External Reviewer Report for the Department of Chemistry
University of Hawai'i, Hilo
October 20-21, 2014

Thomas Poon
Acting President
Pitzer College
1050 N. Mills Ave.
Claremont, CA 91711

Professor of Chemistry
W.M. Keck Science Department
Claremont McKenna College, Pitzer College, and Scripps College
925 N. Mills Ave
Claremont, CA 91711

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Methodology

On July 24, 2014, Prof. Norbert Furumo, Chair of the Chemistry Department, contacted me with a request to serve as external reviewer for the Program Review of the Department of Chemistry. A subsequent official letter of invitation to serve was received in late August from Vice Chancellor Platz. I was then offered an opportunity to request meetings with individuals or groups of my choosing and was kindly obliged with a full 2-day's worth of appointments with administrators, faculty, students, and staff from the UHH community (Table 1). One week prior to the visit, I was provided with pdfs of the UH Hilo 2013 Program Review Guidelines, a draft of the 2014 Chemistry Program Review, and a quantitative data table of chemistry program enrollment and student statistics. Review of these documents generated questions that were then posed to the individuals in Table 1 (where possible, more than one individual was asked the same question). During the visit, I was also provided with additional documents from various individuals, such as (1) results from the Department's assessment of written communication, (2) undergraduate enrollment, degree, and majors data for the College of Arts and Sciences, (3) enrollment, degree, and majors data for the Division of Natural Sciences, and (4) retention data for various student cohorts (e.g., first-time freshmen, transfer students, etc.). I also requested curricula vitae of the Chemistry faculty and course syllabi from the Department's course offerings.

Table 1. Meeting Schedule for Chemistry Department External Review Visit

Time	Monday, October 20	Tuesday, October 21
8 am		
9 am	Ernie Kho (STB 318)	Marianne Takamiya (PHYS, STB 218)
10 am	Chem students (STB 305)	Pat Hart (BIOL, STB 119)
11 am	Matt Platz (VCAA)	Randy Hirokawa (Dean CAS)
Noon	Mazen Hamad (STB 314)	Simona Vaduvescu (STB 313)
1 pm	Mitch Anderson and Brian Wissman (MATH, CH8D)	Erica Honda, Stockroom Manager (STB 315)
2 pm	Natalie Crist (STB 316)	Donna Ohora, Library
3 pm	Seri Luangphinith (AOL, K Hall 214B)	Norbert Furumo (STB 319)
4 pm	Charles Simmons (STB 320)	Jon-Pierre Michaud (STB 317)

The opinions expressed herein draw from this author's experiences as a tenure-line faculty member at four different liberal arts institutions (concurrently at the most recent three institutions) since 1997, from 5.5 years of administrative experience, and from past and current literature on education and pedagogy. Considerable attention was given to the missions of both the University and the Department, the Academic Program Review Guidelines adopted by the Faculty Congress in Spring 2013, the draft of the Department's self study, the data provided to me during my visit, and my notes from meetings with individuals listed in Table 1.

The mission of the undergraduate degree program in chemistry, as indicated in the Program Review Self Study, is "to offer a general and specific set of courses in several areas in chemistry that will provide students within its majors a fundamental understanding, through qualitative and quantitative reasoning, of matter and energy and the changes that they undergo. The program is designed to prepare students for advanced degrees in graduate or professional programs and for students who are seeking to immediately enter the work force as teachers and technicians. Because few students major in chemistry, graduates tend to find options for further study and career opportunities."

The mission of the University of Hawai'i Hilo, as listed on the University website, is "to challenge students to reach their highest level of academic achievement by inspiring learning, discovery and creativity inside and outside the classroom. Our kuleana/responsibility is to improve the quality of life of the people of Hawaiʻi, the Pacific region and the world."

Taken together, these two missions might be represented as shown in Figure 1, which shows that the two missions can and should overlap to produce graduates who are competitive for the varied postgraduate options identified by the Chemistry Dept. mission.

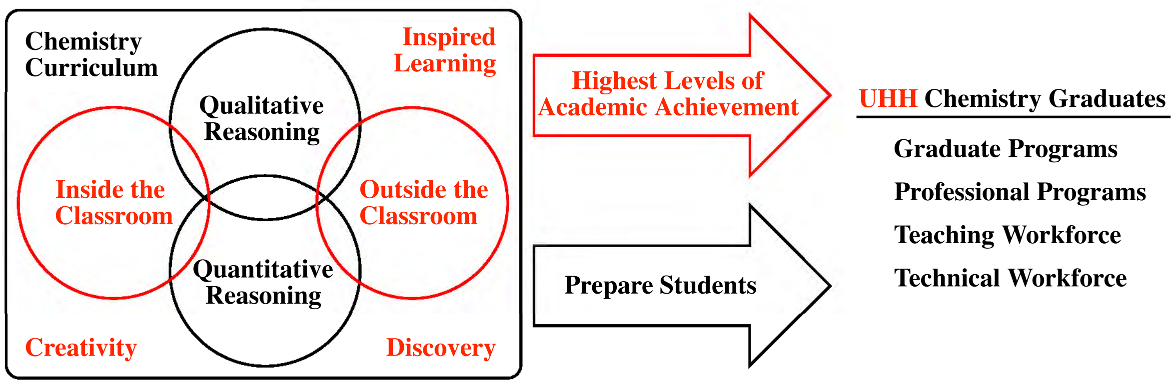

Figure 1. Graphical interpretation of University (red) and Department (black) Missions.

Additionally, WASC Accreditation Standard 2.7, which the UHH Academic Program Review Guidelines cites in its Preamble, states that the program review should include "analyses of achievement of the program's learning objectives and outcomes, program retention and completion."

Using the two mission statements and the WASC standard as a guide, I have identified several foci for this report. The foci are discussed below and include some suggestions for improvement. Synthesizing statements in this regard will be presented in **bold**, and references to published work or trends in a focus area are provided at the end of the document.

Introduction

I would like to express my appreciation to the students, faculty, and staff of the University for the cooperation, hospitality, and frankness they displayed during my 2-day visit to review the chemistry program. The visit was well planned and all participants, especially the chemistry faculty, staff, and students, appeared fully engaged in the review process.

Within the chemistry department, there is overall great enthusiasm for teaching from the tenured faculty, instructors, and educational specialists alike. There is also a general recognition of the retention issues and a concern for the success of the students in the program. Despite large class sizes, especially in the introductory chemistry courses, I witnessed faculty calling students by name and the acknowledgement of faculty by students. The department recently took occupancy of a new science building and appears to have taken advantage of the teaching spaces within. I noticed that the department chose to install tables and chairs in as many hallway spaces as possible to provide opportunities for students to study on the third floor of building and to encourage collaboration and cohorting among the students. It also became apparent from speaking with individual faculty that the department has a practice of taking all comers when it comes to courses required for the major (opening extra lab sections when needed), as well as in the service courses such as general chemistry and organic chemistry.

Faculty and instructors are passionate about their teaching, and some have utilized active pedagogies in their classes, such as the use of clickers and flipped/hybrid approaches, as well as incorporated novel uses of technology in their courses, such as the use of Notability as a digital whiteboard and as a way to provide students with lecture notes; LCD projection of one's ipad in the class to use ebooks with multimedia features; and the use of online resources (techniques videos, problems, and other content) to prepare students for general chemistry laboratory experiments. These approaches to teaching have the potential to improve student accessibility and learning, which could also have a positive effect on retention. The department is also to be commended for offering CHEM 124/124L and 125/125L in both semesters, providing students with flexible entree options into the major.

The department's facilities, aside from being new and modern, are also adequately suited to the program goals and mission. Student labs are well equipped and by all accounts, the stockroom manager, Erica Honda, is meticulous about laboratory preparation and laboratory safety. In fact, during my tours of the new building, I did not notice any safety issues. I do, however, have concerns about the existing chemical storage shed, which I was told is utilized by the entire institution (i.e. other departments, as well as chemistry) for chemical storage and chemical waste storage. I see the latter as problematic. There were unlabeled containers, inadequate ventilation, and very old samples that could pose safety hazards. **It is very important that these items be disposed of properly and not merely transferred to the new shed when construction is completed**.

Instrumentation, in terms of variety, is on par with or better than that of many chemistry departments I have seen. Through several tours of the facility I noticed the following instrumentation:

X-ray diffractometer	90 MHz NMR Spectrometer (nonsuperconducting)
Cary 5000 UV-Vis-NIR Spectrophotometer	Parr 1455 Solution Calorimeter
Agilent Dissolution Apparatus	Densitometer
Rotary Evaporator(s)	Bomb Calorimeter
Nanosurf Surface Scanner	Hydrogenator
Digital Polarimeter	Fluorimeter
Shimadzu UV-2450 Spectrophotometer	Gas Chromatograph
Surface Tensitometer	GC-MS
Constant Temperature Bath(s)	Infrared Spectrophotometer
Automatic Osmometer	HPLC
Parr 6200 Calorimeter	[There may be others I have missed]

The department is especially well equipped in terms of instrumentation for physical chemistry, and I will provide ideas and suggestions with regard to facilities and instrumentation in other sections of this report.

Chemistry students at UHH appear to have ample support available to them when it comes to obtaining tutoring in several STEM subjects. The University is to be commended for its Kilohana: Academic Success Center, which offers tutoring in writing, math, physics, marine biology, and chemistry (and perhaps other subjects?). The Center appears to be administered out of the library, but the tutoring for science subjects is strategically offered 4 days per week (M-Th) in the new Science building in STB 117, and on Saturdays in the main library. The hours for chemistry tutoring in STB 117 are very generous and easily accessible on the Kilohana website. If it is not already done, **usage of Kilohana tutoring should be tracked and the academic progress of students who use the service should be evaluated**. Such assessment could be used to support requests for further funding, drive programming, or expand tutoring options to other subjects. It could also be used as a benchmark to assess efforts to increase usage of the Center's services. In addition to tracking and evaluating users, the academic progress of *tutors* should also be assessed and disaggregated with regard to student demographic indicators such as diversity, major program, familial history of college attendance, etc.

Retention of Majors

Retention of STEM majors is a national problem, and most institutions are not immune from the trend that approximately 50% of all students who display an initial interest in majoring in STEM disciplines reach their goal; this percentage drops to just 25% for minority students (Chen et al., 2013; Hurtado et al., 2008). During this review process, I was shown data and impressed upon by many at the College that while the number of declared chemistry majors has increased by 87.3% since fall 2008, an increase from 55 declared majors to 103 declared majors, the number of graduates with chemistry degrees has fluxuated between only 3 to 10 in the same time period. Thus, the percentage of graduates relative to declared majors in any given year ranges from 5.1% to 12% and averages 7.7% from academic years beginning 2008-2013. These values are far below the national STEM retention numbers cited above. They are also below the institutional 6-year graduation rate reported to US News (36%), and it quickly became apparent from nearly every faculty member and administrator I met with that increasing the completion rate for chemistry majors must be a priority.

It is important to have context for why there is such a drastic increase in declared chemistry majors and why this has not resulted in an increase in chemistry graduates at UHH. With regard to the former, I was told by faculty and administrators that the main reason for the increase in declared chemistry majors was the opening of the Daniel K. Inouye College of Pharmacy (DKICP) in 2007, and the notion that many pre-pharmacy students find the Chemistry Health Sciences major an ideal pathway for completing their prerequisite courses for pharmacy school. Table 2 shows that this notion is valid, as 35 credit hours of prerequisite courses for DKICP are also required for the Chemistry Health Sciences major (indicated with *) and 24 credit hours of courses can be used to satisfy UHH's general education requirements (indicated with †). Thus, a Chemistry Health Sciences major would only need to take two extra courses, microbiology with lab and a communications course, to complete all of the requirements for DKICP's Pharm.D. program.

I was told by many whom I met that the reason why the increased numbers of chemistry majors has not resulted in a concomitant increase in chemistry graduates at UHH can be partially found in the fact that declared chemistry majors at UHH who go on to pharmacy programs before they graduate are not counted as degree earners. It is not clear whether these students are counted as withdrawals from the College of Arts & Sciences or whether the CAS tracks these students, as I was not provided with such information. However, **it is very important for the CAS to account for pre-bachelors pharmacy matriculants moving forward, especially if administrative decisions on departmental resources are to be made based on retention and degree completion numbers**. Such numbers could, in principle, be determined, by collaborating with the Registrar's Office to correlate official transcript requests to pharmacy schools, with students disaggregated by major, year in college, etc. Another possibility would be to conduct exit surveys for students who withdraw from the institution.

Table 2. Daniel K. Inouye College of Pharmacy Pharm.D. prerequisite courses‡

Required Prerequisite Courses	Semester Hours	Quarter Hours
General Biology I & II for Science Majors with Labs*	8	12
Microbiology with Labs	4	6
General Chemistry I & II for Science Majors with Labs *	8	12
Organic Chemistry I & II for Science Majors with Labs *	8	12
Human Anatomy & Physiology I & II with Labs *	8	12
Calculus 1 or Advanced Calculus *	3	4.5
English (including 3 credits composition)†	6	9
Humanities†	6	9
A course that includes a World/Cultural Diversity component†	3	4.5
Social/Behavioral Sciences†	6	9
Economics†	3	4.5
Communications (with a public speaking component)	3	4.5
Total Credit Hours	**66**	**99**

‡Taken from http://pharmacy.uhh.hawaii.edu/academics/pharmd/admissions.php. *Required for the Chemistry Health Science Major. †Required general education course.

The next table (Table 3) calculates the percentage of graduates relative to declared majors in any given year for select majors, as well as for the entire Natural Sciences Division (data provided by the Dean of CAS). It reveals two important facts; (1) that retention of majors is below the national STEM average in all departments shown, and (2) the Natural Sciences Division has a retention problem in general, with a 6-year average completion rate of 14.6%.

Based on this data, retention should be a concern *throughout* the Division of Natural Sciences since the highest average completion rate over six years among the major programs shown in Table 3 is 21% (for geology). However, chemistry, with a 6-year average completion rate of 7.7% (Table 3), is roughly 50% that of the 6-year rate (14.7%) for the Division. The department's relative placement on this list, especially in a period of growth with respect to numbers of majors, is a concern for nearly everyone I spoke with.

As a nationwide problem, retention in the STEM disciplines certainly has no easy solutions. However, there are several first-level steps that can be taken in an attempt to address the problem. All of these steps are potentially well suited to the strengths of the chemistry department, the resources available at the University, and the fact that a large number of UHH students are first-generation students and/or students of color.

Table 3. Percentage of graduates relative to declared majors (2008-2013).

Year		2008	2009	2010	2011	2012	2013	Average
Chemistry	Declared Majors	55	76	69	83	98	90	79
	Graduates	3	4	8	10	5	6	6.0
	% Completion	5.5	5.3	11.6	12.0	5.1	6.7	7.7
Biology	Declared Majors	213	238	273	259	233	220	239
	Graduates	28	20	32	27	33	32	28.7
	% Completion	13.1	8.4	11.7	10.4	14.2	14.5	12.1
Geology	Declared Majors	26	32	33	40	43	52	38
	Graduates	6	6	8	7	11	8	7.7
	% Completion	23.1	18.8	24.2	17.5	25.6	15.4	21
Physics	Declared Majors	17	17	22	26	28	27	23
	Graduates	4	3	8	4	2	3	4.0
	% Completion	23.5	17.6	36.4	15.4	7.1	11.1	19
Marine Science	Declared Majors	180	174	169	186	189	215	186
	Graduates	32	31	29	26	31	25	29.0
	% Completion	17.8	17.8	17.2	14.0	16.4	11.6	15.8
Mathematics	Declared Majors	45	55	54	52	49	47	50
	Graduates	7	8	8	7	8	6	7.3
	% Completion	15.6	14.5	14.8	13.5	16.3	12.8	15
Natural Science Majors	Declared Majors	1058	1149	1197	1202	1230	1230	1178
	Graduates	164	146	195	170	177	178	172
	% Completion	15.5	12.7	16.3	14.1	14.4	14.5	14.6

My first recommendation stems from findings which show that first-generation students often have acquired lower cultural capital than students who have at least one parent who has attended college (Espinoza, 2011). Cultural capital is defined as a set of dispositions, attitudes, and beliefs related to educational success that in upper class households (i.e., homes that have college-educated adults) are qualitatively different from that in lower-income households where adults frequently have low levels of education (Bourdieu and Passeron, 1977). As a result, first-generation students are much less likely to possess the study skills and help-seeking behavior that is needed to succeed in the sciences. During my visit, I had the opportunity to meet with senior and junior students enrolled in an upper level chemistry class (CHEM350). All of them were either chemistry majors or minors, and all of them were appreciative of many of the interactions and courses they took within the chemistry department. They were also invested in the success of the chemistry program and showed a concern for future generations of students. The institution and/or the chemistry department could utilize the sentiments and good will of these and future students by **creating a student mentor program staffed by upper level science students to help first and second year students navigate their first two years as UHH science students.** Each student mentor would be assigned to a small group of first year students and be responsible for introducing these students to the resources available to them such as Kilohana tutors in math, science, and writing courses, faculty office hours, the career center, and any programming that the mentoring program develops. Mentors would provide advice to students about developing good study habits, relay transferrable study skills, and serve as a resource to students with questions about navigating through a chemistry major or minor. Student mentors would be provided with an official title and a small stipend if possible. If stipends are not possible due to budgetary constraints, other cost-free incentives can be offered such as priority for registration for classes, priority for room draw, etc. Gershenfeld has published a review of undergraduate mentoring programs (Gershenfeld , 2014) and her article could be used for ideas and guidance in establishing this type of program, including methods for training the student mentors.

Degree and Curricular Offerings

The Chemistry Department offers two types of chemistry degrees. One is the B.A. in Chemistry and the other is the B.A. in Chemistry Health Sciences (Table 4).

Table 4. Comparison of Chemistry Major Requirements for the Two Departmental Major Offerings. Red text indicates a *de facto*, but unlisted, major requirement due to the course being a prerequisite for another course.

Chemistry Major (option 1)	Chemistry Health Sciences Major
Required courses from Chemistry (credit hours)	
CHEM 124–124L Chemistry I w/Lab (4)	
CHEM 125–125L Chemistry II w/Lab (4)	
CHEM 241–241L Organic Chemistry I w/Lab (4)	
CHEM 242–242L Organic Chemistry II w/Lab (4)	
CHEM 320 Descriptive Inorganic Chemistry (3)	
CHEM 333 Quantitative Analysis w/Lab (5)	
CHEM 351–351L Physical Chemistry I w/Lab (4)	CHEM 350–350L Physical Chemistry for the Life Sciences w/Lab (5)
CHEM 352–352L Physical Chemistry II w/Lab (4)	
CHEM 421 Intermediate Inorganic Chemistry (3)	CHEM 200+ Elective (3)
CHEM 431–431L Instrumental Analysis w/Lab (4)	
CHEM 495A–495B Seminar (2 semesters) (2)	
Chemistry Credit Hours = 41	*Total Chemistry Credit Hours = 38*
Required courses from related fields (credit hours)	
BIOL 175–175L Introductory Biology I w/Lab (4)	BIOL 175–175L Introductory Biology I w/Lab (4)
BIOL 176–176L Introductory Biology II w/Lab (4)	BIOL 176–176L Introductory Biology II w/Lab (4)
BIOL 270 Interm. Cell & Molecular Biology (3)	BIOL 270 Interm. Cell & Molecular Biology (3)
BIOL 410 Biochemistry (3)	
MATH 205–206 Calculus I-II (8)	
MATH 231 Calculus III (3)	
	BIOL 466 Genetics (3)
	BIOL 243–243L Human Anat. & Phys. I w/Lab (4)
	BIOL 243–243L Human Anat. & Phys. II w/Lab (4)
PHYS 170–170L General Physics I with Lab (5)	PHYS 106–170L College Physics I w/Lab (4) **or** PHYS 170–170L General Physics I w/Lab (5)
PHYS 171–171L General Physics II with Lab (5)	PHYS 107–171L College Physics II w/Lab (4) **or** PHYS 171–171L General Physics II w/Lab (5)
Non-Chemistry Credit Hours = 24 (35)	*Non-Chemistry Credit Hours = 37 (41) - 39 (43)*
Overall Credit Hours for Major = 65 (76)	*Overall Credit Hours for Major = 75 (79) – 77 (81)*

Some features stand out in comparing the two majors. First, both majors contain hidden requirements due to the fact that BIOL410, biochemistry, has BIOL175 and BIOL270 as prerequisite courses. Further, BIOL270 has BIOL175 and BIOL176 as prerequisites. Such hidden requirements may not pose a problem for students who know how to navigate the system or who have advisors who hammer home the message. However, students with lower cultural capital (as described earlier) may be less inclined to spot these requirements in time, potentially leading to delays in completing their degrees or the need to switch majors due to timing concerns. **I recommend that the courses from Table 4 that are coded in red be added to the official list of courses required for the major.** Full disclosure of major requirements would better help students to plan their curricula and avoid scheduling snafus, which could, in turn, contribute to the retention problem.

One factor that became clear in my discussion with the students is that the absence of a B.S. degree option is a deterrent to students choosing to major in chemistry. Students felt that both chemistry degree options are just as rigorous and require as many courses as some of the B.S. degrees offered at UHH such as astronomy, marine science, and cellular and molecular biology. Table 5 compares the chemistry B.S. degree option at U.H. Manoa with the two chemistry major options at UHH.

Table 5. Comparison[*] of B.S. Chemistry degree at UH Manoa with UHH B.A. Chemistry degrees. Courses in red are hidden requirements (see Table 4).

UH Manoa Chemistry B.S.	UHH Chemistry B.A. (option 1)	UUU Chemistry Health Sciences Major
CHEM 161/161L (4)	CHEM 124–124L (4)	CHEM 124–124L (4)
CHEM 162/162L (4)	CHEM 125–125L (4)	CHEM 125–125L (4)
CHEM 272/272L (5)	CHEM 241–241L (4)	CHEM 241–241L (4)
CHEM 273/273L (4)	CHEM 242–242L (4)	CHEM 242–242L (4)
CHEM425/425L (5)	CHEM 320 (3)	CHEM 320 (3)
CHEM274/274L (5)	CHEM 333 (5)	CHEM 333 (5)
CHEM 351 (3)	CHEM 351–351L (4)	CHEM 350–350L (5)
CHEM 352/352L (5)	CHEM 352–352L (4)	
CHEM 427 (3)	CHEM 421 (3)	
	CHEM 431–431L (4)	CHEM 431–431L (4)
	CHEM 495A–495B (2)	CHEM 495A–495B (2)
CHEM 445/445L[†] (2)		CHEM 200+ Lvl Elective (3)
CHEM Upper Lvl Elective (3)		
CHEM Upper Lvl Elective (3)		
BIOL 171/171L (4)	BIOL 175–175L (4)	BIOL 175–175L (4)
	BIOL 176–176L (4)	BIOL 176–176L (4)
BIOL 275/275L (4)	BIOL 270 (3)	BIOL 270 (3)
CHEM 372 (3) or BIO 402 (4)	BIOL 410 (3)	BIOL 410 (3)
MATH 241-242 (8)	MATH 205–206 (8)	MATH 205–206 (8)
MATH 243 (3)	MATH 231 (3)	
		BIOL 466 (3)
		BIOL 243–243L (4)
		BIOL 243–243L (4)
PHYS 170/170L (5)	PHYS 170–170L (5)	PHYS 106–170L (4) or PHYS 170–170L (5)
PHYS 272/272L (4)	PHYS 171–171L (5)	PHYS 107–171L (4) or PHYS 171–171L (5)
Total Courses[‡] = 20	*Total Courses[‡] = 19.66*	*Total Courses[‡] = 20.66*
Total Cr. Hrs = 77-78	*Total Cr. Hrs. = 76*	*Total Cr. Hrs. = 79-81*

*Analogous courses are placed in the same row. [†]Advanced organic synthesis and analysis with lab. [‡]Labs and lectures counted as one course. The two chemistry seminar courses (CHEM 495A/B) were counted as 2/3 of a course.

The data shows that the chemistry major (option 1) at UHH is just shy of the 20 STEM courses and 77-78 credit hours that constitute the B.S. major at UH Manoa. Furthermore, the current chemistry health sciences major at UHH has slightly more coursework by course count and by credit hours than the B.S. major at UH Manoa. Also, I referred to the UHH website for the B.S. Biology degree-cellular and molecular biology track and saw that it's requirements total 19.66 total courses and 80 credit hours. It would thus appear that the students I spoke with were correct; both chemistry degrees are roughly equivalent to a B.S. degree, with the chemistry health sciences option definitively meeting similar course count and credit hour standards of at least two B.S. degrees offered at UHH and at UH Manoa. It would be both attractive and a significant advantage to students in the chemistry program if at least one of the chemistry major options was offered as a B.S. degree, and **I strongly recommend that the department take the appropriate steps to convert the chemistry health sciences degree to a B.S. option**. Of course, I know little beyond little bits of information I heard regarding the process required to propose and pass such a change, but from a curricular standpoint, it appears that the health sciences option would require little to no change to justify the switch (whereas option 1 of the chemistry major might require the addition of an extra course). It is also the equitable and fair thing to do for the students in the major, and could potentially help with employment and graduate school opportunities after college.

An additional reason for the above suggestion is so that the department can show the rigor in its majors. During my visit, faculty expressed varying opinions with regard to the department's recent surge in majors. It was noted that most of the students who major in chemistry have chosen the health sciences option. I got the sense that some faculty (both within and outside of chemistry) view this as a less rigorous major. One faculty member repeatedly referred to the Chemistry (option 1) major as the "real" chemistry major, implying that the Health Sciences option is not a "real" chemistry major. This sentiment was not lost upon the students with whom I met with. Some of them expressed concerns that Chemistry Health Sciences students are not equally valued by a particular faculty member. It became apparent to me during my discussions with the students, only one of which was an option 1 major, that they felt intimidated by one faculty member and avoided majoring in chemistry altogether, at least in part, to avoid taking classes with this faculty member. The students, of course, were very diplomatic and did not reveal the identity of the faculty member, but the fact that students notice a discord in the department around the curriculum drives home my next recommendation, which is to **suggest that the department approach its curriculum with a united front if it wishes to retain its majors and attract new students.** The message that students get from faculty needs to be consistent, and it needs to be welcoming. Only then, will the department have any chance of capturing and retaining its students.

A related action the department might consider is to **change the name of the Chemistry Health Sciences major**, especially if it is not seen as a "real" chemistry major by members of its own faculty. The Health Sciences option represents an interdisciplinary major, and many disciplines are quickly becoming cognizant that, in this day and age, interdisciplinarity in science can potentially reap very real benefits (Larivière, 2011). Table 4 shows that (1) the Health Sciences option has just 1 less chemistry course in its curriculum than the option 1 major, and (2) that it has 3-5 additional credit hours worth of STEM courses than the option 1 major. Thus, the notion that the Health Sciences option is not a rigorous major is misconceived. Another reason for suggesting a name change is that for those students who do not intend to go to a health professional school after UHH, the words "Health Sciences" in the title of the major may cause potential employers or graduate school committees to characterize the degree as a tailor-made pre-health degree with the primary purpose of preparing students to apply to medical, pharmacy, dental, and similar professional schools. Whether or not this is the case, the perception may have the unfortunate effect of reinforcing the myth that the degree program is not rigorous, or is science-lite. Examples of some names that might more accurately reflect the curriculum include: Chemical Biology, Chemistry-Interdisciplinary Track, Chemistry-Biology, and Chemistry-Biosciences Track.

Another curriculum-related topic that was discussed was whether the department should apply for program approval by the American Chemical Society (ACS). This is would be a worthwhile goal that would bring external validation to the Chemistry Program, and as with the B.S. degree option described above, enhance a graduate's credentials and post-graduate opportunities. There are many items in place within the Program that would position it for ACS approval. As I indicated above, the department possesses a commendable list of chemical instrumentation. According to UHH faculty I spoke with, access to a high field NMR for research purposes could be arranged through DKICP, and represents a pathway to access that sometimes satisfies the ACS Committee on Professional Training. The library resources for chemistry are also sufficient to satisfy the ACS. The department has more than the minimum number of chemistry faculty in the appropriate subdisciplines, and the faculty also have the depth and breadth of course offerings for an ACS approved major. The only issue I see with regard to course offerings is the fact that three of the major courses, CHEM352, CHEM352L, and CHEM421, have not been offered on a regular basis. The department needs to discuss the reasons for this and address the issues that exist including, if necessary, including the Division Chair and Dean of Faculty in such discussions.

There are, however, some areas that the department will need to shore up before ACS approval can become a reality. The ACS Guidelines for Bachelors Degree Programs (American Chemical Society, 2008) requires that departments have resources for capital equipment acquisition and replacement along with the expendable supplies required for high-quality laboratory instruction. It was not clear to me, from the budget information I was provided, that this is the case. In fact, despite substantial *increases* in SSH (25.6%) and declared majors (69.1%) since 2008-09, the overall departmental budget has *decreased* by 23.1%. I was informed by one department member that the operating budget for chemistry is approx. $12,000. **The department absolutely needs a larger budget to provide modern laboratory experiences for its students, and to implement some of the suggestions from this report.**

Another requirement is the minimum 400 hours of laboratory instruction that students with ACS approved majors must experience. I was not provided with all of the syllabi for course offerings in the department, so I am unable to determine if this requirement is met in the Program. Many ACS approved chemistry programs count student research with faculty towards this minimum requirement (up to 180 of the 400 hours are allowed to be from undergraduate research experiences). **I recommend that the department review the ACS Guidelines and meet as a group to discuss the requirements for ACS approval**. Whether or not the department wishes to eventually apply, seeing and discussing the standards that our professional organization sets for undergraduate chemistry degree programs could inform the department in myriad ways for future planning of the curriculum, staffing, facilities, and activities of the department.

<u>Student and Faculty Research and Professional Development</u>

Many of the science faculty with whom I spoke were or currently are research active. It appears that many of the chemistry faculty, who are all tenured, were able to publish and engage in scholarship during the probationary period prior to earning tenure. However, there seems to be a sentiment among the UHH science faculty (with whom I spoke) that there is very little time for research, especially research with students, and furthermore, that such activities are not valued or rewarded by the institution. This is unfortunate, because research with undergraduates is now a standard expectation at competitive science programs at 4-year, primarily undergraduate institutions (PUIs). Some institutions incentivize these activities for faculty by providing teaching credit/course releases*, stipends in the summer, or additional consideration in promotion and tenure cases. Furthermore, many faculty with active research programs at PUIs have structured their research to take advantage of student contributions, much like faculty at research universities depend on the research done by their graduate students. In the UHH chemistry department, I learned that an additional perceived barrier to faculty research productivity is the lack of research space in the science building. However, during my tour of the facilities, I noticed several lab spaces that held instruments and equipment, and it appeared to me that several of these spaces could indeed be utilized for faculty research. **I recommend that the department think strategically about how to reapportion instrumentation so that either (1) one or two of the smaller lab spaces can be dedicated to faculty for research, or (2) the courses that utilize the spaces do so in an efficient way that frees up space for research during certain days of the week, whole stretches of a semester, or whole semesters**. The teacher-scholar model is crucial to faculty vitality. Even at teaching-focused institutions, faculty research informs and enhances faculty teaching. And, of course, it provides students with very important opportunities to learn and distinguish themselves. Research with faculty is also a high-impact practice that increases retention. For a science department that is seeing very low completion rates in the major, incorporating a student research component is one of the most effective means for capturing and retaining majors that one can adopt.

With only five tenure-line faculty, it is not practically possible to provide research experiences in-house to the 90+ majors that the department is currently serving. But that does not mean that the department shouldn't strive to provide their students with such opportunities. In addition to my suggestion above for reapportioning laboratory instrumentation and spaces, I have three more suggestions for increasing the number of research opportunities for students. The first is purely an advising and mentoring initiative. I learned that 7 of the 13 students I spoke with had participated in undergraduate research. Some of these experiences were through working with faculty in their majors (which were in all but one case in a department other than chemistry). Another source of these experiences was through summer research experiences at other institutions (e.g. NSF REU opportunities). The fact that UHH has the most diverse student body in the nation and a significant number of students from low-income families, UHH science students would be *very* competitive for NSF REU and other fellowship experiences. In fact, many of these programs specifically target underserved college students. **The chemistry department should advertise and promote these experiences to its students very early on in their academic careers (many accept first-year applicants)**. More than that, however, **the department should establish more proactive support to encourage and help students to apply for these opportunities** because, as I indicated earlier, many first-generation students lack the cultural capital to pursue these endeavors on their own. This support can be provided by faculty or, for example, faculty can train student mentors to provide assistance. Kilohana Services might even be asked to devote a portion of its chemistry programming to such activities. Programming like this has the potential to increase retention and

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* It should be noted that UHH does, in fact, provide incentives for faculty to pursue their scholarship. I was informed that the normal teaching load in the science division is 4-4, but that tenure-line faculty are eligible for a 3-3 load if they are research active.

attract students to the major, especially if chemistry leads the way in the Science Division in offering such support. In the appendix, I attach a list of summer opportunities that I promote to students in my chemistry classes for your reference.

The next suggestion I have for providing research (or research-like) opportunities for students does require a curriculum change, and it has to do with the seminar courses (CHEM 495A and 495B) that the department offers in conjunction with the physics, geology, and astronomy departments. The sense I got from the faculty is that because the courses enroll students from different majors, the level of chemistry that the students cover, perform literature research on, report on, and present on does not, by necessity, contain very much chemical depth. **I recommend changing the major requirement such that one of these seminar courses is offered in the fall of the junior year for chemistry and chemistry health sciences majors only. I then recommend changing the emphasis of the course to proposal writing**. One possible way to structure the new course is to have students peruse the NSF REU site, which has hundreds of research opportunities, and select one faculty project to research and write a mini-proposal on. Structuring the course in this way has several benefits. First, the course would be writing intensive and could satisfy the upper level writing G.E. of the university. Second, students would have picked out an REU project that interests them and have already written a proposal that can then be modified to constitute their application to that very same REU program. Students would gain valuable chemical knowledge and disciplinary writing skills, which would serve them well in upper level chemistry courses that they take later on, including the second seminar course which could remain the same or also be changed. And, again, this could serve to capture and retain more students to the major.

Another possibility for increasing research opportunities for students and for promoting a faculty member's research agenda is to offer a lab-based research course required of all majors. The course could be taught on a rotating basis and be structured so that students learn about and do experiments that fall under a faculty member's disciplinary interests. Over time (or even within one semester), enough research results could be generated to serve as preliminary data for a grant or the basis for a research paper.

It is also important to **celebrate the research accomplishments of students (and faculty)**. I saw research posters by faculty and by faculty with student co-authors hung within the halls of the new science building. An organized research presentation day or a publication of activities distributed to the Division or entire UHH Community would symbolically elevate the importance of research on campus, and provide students and faculty alike with a point of pride in their accomplishments. Research with undergraduates is often cited by faculty at PUIs as one of the most rewarding experiences in their careers. While there are some barriers to doing this at UHH, creating an environment within the department for such activities would potentially pay dividends for both students and faculty alike.

Assessment of Student Learning

In this section of my report, as per the UHH Program Review Guidelines, I include an evaluation of the department's assessment efforts. WASC expects institutions to engage with assessment at the course level, program level, and institutional level, and for faculty to be involved at all of these levels.

With regard to the department's engagement with course level assessment, I was provided a total of 22 syllabi in electronic format via email from two instructors and three tenure-line faculty. The

19 unique courses that were represented are listed in Table 6. The department did a great job in providing me with syllabi for a majority of the courses required for the two chemistry degrees (missing are CHEM351, CHEM351L, CHEM352, CHEM352L, CHEM421). As the table shows, 31.6% of the courses do not have student learning outcomes. However, for those courses that do have learning outcomes, only two had outcome statements that might prove difficult to measure. These include statements such as, "To gain an increased sense of wonder and amazement," "To learn enough chemistry to help you do well in: physiology, pharmacology, nursing, agriculture and nutritional sciences and to become at least semi-conversant in organic & biochemistry," and "ability to apply the principles of analytical chemistry to personal lives and to academic, research, and work-related interests." While statements such as these are lofty and desirable, they would be very difficult to measure using known metrics. **I recommend taking these statements out of the "Learning Outcomes/Objectives" sections of the syllabi (perhaps moving them to a different section) and replacing them with measurable outcomes**.

I did not see much evidence of departmental efforts to actually *assess* the individual course learning outcomes, although the potential is there because many professors administer an ACS standardized exam in his or her course. **The next step for the department with regard to course level assessment would be to code particular questions from these exams to their stated learning outcomes and to analyze student performance in this regard**. In addition, **learning outcomes should be added to courses that currently do not have them**.

Table 6. List of Course Syllabi Reviewed and Evaluation of Learning Outcomes*

Course Number	Some form of Learning Outcomes Listed?	Outcomes Easily Measurable?
AG215	Yes	Yes
CHEM114	Yes	Yes
CHEM114L	Yes	Yes
CHEM124	Yes	Yes
CHEM124L	No	NA
CHEM125	Yes	Yes
CHEM125L	No	NA
CHEM141	Yes	No
CHEM241	No	NA
CHEM241L	Yes	Yes
CHEM242	No	NA
CHEM242L	No	NA
CHEM320	Yes	Yes
CHEM333	Yes	No
CHEM350	Yes	Yes
CHEM350L	Yes	Some
CHEM360	No	NA
CHEM431	Yes	Yes
CHEM431L†	Yes	Yes

*Items in red represent course syllabi that either do not contain some form if learning outcomes, or contain learning outcomes that would be very difficult to measure. †Lab syllabus combined with CHEM431 class syllabus.

I did not see evidence of program level assessment within the department except, of course, through this external review. **One way that the department can conduct some level of program level assessment is to determine learning outcomes for the majors that they offer.** Then they can perform an analysis on which courses help students to achieve particular outcomes. For example, at my institution, the chemistry faculty have identified the following learning outcomes for the biochemistry major:

Graduates in biochemistry will:

1) be able to apply knowledge of chemistry and biology to solve biochemical problems,
2) possess a breadth of knowledge in organic, physical, and bio-chemistry, as well as genetics, molecular biology and cellular biology,
3) be able to identify, formulate and solve complex biochemical problems,
4) read and understand original research
5) be able to design and conduct experiments,
6) have a mastery of techniques and skills,
7) be able to communicate results and findings.

We then subsequently created a matrix (Table 7) with these outcomes and all of our courses in the major and determined which courses achieve the desired outcomes of the major. Note that it is common for courses to only achieve some of the 7 major outcomes.

Table 7. Sample learning outcomes assessment matrix for the biochemistry major at this reviewer's institution.

Course	**Apply Knowledge of chem, & biology to solve problems**	**Breadth of knowledge in physical , organic, & biochem, genetics, cell & molecular biology**	**Identify, formulate, & solve complex biochemical problems**	**Read and understand original research**	**Design & conduct experiments**	**Mastery of techniques and skills**	**Communicate results & findings**
Chem 14L	X	X	X		X		X
Chem 15L	X	X	X		X		X
Bio 43L	X	X	X		X		
Bio 44L	X	X	X		X		X
Chem 116L	X	X	X				
Chem 117L	X	X	X				
Chem 121	X	X	X				
Chem 122	X	X	X				X
Chem 126L	X	X	X		X	X	X
Chem 127L	X	X	X		X	X	X
Bio 143	X	X	X	X			X
Bio 157L	X	X	X	X	X	X	X
Bio 170L	X	X	X	X	X	X	X
Chem 177	X	X	X				X
Chem 188L	X	X	X		X	X	X
Chem 190L	X	X	X		X	X	X
Chem 191L	X	X	X				X
Chem 199L	X	X	X		X	X	X

Then on each course syllabus, we identify the activities that evaluate students' levels of achievement of these outcomes. Table 8 is an example of this identification process for our CHEM14L course (general chemistry with lab).

Table 8. Example of major level outcomes correlated to metrics/activities in CHEM14L, a course taught in this author's chemistry program.

Objective	Homework	Exams	Laboratory
Identification, Formulation, and Solution of Complex Problems	√	√	
Design and Execution of Experiments			√
Communication of Results and Findings			√
Acquisition of Techniques and Skills			√
Breadth of Knowledge	√	√	√

The preceding is but one example of what departments can do for program level assessment that, at least for my institution, WASC has found acceptable.

Finally, we turn to institutional level assessment. I learned from UHH's ALO that departments were asked to assess the institution's core objective for written communication that is expected of all institutions. Based on my understanding, each department was asked to select one course that fulfilled UHH's upper level written communication requirement and assess the writing assignments from the course using a rubric provided by the ALO. I was provided with the rubric and found it to be appropriate and similar to rubrics that many institutions use for assessing student writing. The department chose to assess the major-required course CHEM 431, which had 12 students enrolled. The papers were assessed for "line of reasoning, organization and structure, content, and language/prose/syntax." I found that the assessment of the papers from this course lacked the rigor in assessment that WASC would like to see. First, only one faculty member participated in the evaluation of the papers. Second, the evaluator was the instructor of the course. Best practices in assessment/evaluation recommend that (1) papers be evaluated by at least two evaluators, (2) names and scores that students received on the paper be removed, and (3) the evaluation process undergo a norming procedure so that evaluators are approximately on the same page with respect to beginning, emerging, competent, and advanced characteristics of each category. **I recommend that future assessments be done using the guidelines set forth by the ALO/Assessment Office**.

While I am on the topic of UHH's written communication requirement, **I would like to suggest that the department consider applying for other courses to count for the institutional written communication requirement.** This suggestion is based on student comments I received during my meeting with students. They pointed out that some courses in chemistry satisfy the written communication requirement, while other courses do not, even though they have similar or even greater amounts of writing by students and critique of writing by faculty. Offering more courses that satisfy the requirement, especially if doing so only requires making the case to the appropriate committee that these courses already satisfy the requirement, would create more opportunities for students to satisfy the requirement and thus have more choices with respect to overall course selection.

Final Thoughts

The chemistry department has experienced tremendous growth, has a new building it shares with other science departments, and is staffed by faculty, instructors, and support staff who are passionate about their teaching and care deeply for their students. These and the many other positive characteristics highlighted in this report situate the department well to increase their retention, provide invaluable experiences and opportunities for their students, enhance their curriculum, and become a leading department within the College of Arts and Sciences at UHH. It is important to underscore and reiterate that the key to achieving these endeavors, should the department decide to take on these challenges, is the capture and retention of the students that are served by the department. Nearly every suggestion I've provided in this report is targeted at the retention issue. This includes assessment, as well, because the department needs to know whether it is achieving its goals before it can know which areas need the most attention. There are many other suggestions I could have made and elaborated on such as (1) tracking and developing a lasting relationship with chemistry alumni, (2) providing more opportunities for chemistry faculty, from a scheduling standpoint, to attend the various professional development seminars that are held around teaching and pedagogy, (3) ramping up efforts to apply for external funding both for research and curricular projects, (4) increasing the efforts the department has already begun to collaborate with faculty from other departments, with a particular emphasis on departments that also serve chemistry students (e.g. mathematics, physics, and biology), and (5) providing the administration with data driven proposals for increased support and funding.

I wish the department and the University all the best in its efforts "to challenge students to reach their highest level of academic achievement by inspiring learning, discovery and creativity inside and outside the classroom."

References

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Appendix

Copy of a Handout listing summer opportunities for students enrolled in this author's organic chemistry course.

CHEM116L KS Dr. Poon

Summer Research and Other Opportunities (start looking over the break *or sooner*)

A) National Science Foundation Summer Research Programs (Deadline: varied)
http://www.nsf.gov/crssprgm/reu/reu_search.cfm
Click on a topic under "Search for an REU Site" to search by research area (e.g. chemistry, biology, etc.)

B) National Institutes of Health Summer Internships in Biomedical Research (Deadline: February 15)
http://www2.niddk.nih.gov/OMHRC/OMHRCResearchTrainingForStudents/OMHRCStudentTraining.htm

C) Keck Science Summer Research Fellowships (Deadline: Early February)
http://www.jsd.claremont.edu/Research/SummerResearch.asp
Provides information on the types of research opportunities offered in the summers here at JSD.

http://www.jsd.claremont.edu/Research/ReseachInterest.asp
Lists the research areas of JSD faculty members. The front office has a more descriptive list of research projects for each faculty member. To get the process started, speak to one or more profs. regarding their availability this summer and whether they are accepting students into their research groups. The best way to start the conversation is to say "Dr. NNN, I saw the type of research that you do on the web/research projects list/other and I was wondering if I could talk to you about research opportunities in your group?"

D) SCI Scholars — Industrial Internships for Chemistry and Chemical Engineering Undergraduates (Deadline: December 15)
http://www.acs.org/sci

E) Mayo Clinic Summer Undergraduate Biomedical Research Fellowships (Deadline: Feb 1)
http://www.mayo.edu/mgs/surf.html

F) Summer Medical & Dental Education Program (Deadline: available Nov. 1…..appears to be rolling)
http://www.smdep.org
Six-week programs available around the country designed to prepare and familiarize students with professions in medicine or dentistry.

G) DeBakey Summer Surgery Program (Deadline: applications are accepted from Oct 1 through mid-January)
http://www.bcm.edu/surgery/summersurgery
Eight-week program at Baylor College of Medicine in which participants are assigned a surgery faculty mentor.

H) Gerstner Sloan-Kettering Summer Undergraduate Research Program (Deadline: Feb 1...but sooner is better)
http://www.sloankettering.edu/gerstner/html/54513.cfm
Research in biomedically related sciences.

I) Amgen Scholars Program (Deadline: Feb 1...for most of the institutions)
http://www.amgenscholars.com
Research at one of several top-notch universities sponsored by Amgen, one of the most well-known biotech companies.

J) Fred Hutchinson Cancer Research Center Summer Undergraduate Research Program (Deadline: Jan 18)
http://www.fhcrc.org/en/education-training/undergraduate-students.html
Research at this world-renowned life sciences research center. Research areas include basic science, human biology, public health, clinical research, vaccince and infectious disease.

K) Volunteering

http://www.volunteermatch.org/ Great website for finding volunteer opportunities anywhere in the world.
http://www.projects-abroad.org/projects/ Volunteer opportunities *abroad* in various fields

L) Other Internship or summer job opportunities
Visit your College's Career Counseling Center and let them know what you are looking for (they may know alumni/alumnae who can provide you with some great opportunities). Utilize any and all family, friends, or other contacts for research, job, or shadowing opportunities.

http://rusk.med.nyu.edu/about-rusk-health-career-opportunity-program

GOOD LUCK!

(Please visit http://ochem.jsd.claremont.edu/tp_letters.htm before asking Dr. Poon for a letter of rec.)