Assessment Review Professional Development
Chemistry Ph.D. Program, The Graduate Center, CUNY

The Learning Goals of the Ph.D. Program in Chemistry include the following with respect to professional development: students must interact effectively, collegially and professionally with other in the field and conform to the fundamentals of ethical research conduct.

The Chemistry Ph.D. Program’s curriculum is designed to provide all students with training in professional development and ethics. This training begins at orientation, before the start of classes in their First Year, with a formal presentation of the Ethical and Professional Guidelines and the Chemical Professional’s Code of Conduct, both developed by the American Chemical Society, the world’s largest scientific society. This introduction is used to set the expectation that our Program is preparing our graduates to be professional chemists.

All first year students are required to take a course in Professional Development entitled Project TEACH, Spring 2016 syllabus attached. Project TEACH covers a range of topics including professional behavior/ethics (formal lecture on how to fail out of graduate school in less than 15 minutes), professional presentations (three-minute thesis type exercises, formal seminar on seminar presentation), critical reading skills (a series of exercises starting with a discussion of assigned literature leading to a presentation on five papers as preparation for their Original Research Proposal, part of their Second Examination), teaching (exercises in classroom management and active learning pedagogies, i.e. POGIL, PLTL, flipped classroom), academic structure and the academic job search (exercise on assistant professor CVs, introduction to blogs The Professor is In and chembark), grant writing and review (formal lecture), and leadership (formal lecture). The effectiveness of Project TEACH varies by instructor as evidenced by the course evaluations. In addition, all students are required to take the online course and workshop on the Responsible Conduct of Research offered at the Graduate Center. All students have annual meetings of their dissertation committees where professional behavior is expected as students present a seminar on their work and receive feedback from their committees.

Students receive informal training in professionalism from their research mentors starting in their Second Year of the program. Because quantity and quality of this training is highly variable between research mentors, the Ph.D. Program in Chemistry tries to supplement their professional development training with offerings from the Office of Career Planning and Professional Development, the Center for Teaching and Learning as well as outside events. The GC-sponsored events are poorly attended because chemistry students reside at the senior campuses for the majority of their careers at CUNY. Campus-based professional development offerings, i.e. Grant Writing Workshops, are better attended, but typically only attended by students at a single campus. The Ph.D. Program publicizes the free professional development webinars presented by the American Chemical Society. The topics covered range from intellectual property rights
to professional etiquette to science communication to authorship. In addition, the Ph.D. Program invites the graduate students to the Graduate Center Science Center to participate in the ACS Program-in-a-Box webinar each Fall. This year’s topic is The Chemist’s Code for Success: 3 Essential Skill Sets for Your Career, last year’s was Tales of Lab Safety: How to Avoid Rookie Accidents.

Writing abstracts, papers and research proposals is an important aspect of the professional development of the chemistry Ph.D. students. The average graduate of the Ph.D. Program in Chemistry has authored four journal articles during their studies. The chemistry Ph.D. Program’s Second Examination requires the writing and oral defense of an Original Research Proposal (ORP). Students are familiarized with the proposal writing process in their first year, and some students may take a course in proposal writing in their second year. Chemistry offers its molecular biophysics subdiscipline students a course, Chem 87901 Molecular Biophysics, in which the students are instructed in the proposal writing process as a preparation for their Second Examination Original Research Proposal. The course is populated with Biochemistry Ph.D. students as well. Other chemistry students have taken BIOL 79303 Grantsmanship and Developing a Research Proposal. Both of these formal course offerings are well received and often aid in students receiving external fellowship support.

The greater New York area also offers our students a range of professional development opportunities. Our students avail themselves of the offerings at the New York Academy of Sciences (NYAS), and the New York Local Section of the American Chemical Society (NYACS). The NYAS offers technical symposia and networking events throughout the year. The NYACS offers technical symposia, networking events, conferences, and community outreach events during the academic year. The NYACS hosted the 2016 Middle Atlantic Regional Meeting at which ten students presented their work. In addition, two of our students, on average, present at the annual Eastern Analytical Symposium hosted by the NYACS as well. Faculty often attend regional and national conferences with their students. The Program keeps our students apprised of upcoming events via email.

**Outcomes:** Project TEACH has been an integral component of the chemistry Ph.D. curriculum for more than fifteen years. In an effort to assess the long-term effectiveness of Project TEACH and our other professional development efforts, an analysis of the 110 chemistry Ph.D. degree recipients from 2007 – 2013 was performed. We were able to locate 102 of the 110 graduates using LinkedIn and Google. The data show that 101 of the 102 Ph.D. graduates found are employed in the field of chemistry at this time. We believe that this metric is a more true reflection of the impact of Project TEACH and our other professional development efforts. 20 graduates are in tenure-track positions in academia, 33 graduates are employed in the chemical industry. 12 graduates are employed by government labs. The 37 remaining graduates are in postdoctoral positions. We consider the 24 pre-2012 graduates in postdoctoral positions to be underemployed, as they have not obtained permanent positions 4-years post graduation. Thus, the professional development training that the Ph.D. Program offers to its students is not serving about a quarter of our graduates and needs improvement.
**Proposed changes:**

While the outcomes analysis indicates that most of our graduates are employed in the field of chemistry, further improvements in our professional development are required to ensure our students are well prepared for today’s competitive job market. Review of the curriculum has shown three areas where improvement is needed to meet our evolving learning goals. These are proposal writing, chemical safety, and professional development self-planning.

*Proposal Writing:* While the current curriculum requires an Original Research Proposal as part of the Second Examination, practical training on this requirement is absent in the subdisciplines of chemistry with the exception of Chem 87901 Molecular Biophysics. The Ph.D. Program will model a series of courses on the successful Chem 87901 Molecular Biophysics and BIOL 79303 Grantsmanship and Developing a Research Proposal courses for the chemistry Ph.D. students. These courses will provide students with the practical know-how to write effective research proposals for their Second Examination and for external fellowships.

*Chemical Safety:* There is a growing recognition of the need for a culture of safety in graduate school education. Laboratory accidents are becoming both more prevalent and more serious. The current curriculum does not include chemical safety training until the Fall of the Second Year. This is a clear lapse, since students are required to perform laboratory rotations during their first semester of study. The curriculum will be changed to include mandatory chemical safety training at the beginning of the Fall semester of Year One, before any laboratory rotations are performed.

*Professional Development Self-Planning:* American Association for the Advancement of Science (AAAS) has recently provided an online professional development tool called the IDP, or individualized development plan for science students. The American Chemical Society has followed with the ChemIDP designed specifically for chemists. These tools (IDP and ChemIDP) help students in the process of self-reflection required to plan a successful professional career. They also provide an indication of the possible career paths available to students including careers outside academia, so called Alt-ACs. The Chemistry Ph.D. Program will use the ChemIDP in its professional development activities. Students will first encounter the ChemIDP during their first semester to show them the range of skills that a professional chemist may want to acquire, and how their motivations reveal probable career paths. Students advancing to Ph.D. candidacy will be asked to use the ChemIDP to determine what they have learned during their time in graduate school (skills acquired), and the skills that still need to be acquired to maintain their trajectory towards the career of their dreams. Lastly, students who are depositing their thesis will be asked to do the ChemIDP exercise to review their career plan and goals.
Course Goals:

As lifelong learners, Chemistry professionals are always seeking new challenges and opportunities to grow. Your professional development is a significant aspect of your graduate studies. Outside of technical knowledge and expertise, there is a critical need for professionals to possess ‘soft skills’ in order to be employable. In this course, we will use presentations and class discussions to explore the expected behavior of a professional chemist and educator. These lessons are designed to engage you in discussions of professional behavior in the classroom, the research laboratory, the literature and your career. Through in-class presentations, you will become proficient in public speaking which is necessary to command a classroom or a technical audience. Through lecture instruction, you will become familiar with the processes surrounding publishing research findings, securing grant funds, and optimizing your career opportunities. The exercises are designed to improve your ability to critically read the literature, synthesize new ideas, and prepare a cogent argument in preparation for your Second Level Exam. This practical knowledge will aid you in developing the technical and soft skills that serve as a foundation for your future career as a professional scientist.

Assignments:

The course will meet six times throughout the Spring 2016 semester.

1. Rotation Presentations (3 min, 3 slides)
   Lecture: How to fail out of Graduate School in 15 min. or less
   Discussion of Mentor Selection

2. Discussion of Assigned Papers (each student has one unique paper)
   Lecture: Professionalism and Ethics

3. Presentation of a General Chemistry Concept (3 slides, 3 min.)
Group discussion of an assigned paper (all students discuss same paper)
Lecture: Discussion of Academic Structure

4. Group Analysis of Asst Prof CVs
   Discussion of CV/resume writing
   Lecture: Grant writing / review process

5. Teaching presentations
   Teaching best practices
   Discussion of a paper on an assigned topic (each student finds one paper on the topic)

6. Literature presentations (3 min, 3 slides based on 5 papers from at least 3 research groups)
   Lecture: Leadership skills

Grading: The course grade is based on in class participation.

Academic Honesty Academic dishonesty will not be tolerated. The CUNY Academic Integrity Policy and the Brooklyn College procedure for its implementation are available at:
http://www.brooklyn.cuny.edu/bc/policies
Evidence of plagiarism, or copying from others will result in a failing grade for the course, without exception.
Assessment Review of the PhD Dissertation
Chemistry Ph.D. Program, The Graduate Center, CUNY

The Learning Goals of the Ph.D. Program in Chemistry include the following with respect to the dissertation: students must make a substantial and original contribution to the field that includes publication of one or more first-author papers in peer-reviewed journals in addition to the preparation of a dissertation.

The Chemistry Ph.D. Program’s curriculum is designed to provide all students with training in writing and authorship. This training begins in the First Year when students are asked to read and critically evaluate the chemical literature. In the Project TEACH course, students are taught how to read the primary literature in a critical fashion. This foundation is used to read literature for their advanced courses, their literature seminar and Original Research Proposal (the latter two are part of the Second Level Examination). This introduction and exercises are used to set the expectation that our Program is preparing our graduates to write the literature.

Chemistry PhD students receive informal training in authorship from their research mentors starting in their Second Year of the program. Because quantity and quality of this training is highly variable between research mentors, the Ph.D. Program in Chemistry tries to supplement their professional development training with offerings from the Office of Career Planning and Professional Development, the Center for Teaching and Learning as well as outside events. The GC-sponsored events are poorly attended because chemistry students reside at the senior campuses for the majority of their careers at CUNY. The Ph.D. Program publicizes the free webinars presented by the American Chemical Society. The topics covered range from intellectual property rights to professional etiquette to science communication to authorship.

Writing abstracts, papers and research proposals is an important aspect of developing the skills necessary to write the dissertation. Chemistry PhD students write and orally present a report to their thesis committee each year. This exercise builds on their training in reading and writing. The chemistry Ph.D. Program’s Second Examination requires the writing and oral defense of an Original Research Proposal (ORP) as well. Students are familiarized with the proposal writing process in their first year, and some students may take a course in proposal writing in their second year. Chemistry offers its molecular biophysics subdiscipline students a course, Chem 87901 Molecular Biophysics, in which the students are instructed in the proposal writing process as a preparation for their Second Examination Original Research Proposal. The course is populated with Biochemistry Ph.D. students as well. Other chemistry students have taken BIOL 79303 Grantsmanship and Developing a Research Proposal. Both of these formal course offerings are well received and often aid in students receiving external fellowship support.
Table 1. Chemistry PhD Applicant Outcomes

<table>
<thead>
<tr>
<th>Year</th>
<th>Applications</th>
<th>Admitted</th>
<th>Enrolled</th>
<th>In Progress</th>
<th>PhD Graduates</th>
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<tr>
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<td>89</td>
<td>49</td>
<td>25</td>
<td>1</td>
<td>18</td>
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<tr>
<td>2009</td>
<td>95</td>
<td>42</td>
<td>24</td>
<td>1</td>
<td>16</td>
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<tr>
<td>2010</td>
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<td>43</td>
<td>24</td>
<td>8</td>
<td>9</td>
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<tr>
<td>2011</td>
<td>87</td>
<td>48</td>
<td>27</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>2012</td>
<td>78</td>
<td>38</td>
<td>23</td>
<td>19</td>
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</tbody>
</table>

**Outcomes:** We began our analysis of student outcomes with applicants for Fall 2008 admission, the first cohort of CUNY Science Scholars admitted to the PhD Program in Chemistry with a five-year support package. Since our average time-to-degree is six years, we terminate our analysis with students admitted in Fall 2012, five years ago. Table 1 above shows the data from admissions to completion of the PhD degree for years 2008-2012. The Program is receiving 86 applications, on average, and admitting 51% of these students to the Program. Of the admitted students, about 56% accept the offer of Admission, however, one student fails to matriculate because of immigration or personal issues. The data for 2008-2009 show that about 70% of enrolled students complete their PhD studies at CUNY. Most of the attrition seen in years 2008-2009 was due to poor academic performance with most failing out of the program without passing their First Level Examination. Attrition in years 2010-2012 appears to be higher and due to a greater number of students leaving the Program for personal reasons.

One hallmark of a substantial and original contribution to the field is the quality and quantity of a student’s publications. We analyzed the productivity of our PhD graduates in years 2012-2015, some of which were admitted to the Program without CUNY Science Scholarship support, i.e. before 2008. The data show that, on average, students publish 3.8 journal articles before their thesis defense and graduation. Our PhD students continue to publish beyond graduation with the average student publishing another 1.2 papers. We could not find national statistics on the publication records of Chemistry PhD graduates, but we feel that it might be about 5 for a top-50 ranked PhD Program. Thus, we feel that
our 3.8 value is likely low. We also think that many of the papers are being written by the student’s advisor and not by the student themselves. Thus, the student is not receiving sufficient training in authorship. What is more worrisome is the fact that our graduates tend to stop publishing after the completion of their PhD studies. This is due in part to the 25% that are working as adjunct instructors after graduation and those students who have progressed into industry jobs where publications are not desired. However, the majority of our PhD graduates move on to postdoctoral appointments where publications are expected. Thus, we feel that the relatively few that continue to contribute to the chemical literature is disappointing.

Proposed changes:

The PhD is a research degree and the dissertation and publications demonstrate the value of the graduate as an expert problem solver who can devise novel solutions to outstanding issues in the field of chemistry. The outcomes assessment provides factual data on the success of our students in gaining authorship skills relevant to their development as scholars. A review of these data suggests a couple areas of improvement so that we meet our learning goals. Specifically, these are increasing time in the research laboratory and scientific writing.

Increasing Time in the Research Laboratory: One factor that may limit the research productivity of our PhD students, and lengthen their time to degree, is the fact that they were not allowed to select a mentor until the end of their second semester due to research rotations. This late entry into the thesis research laboratory, relative to national norms, is believed to lengthen the time to degree and reduce publication output by our students in two ways. Research-ready students were prohibited from starting their thesis lab work until May of their first year as they were required to perform three research rotations in their first year. Starting in AY 2015-2016, the Chemistry Program has allowed first year students who have passed their first level examination, and have performed two research rotations at two distinct CUNY campuses to join the laboratory of their thesis mentor in January, rather than May. It is hoped that this change will decrease the time to degree and increase student productivity.

The PhD is a research degree and the Chemistry PhD Program has revised its curriculum to facilitate the progression of its students in the research lab. In conjunction with the changes to the timing of mentor selection, the Chemistry PhD Program has just implemented a new curriculum designed to achieve our learning goals with students taking a minimal number of classroom courses. The redesigned curriculum makes the number of courses taken by a student uniform across the program – in the prior curriculum a student was required to take between 6 and 8 courses depending on their chosen subdiscipline. This has been reduced to a uniform 5 courses, three first level courses plus two second level courses.
Scientific Writing: While the current and revised curriculum requires an Original Research Proposal as part of the Second Examination, practical training on this requirement is absent in the subdisciplines of chemistry with the exception of Chem 87901 Molecular Biophysics. The Ph.D. Program will model a courses on the successful Chem 87901 Molecular Biophysics and BIOL 79303 Grantsmanship and Developing a Research Proposal courses for the chemistry Ph.D. students. This course will provide students with the practical know-how to write effective research proposals for their Second Examination and for external fellowships and provide the foundational basis for their skills in writing their publications and dissertation.