

Course	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2108	2018-2019
Gen Chemistry Fall	5.1% (67/1321)	6.6% (82/1248)	6.5% (82/1260)	5.7% (74/1303)	4.4% (53/1206)	3.6% (42/1154)	4.9% (51/1033)	5.3% (48/914)
Gen Chemistry Spring		1.8% (23/1248)	3.0% (38/1260)	3.3% (43/1303)	2.4% (29/1206)	1.9% (29/1154)	3.4% (35/1033)	
Analytical Fall							1.2% (12/1033)	1.2% (11/914)
Analytical Spring	2.3% (31/1321)	3.1% (39/1248)	3.0% (38/1260)	2.8% (36/1303)	2.1% (25/1206)	2.4% (28/1154)	3.3% (34/1033)	
Inorganic			0.56% (7/1260)	0.91% (11/1303)	0.84% (12/1154)	1.0% (12/1154)	1.9% (20/1033)	

Adding a BS in Chemistry and Biochemistry (Table 10) ***Pending external approval**
For a number of years, we have contemplated the possibility of creating a BS degree for Chemistry and Biochemistry. Feedback from our alumni (in our survey and anecdotally) has suggested that a few feel disadvantaged not having a BS. With the imminent introduction of the engineering major, the Monmouth faculty has approved the granting of BS degrees and our department has proposed a BS in Chemistry and Biochemistry. We are keeping the BA degree in chemistry but have modified it to be a degree that would work for students interested in industry because those students do not necessarily need Calculus II or Physical Chemistry II. However, students going on to graduate school would register for the BS in chemistry due to the graduate school requirements. Because of the breadth of courses necessary for a major in biochemistry (currently noted as an "exceptional" major), biochemistry will become a BS major only.

Table 10: Comparison of BA and BS Majors

Course	Current Majors				Newly Approved Majors			
	B.A. CHEM	(ACS) B.A. CHEM	B.A. BIOC	(ACS) B.A. BIOC	B.A. CHEM	(ACS) B.S. CHEM	B.S. BIOC	(ACS) B.S. BIOC
CHEM-140 (General Chemistry)	M	M	M	M	M	M	M	M
CHEM-220 (Introductory Analytical Chemistry)	M	M	M	M	M	M	M	M
CHEM-228 (Organic Chemistry I)	M	M	M	M	M	M	M	M
CHEM-230 (Organic Chemistry II)	M	M	M	M	M	M	M	M
CHEM-270 (Inorganic Chemistry)	M	M	-	M	M	M	-	M
CHEM-312 (Physical Chemistry I)	M	M	M	M	M^	M	M	M
CHEM-322 (Physical Chemistry II)	M	M	E*	E*	E*^	M	E*	E*
CHEM-340 (Instrumental Analysis) & CHEM-325 (Integrated Laboratory)	M	M	E*	E*	M	M	E*	E*
CHEM-350 (Science Seminar - 4 times)	M	M	M	M	M~	M~	M~	M~
CHEM-362 (Advanced Physical Chemistry)	-	E*	-	-	-	E*	-	-
CHEM-370 (Advanced Inorganic Chemistry)	-	E*	-	-	-	E*	-	-
CHEM-380 (Advanced Organic Chemistry)	-	E*	-	-	-	E*	-	-
CHEM-430 (Research - 2 times)	M	M	-	-	M	M	-	-
BIOC-300 (Bioinformatics)	-	-	E*	-	-	-	E*	-
BIOC-330 (Biochemistry)	M	M	M	M	E*	M	M	M
BIOC-390 (Advanced Biochemistry)	-	E*	M	M	-	E*	M	M
BIOC-430 (Research - 2 times)	-	-	M	M	-	-	M	M
BIOL-200 (Cell Biology)	-	-	M	M	-	-	M	M
BIOL-202 (Genetics)	-	-	M	M	-	-	E**	E***
BIOL-302 (Microbiology)	-	-	E*	-	-	-	E**	E***
BIOL-354 (Molecular Biology)	-	-	M	M	-	-	E**	M
BIOL-204(Anatomy & Physiology)	-	-	E*	-	-	-	E*	-
MATH-151 (Calculus I)	M	M	M	M	M	M	M	M
MATH-152 (Calculus II)	M	M	M	M	-	M	M	M
PHYS-130 (Physics I)	M	M	M	M	M	M	M	M
PHYS-132 (Physics II)	M	M	M	M	M^	M	M	M
PHYS-310 (Quantum Mechanics)	-	E*	-	-	-	E*	-	-
PHYS-325 (Solid State Physics)	-	E*	-	E*	-	E*	-	E*
Total Credits for Major	14.0	15.0	15.5	16.5	13.0	16.0	16.5	17.5
Required to Graduate	32.0	32.0	32.0	32.0	32.0	34.0	34.5	34.5

M = core course for the major; * = take one; - = not required; ^ = need to remove/waive MATH-152 prereq

E = elective for the major; ** = take two of three (can use third as other E*); ~ = increase from 0 credits to 0.25 credits

*** Take one of two (BIOL354 counts as advanced coursework in Biochemistry for accreditation purposes)

BA in Chemistry: For the BA in chemistry, we have decreased the number of required courses by two. Calculus II will no longer be required and students will have the option to choose between Biochemistry (BIOC 330) and Physical Chemistry II (CHEM 322). Students are still required to take four semesters of Science Seminar (CHEM 350), but will now get the same amount of credit per semester, 0.25, as the biology majors. Students who complete the BA in chemistry will have sufficient flexibility to double major or to study abroad which few students are able to currently do unless they enter Monmouth with credits towards the major, typically in math. Students completing this major still will be competitive for admission to some professional schools as well as employment in the chemical industry. This major also allows for flexibility in students' schedules to take business courses, for example, and then to go on to earn their MBA which some of our graduates have done (Figure 1).

BS in Chemistry: The BS in chemistry is aligned with the requirements for ACS accreditation and will be recommended for those students planning to attend graduate school. The accreditation requires: one semester of five foundation courses in chemistry (Analytical, Biochemistry, Inorganic, Organic I, and Physical Chemistry I) and four advanced courses in any of the subfields. There is also a required number of hours in the laboratory required for accreditation, which is why three of the advanced courses with a laboratory component (Instrumental Analysis/with co-requisite of Integrated Lab, Physical Chemistry II, Organic II) are specifically required for the major. An additional advanced class (such as Advanced Biochemistry) is necessary to complete the ACS accreditation. The overall number of courses required for graduation with this BS degree will be 34.

BS in Biochemistry

The BS in biochemistry has the same number of current courses but we now plan to give credit for science seminar. We are allowing some more flexibility in the major by allowing them to choose from 2 of the 3 courses in Biology (Genetics, Microbiology, and Molecular Biology) which will allow the students to better tailor the Biochemistry major to their future plans. For example, students wishing to go to nursing school will most likely wish to take Microbiology instead of Genetics, as it is a prerequisite for many MSN programs, while Genetics is not. The overall number of courses for graduation with this major will be 34.5.

New Minor and New Courses: Investigative Forensics/Forensic Science

Forensic Science (CHEM 102) was first offered by Audra Sostarecz in fall 2010 as a general education science course. This course is now the main required course in the minor in Investigative Forensics. This minor was approved by the faculty in fall 2018 and was proposed with Dr. Christine Myers in the History Department. This minor exposes students to careers in fields related to the civil and criminal court systems. The department is very excited about this minor that includes courses from Art, Biology, Communications, English, Education, History, Political Science, Sociology, and Psychology. Additionally, a May-term trip, Chemistry, Codes, and Crimes in British History (INFO 290), to London and Scotland will be taken as part of this minor in May 2019 (explained in detail later in the document).

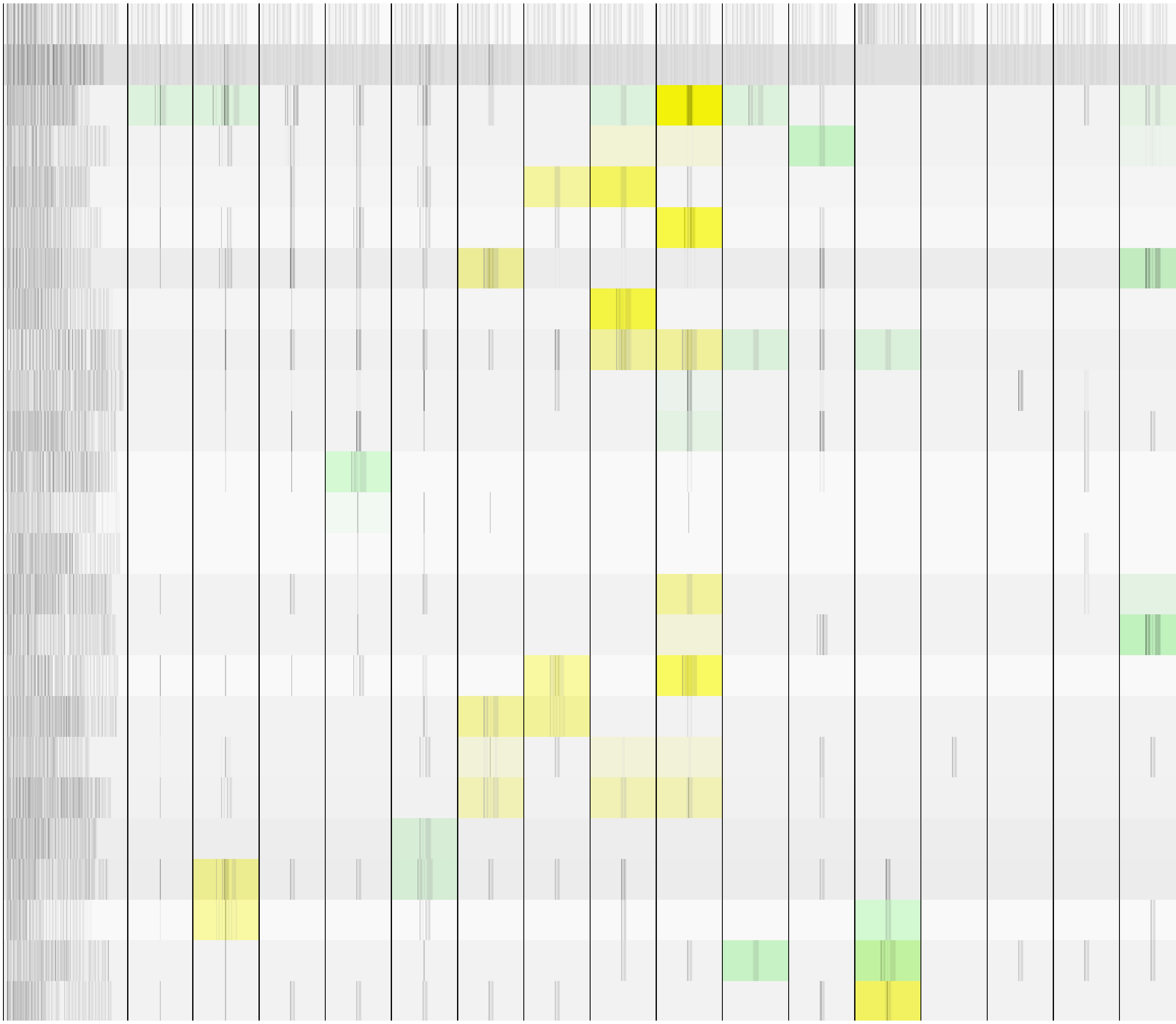
Assessment

Our department discusses often how students are performing in particular classes and if they will be ready for the next course in the sequence. We use qualitative data and our observations to make generalizations about the effectiveness of our courses and assignments which we then use to determine if and when our curriculum should be adjusted as was explained in the Curricular Changes section of this document. We do see the importance of quantitative assessment and have some tools that we use for this but we have not kept up with the analysis. This is an area that we need to improve on. Putting together the curriculum map was a great first step towards determining where we need to do these specific quantitative assessments.

Chemistry Department Curriculum Map (as of February 2019). The department has discussed the content of the curriculum of the courses in the department and mapped it to topics that should be found in a chemistry curriculum. Most of the categories would fall within the content learning objective (Learning Objective 3 as stated earlier). "**I**" means the topic is introduced in the course, "**R**" means the concept is reinforced, and "**A**" means the course has an assessment component. This list is not exhaustive and particularly needs to be supplemented with other topics for the biochemistry majors.

The assessment boxes highlighted in green are courses in which we have assessment data for the course (such as specific questions from ACS Exams), while those highlighted in yellow are courses that we do not have the data for, although we have instruments that could be used to assess these concepts. However, even though we have data for many of the topics, we lack the support staff and time to compile and analyze the data.

The last few categories (general skills) are not concepts tied to courses, but general knowledge and skills all chemistry students should have and are tied to the other learning objectives of the majors. We recognize the need to increase our assessment of the students' understanding of safety (while CHEM 270: Inorganic Chemistry) has assessment of this, it is very specific to radioactivity) and also of ethics. We are considering an online module (the CITI Program, to which Monmouth now subscribes) to help supplement the ethics component for all students who participate in research. See Table 10 for the course names that correspond to the course numbers used in the curriculum map.



Assessment Instruments Used

The content of many courses is currently assessed using the ACS Exams in that particular coursework. ACS exams are given as the final or part of the final in Organic II, Inorganic and the Advanced Biochemistry courses. Giving the same exams over the years has allowed the instructors in these courses see how the student content knowledge has improved in each area. However, it is probably not appropriate to give the ACS exam in every course. For example, our analytical course is taught earlier in the sequence than it is at most schools (freshman vs. sophomore or junior years); therefore, the students may not be as well prepared for the type of questions on these exams.

For a few of our courses, the instructors have developed some questions to assess student learning. For our general chemistry course, all instructors ask the same 5 stoichiometry questions on the final exam. Additionally, the biochemistry final exam has several questions that are always the same on the final exam. In the analytical chemistry course, the same assessment quiz is given on the first day of the semester and copies of the quizzes are kept.

For assessment of speaking, the students are required to give two presentations in Science Seminar. Science Seminar is a course that all science students and science faculty attend. The presenters are given feedback on their presentations by the entire science faculty immediately after their presentation. We keep are record of the presentation (the PowerPoint presentation) in a Dropbox file. We believe this assessment works very well (for both faculty and students).

For assessment of writing, the students are required to write a final paper on their research project. Each individual faculty member reads their own students' research papers. In order to make this an effective assessment tool, we will need to discuss specific criteria as a department.

Future Assessment Plans

The department recognizes that assessment is an area that we perhaps have not worked enough on. We have collected a lot of data, but have not had time to collate and analyze the results. We are interested in how other schools effectively use data they have collected.

Chemistry Department Initiatives

Food Chemistry

The construction of the Center for Science and Business (CSB), which was finished in the spring 2013, allowed the department to establish some unique spaces. One such space is the Nutrition Lab (CSB 201). This room is a food chemistry laboratory space that has a full stove, ovens, glassware, and other equipment dedicated to food chemistry experiments - which the students can consume. The laboratory portion of CHEM 101 (Nutrition & Food Chemistry; a general education non-majors course) and BIOC 201 (Principles of Nutrition; a nutrition course for science majors) are taught in this space. In addition to these classes, there has been the development of food chemistry research projects (e.g. analysis of aroma molecules in bread), as well as the growth of the Monmouth College Coffee Project (see below). In addition to the academic work, this space has become a popular place for our majors to congregate and relax.

Pre-Professional Advising

Many chemistry and biochemistry majors come to Monmouth with an interest in the health careers. Many of our majors have gone on to medical school, physician assistant programs, MSN programs, and dental school. However, there is a need to have better support for these students with these interests. The department has created a class (BIOC 207: Introduction to Health Careers) that will help student better understand the health careers. This course, which will first be offered in the spring 2020, is cross-listed with several other departments. Additionally, the students who take this class will have the opportunity to participate in a 2-week externship during the May Scots term. The department is working with the career center and alumni office to find health care professionals who will be willing to support these students.

Maker Space Tools

In the fall of 2016, the department purchased a CNC X-Carve® router; this was the first "maker tool" purchased for the department. In December 2016, the department purchased a Full Spectrum® 45W CO_2 laser cutter/etcher (H-Series 5th Generation). During the summer of 2017, the department purchased a Prusa® i3 MK2 3D Fused Deposition Modeling (FDM) printer as a part of Kieft Summer Research program. This MK2 was upgraded to an MK2S along with the addition of two more FDM printers (MK2S and a multi-material version).

Neuroscience Major ***pending external approval**

The chemistry department has been involved with the development of a Neuroscience major, in collaboration with the biology and psychology department. Students in the program will take one of two tracks: a molecular or a behavioral track. Chemistry courses will play a central role in both tracks. In addition, the department has been approved to hire a fifth chemist to help support this program. We hope to be able to hire a biochemist who has research related to neuroscience.

Engineering Major ***pending internal and external approval**

The chemistry department has been involved with the development of the new Engineering major, in collaboration with physics. We have particular interest in the development of the chemical engineering track of the major. A chemical engineer will be hired as one of the engineering positions; it is likely that this person will also be a member of the chemistry department. We hope to find a faculty member who has expertise in material science.

Kieft Summer Research (All Faculty)

Starting in late fall, department faculty work with and encourage students to apply for off-campus summer research experiences, REU, SPUR, etc. In early spring, the department puts out an application (sample application in evidence files) for the Kieft Summer Research program. Each faculty member is allowed to select 1-3 summer research students for the 8-week summer research program. Students are paid $4.1k and faculty members are compensated $5.4k. In addition, the summer program has a consumables budget of ~$20k. Students do a public presentation of their work near the end of the program; an example of projects can be found in evidence files.

Monmouth Coffee Project (Sturgeon)

The Monmouth Coffee Project, *where we can smell and taste the science*, is a wholesale coffee roasting company operating in the Nutrition Lab (CSB 201) within the Center for Science and Business on the Monmouth College Campus. The project started in the fall 2009 with a proposal to Dean Jakoubek. The business is inspected by the Illinois State Health Department and operates using a set of "standard operating procedures" (SOPs). This interdisciplinary project is run by students and managed by chemistry professor Brad Sturgeon. Although students are not paid for their work, they will be exposed to all aspects of running a small entrepreneurial business and course credit can be earned. Students hold the roles of customer service representative, promotion planner and marketing, social media coordinator, graphic designer, coffee roaster, accountant, and assistant project manager. Each position has a defined learning objective, deliverables, and time commitment. Students receiving credit for the work must complete an independent student agreement form that further defines the rationale, goals, requirements, and workload expectation.

American Chemical Society (ACS), Local and National Involvement

The department maintains a strong connection to the American Chemical Society. The Monmouth College Student Chapter was chartered in 1949 while Linus Pauling was ACS president. As discussed the department is ACS-accredited.

Local Section ACS Activities

- Officers: Sostarecz Chair/Chair-elect (2008-2010), Sturgeon Chair/Chair-elect (2019-present), Sturgeon Local Section (IL-IA) Chemistry Olympiad coordinator (2009-present).
- Meetings: host local section meetings (~1 each year) and promote attendance at other local section events.

National ACS Meetings

The department has endowed funds (~$14k/year) to travel to the spring National ACS meeting. This has occurred each spring since 2009. Funds generally allow for 1-2 faculty and 8-12 students. All students are required to present their research projects.

ACS Biochemistry Exam

Laura Moore was a contributor to the most recent ACS Exams Institute Biochemistry Exam (BIOC 2017).

Overseas Travel courses

Two-week terms in January and May (Scots terms) were implemented by the College in the 2018-19 school year. They may, in the future, be used as short on-campus academic term, this year they are exclusively travel courses. The chemistry department is involved in two of the overseas travel courses.

CHEM 290: Bahamas January 2019 (Sturgeon, Distin)

This is an immersive field studies course offered during a short-term (~2 weeks) in January. The course content includes the study of natural sciences, creative arts, history, and culture related to the Bahamian environment. The course includes pre-term meetings (~2), on campus instructions/preparation (~1 week), 1-week travel to Andros Island, Bahamas (Sat to Sat), and a written journal documenting travel activities and reflections. It is preferable for students to have basic swimming skills, although on-island activities are both land and sea based. The time spent on Andros Island will be at Forfar Field Station, which is a rustic, former dive resort nestled in a beachfront coconut grove on the east coast of Andros Island. Andros Island is ~115 miles long and is the largest in the Bahama archipelago; at the same time, it is one of the least developed islands, there are no cities, towns are few, and there is a distinctive small-town atmosphere. The facility provides cabin-style lodging along the beach, a dining hall, a classroom and research lab, and an open living area. On-island travel is provided in IFS vans and boats; the field station also has a full-service dive shop.

INFO (Investigative Forensics) 290: *Chemistry, Codes and Crime. England/Scotland* (Sostarecz, Moore)

This is a May term trip that is open to all students. The trip this year was organized by a history faculty member and will be overseen by chemistry, computer science, and history. It is a 10-day trip to London and Scotland and will consist of visits to museums and distilleries and a chance to participate in a forensics science workshop. Students will write a paper on a topic of their choice. Other assignments will be given during the course time which is 2 hours a week for the second half of the semester.

Short Summary of Professional Development of Department Faculty Members (Faculty CVs in evidence files)

The chemistry department members continue to publish (Tables 1 and 2) and attend and present at conferences. Every year, the Doc Kieft Endowment allows at least two faculty members, sometimes, to attend and present at a national meeting. Lately we have been going to both the American Chemical Society (ACS) meeting and the American Society for Biochemistry and Molecular Biology (ASBMB) meeting. In addition to this, Brad Sturgeon is the Treasurer of the Midwestern Association of Chemistry Teachers at Liberal Arts Colleges (MACTLAC) and also organized the MACTLAC meeting at Monmouth College in fall 2018. Brad is also the chair-elect for the local ACS chapter, a position that Audra Sostarecz held for two terms in her early years at the college. Audra is also a visiting research scientist at Colorado State University where her long standing collaborator is a professor in the chemistry department. Laura Moore has attended the AP Chemistry Reading for several years as a grader and Michael Prinsell will grade this year. From the department member information in the tables in this document, it is obvious that the faculty are publishing their research while still maintaining their teaching and service requirements. As always, the faculty are committed to doing research with students (Tables 4 and 5)

Operating Budget
The operating budget of the chemistry department is $47,100. This number has not changed for several years, as all department budgets at the college have been flat. There are funds set aside for student workers ($2,000 for those who have federal work-study and $4,500 for those who do not). Specific funds are also set aside for copying ($6,500). The remaining $34,100 can be moved between the different cost centers; the majority is used for consumables for the laboratories and for repair of instruments.

Endowments
The chemistry department has several department-designated endowments that have contributed to the success of our program. Our largest endowment is the Kieft Endowment, as mentioned previously, which yields approximately $142k/year. The Kieft Endowment is divided into four separate areas, as list below:

- Scholarships for Kieft Scholars, who are Chemistry and Biochemistry majors (~$40k/year). This fund is supporting 13 students in the 2018-19 school year. Students are selected for this scholarship as incoming students in an application and interview process.
- Summer Research Stipends ($68k/year) for students and faculty to participate in an 8-week faculty-mentored student research program. This past summer the fund was used to support 11 students (paid $4.1k) and 4 faculty members (paid $5.4k).
- Summer Research Consumables ($20k/year). This fund is used to buy consumables for the summer research projects.
- Kieft/Gebauer Travel Fund ($14k/year). This fund is used to take students to national professional meetings such as the ACS and ASBMB. Eleven students will attend the 2019 spring ACS meeting in Orlando.

Another set of funds, the LeSuer Endowment ($24k/year up to 2017-2018 and now $38k/year) is used to purchase instrumentation and capital equipment. (See appendix X for list of instrumentation.) These funds have also been used as a source of matching funds for the PittCon grants. The Haldeman Endowment ($30k/year) is used to support library resources. It is currently used to maintain the following resources:

- Web of Science (Partial payment)
- ACS journal Access (partial payment)
- SciFinder Scholar
- Chemical Society Reviews
- Journal of Biological Chemistry
- Science

A recently established endowment, the Knox Fund (~$1.4k/year), will be used to support engagement with industrial organizations or for other flexible spending needs.
Total Endowment spending, ~$211k/year.

External Funding (applied for or granted)
Southern/Central Illinois Louis Stokes Alliance for Minority Participation (SCI-LSAMP) Pre-alliance Planning (*under review*): The purpose of this grant is to fund the pre-alliance planning of the Southern/Central Illinois Louis Stokes Alliance for Minority Participation (SCI-LSAMP), which will serve 10 downstate Illinois institutions: Bradley University, Eastern Illinois University, Heartland Community College, Illinois Central College, Illinois State University, Illinois Wesleyan University,

Monmouth College, Southern Illinois University - Carbondale, University of Illinois - Urbana/Champaign, and Western Illinois University. Among the institutional partners, 116 STEM baccalaureate degrees are offered, and the connections that students make across institutions as participants in the SCI-LSAMP will facilitate potential graduate applications to the 134 STEM graduate programs available across the partners.

NSF-STEP, 2012 (*not funded*)
The department, in collaboration with the physics department, applied for an NSF-STEP grant in 2012. The proposal set out ways in which we could support students with academic potential who have intermediate standardized test scores that suggested they would need some support to be successful in science. While this proposal was not funded, we often revisit this topic and the same goal may become motivating factor of a future SSTEM grant.

HHMI, 2015 (not funded)
The department, in collaboration with the physics and biology departments, submitted a pre-proposal for the 2015 competition. We were not selected to write a full proposal.

PITT CON, 2012 (funded $10k)
The Monmouth College chemistry department requested a grant of $10k to purchase 16 Vernier LabQuest systems with a variety of Vernier accessories for our undergraduate chemistry laboratories. Monmouth matched this grant with $8893 to complete the package. This was exactly the right time for us to upgrade our data collection equipment. As of fall 2013 the department had fully moved into new lab and classroom facilities in the new Center for Science and Business. We had recently revised our chemistry curriculum and upgrading and expanding our lab equipment was a part of these revisions. As a result of this funding, we have been able to integrate more active-learning laboratories and student-designed projects into our curriculum.

PITTCON, 2016 (funded $10k)
The Monmouth College chemistry department requested a grant of $10k to purchase an ion chromatography system; Monmouth College matched this grant with $10k. Our department has a history of integrating independent and faculty-mentored research projects into all levels of the curriculum and the acquisition of this instrumentation allowed us to expand our range of sample analysis. This ion chromatography system joined our other highly used chromatography systems including: a Waters HPLC/UV used primarily with a C18 column, a Viscotek HPLC/RI with an amine column used primarily for sugar analysis, a Griffin (FLIR) GC-MS used for the separation and analysis of volatile compounds including a recent focus on the use of SPME to analyze aroma compounds, a Teledyne Isco CombiFlash RF200i with both UV and ELSD detection and 2 GC systems.

ACS FaCE Grant (funded $37k)
The proposed two-day workshop, building ACM-wide partnerships for developing virtual-/augmented-reality tools for pedagogy, at Grinnell College forges, within the Associated College of the Midwest (ACM), a community of faculty blending immersive technologies with liberal-arts classrooms. Immersive technologies such as virtual- and augmented-reality (VR/AR/3D) offer innovative frameworks for pedagogy, and the ACM could become a collaborative hub for tapping into this promising potential.

Knox NMR Collaboration (funded $300k)
Monmouth College is a collaborator on the NSF proposal to acquire a high-field NMR that is located on the Knox College campus.

Western Illinois Mass Spectrometry Collaboration (funded $400K)
MRI: Acquisition of a Quadrupole Time-of-Flight Mass Spectrometer with Chromatographic Accessories for Research and Education in the Rural Western Illinois Region.
The facility is expected to be online in the Summer of 2020.

Departmental Members Committee work (over the last 13 years)

- Curriculum (Prinsell, Sostarecz, Sturgeon)
- Faculty and Institutional Development Committee (Sostarecz, Moore, Sturgeon)
- Student Activities and Support Committee (Sostarecz)
- Admissions and Academic Status Committee (Sostarecz)
- Grievance (Sostarecz)
- Quantitative Reasoning (Sostarecz)
- Higher Learning Commission Steering Committee (Sostarecz)
- Faculty Senate (Sostarecz, Moore)
- Faculty searches (Prinsell, Moore, Sostarecz, Sturgeon)
- President's Priorities and Planning Subcommittee (Sostarecz)
- Doing the Discipline (Sostarecz, Sturgeon)
- Campus Technology Futures Group (Sturgeon)

Instrumentation
The chemistry department has the following instruments available for undergraduates to use in research and teaching laboratory activities (the year is the year the instrument was acquired):

Atomic Absorption Spectrometer – Varian AA240FS with graphite tube atomizer – 2006
UV/Vis Spectrometer – Agilent 8453 – 2000
UV/Vis Spectrometer – Thermo-Fisher Nano Drop One – 2017
Infrared Spectrometer – Thermo Nicolet Nexus 470 FT with ATR attachment – 1997 Upgraded: 2010
Electron Paramagnetic Resonance Spectrometer – Bruker EMX X-Band – 2018 on loan from NIEHS
Nuclear Magnetic Resonance Spectrometer – Varian 360A FT 60 MHz – 2000
Gas Chromatograph/Mass Spectrometer – Griffin 450 with gas sampling port and X-Sorber portable SPME sampler – 2010
High Performance Liquid Chromatograph – Waters Breeze 1525 with dual wavelength detector, column heater, and autosampler – 2005
High Performance Liquid Chromatograph – Viscotek GPC with refractive index detector – 2010
Ion Chromatograph – Thermo-Fisher Dionex Aquion – 2016
Flash Chromatograph – Teledyne ISCO Combiflash Rf200i – 2015
Langmuir Trough – two LB and one G2 – 2004, 2018 respectively
Potentiostat/Galvanostat – Pine Wavedriver 10 - 2016
Bomb Calorimeter – Parr Instruments – 1970

The department also maintains various minor instruments and ancillary equipment necessary to conduct research and teaching laboratories. This equipment includes but is not limited to: various gel electrophoresis apparatus, a Schlenkline, a lyophilizer, sixteen Vernier Lab Quest 2s with various probes, three FDM 3D printers, an SLA 3D printer (shared with math/computer science), a 40W laser CNC, and various fabrication equipment.

Goals for the Future

1. The incorporation of chemistry courses and research into the new interdisciplinary majors (Neuroscience and Engineering).

2. More targeted assessment of courses.
3. Improve upon science writing instruction.
4. Help students to use literature sources more effectively.

Things to Improve On

The department would like to improve the following in the next few years:

1. More safety training for students.
2. Train students in research ethics.
3. Increase computational resources for faculty.
4. Improve science writing pedagogy.
5. Increase research student management.
6. Include more synthetic Inorganic Chemistry into the curriculum which may require the hire of an Inorganic Chemist.
7. Satisfy polymer requirement for the American Chemical Society.

Advice Sought from Consultant

Scientific Writing

The department would like to gain insight into incorporating instruction on scientific writing in our courses in a more deliberate way. We do assign lab report writing in most of the lab courses. However, with student enrollment upwards of 25-35 in the freshman and sophomore courses, it is difficult to truly teach scientific writing while also teaching laboratory techniques. We have tried to address this issue a few ways:

1. Teach scientific writing in a stepwise manner in the Analytical Chemistry lab course (second semester freshman course). However, it appears that these skills don't translate to the future courses due to the lack of emphasis on writing in them.
2. Audra Sostarecz piloted a science writing course on her sabbatical in fall 2013 and then offered the course one more time. This course was offered without credit so it was very difficult for the students to put all their effort into it especially with the demand of their other courses. With our current curriculum being at the maximum allowable credits, assigning credit to this course is not possible at this time.

Other Areas where Advice is Sought

1. The department would like to improve the relationship with the biology department. This relationship suffered when the biology department removed most chemistry courses from their major. We have many common students, some of which do research in our department, and we also share some of the same interest in the need for imaging analysis such as fluorescence and atomic force microscopy. Due to these reasons, we would like to communicate in a more effective manner with the biologists.
2. Safety and ethics training are two things that the chemistry department is passionate about having the students do but does not currently put an emphasis on. We have thought about having the students take CITI training online which the institution has a subscription to.
3. The department would like to discuss breadth versus depth when it comes to courses and topics covered in them. This was a large part of our discussion as we were doing the curriculum map and deciding where topics were covered in the courses we teach.
4. The department would like to know how best to incorporate the new Macromolecular, Supramolecular, and Nanoscale Systems requirement into various areas of our curriculum.
5. The department would like advice on how to specifically assess course content.