

Chemistry Periodic Program Review Follow-up Report

1) Mapping core concepts and skills

The Chemistry Curriculum Committee has established a working document to map the core concepts and skills in the Chemistry program. As this is a working document, we feel free to add and subtract items from it and to modify the document as we make changes to our courses. To date we have mapped many of the core concepts important to chemistry to the first year general chemistry courses (CHY 103 and CHY 113) as well as the introductory courses in each of the five core specialties of chemistry, analytical chemistry (CHY 213 and CHY 223), biochemistry (BCH 261), inorganic chemistry (CHY 334 and CHY 449), organic chemistry (CHY 142 and CHY 242), and physical chemistry (CHY 381 and CHY 382).

Our mapping exercise has identified that intermolecular forces is not formally included in the general chemistry curriculum, yet is built on in the courses that follow from this. The instructors are discussing ways to include this concept in general chemistry in a meaningful way.

Our mapping also revealed gaps in designing experiments as well as oral and informal communication skills in the courses that were mapped. Some of these skills are developed in other courses later in the curriculum that have not yet been mapped. However, we are also discussing ways to bring some of these communication components into the foundational courses in a manageable way. This can be challenging with particularly large courses such as the general (first year) chemistry courses.

We will be extending this mapping to upper year core and elective chemistry courses as well as using this mapping to refine the offerings in our courses. We have identified general chemistry, analytical chemistry and inorganic chemistry as courses on which to focus our initial redevelopment efforts. The maps are presented in chart form at the end of this document.

2) Analysis of entrance requirements

The First Year and Common Science Office and the Associate Dean of Undergraduate Programs in the Faculty of Science have begun a preliminary assessment of the academic backgrounds of incoming science students to determine indicators which could help identify students that could most benefit from early intervention strategies and/or additional academic support. In Winter 2015, the Office of the Registrar provided background information and standing data for incoming students in the 2013-2014 and 2014-2015 academics years.

A number of potential academic indicators were examined to determine if there were factors in a student's high school background that would suggest the need for additional academic

support. Recognizing that there may be non-academic factors which could not easily be summarized by academic statistic alone, a wide variety of academic factors were examined including:

- number of high school (grade 12U) science courses taken
- number of high school (grade 12U) math courses taken
- average grade in high school (grade 12U) science courses
- average grade in school (grade 12U) math courses taken
- average grade in individual math or science courses
- combination of specific high school (grade 12U) math and science courses taken
- Average of Best 6 High School Courses

The only statistical category that appears to have a difference in determining whether or not a student will remain on Clear academic standing throughout their first 3 academic terms was the overall Best 6 Courses Average. No matter which program students were accepted into in the Faculty of Science, students with an incoming Best 6 Course Averages of 85% or better were much less likely to end up on Probation or Required to Withdraw by the end of their third academic turn.

Unfortunately for the Chemistry Program only 3 students with incoming best 6 course averages over 85% enrolled in the Chemistry Program in Fall of 2013, and none of the incoming averages were above 90%. A slight improvement was noted in Fall 2015 where 11 students coming into the Chemistry Program had averages of 85% (with 2 having averages of over 90%).

In order to attract more students with Best 6 Course Averages above 85%, the FYCSO and Associate Dean's Office will be exploring the possibility of targeted recruitment and outreach activities in order to increase the number of students with 85% or greater Best 6 Course Averages that list Ryerson's Chemistry Program in their Top 3 desired programs which is expected to lead to an increase in the number of these students which enroll in the program.

3) Registration by cohort

Rationale: In October 2014, Dr. Andrew McWilliams of the First Year and Common Science Office (FYCSO) attended the Academic Impression Conference on the First Year Student Experience. Many of the program recommendations given during the conference for improving the first year experience for students entering university are already in place at Ryerson University for students entering the first year of programs within the Faculty of Science including student mentor programs (i.e. Trimentoring and RyeSciMatch), continuing orientation programs throughout the Fall term (i.e. SCI180 Orientation), peer-led study groups (i.e. Student Learning Groups and Math Centre activities) and personal and career counseling. One practice which is currently absent from Science Programs at Ryerson University that has been shown to aide in

the success of first year students is the practice of cohort registration, the practice scheduling of groups of students from the same academic program into the same sections of required courses.

The FYCSO believes that the common nature of the required courses in each of the Chemistry, Biology, and Medical Physics, and Undeclared Science programs should help to facilitate the cohort registration of students within each of the Science degree programs, providing students with a sense of community that would continue throughout their undergraduate program and promoting student success. While it would be ideal to allow a pilot that involves as many of these degree programs as possible, an initial pilot project involving two programs was proposed for the 2015-2016 academic year to evaluate how a cohort registration approach would potentially impact the scheduling and registration process.

Pilot Project Description: 22 incoming chemistry students were selected randomly selected to participate in a Cohort Registration Pilot Project in the 2015-2016 academic year. In Fall 2015, these selected students were all enrolled in common lecture, tutorial and laboratory sections for all 5 required first term courses in the program (BLG143, CHY103, CPS118, MTH131, and PCS 120). In the Winter 2016 semester the same selected students were enrolled in common lecture, tutorial and laboratory sections for all 4 required second term courses in the program (BLG 144, CHY 113, MTH 231 and PCS 130). Students were notified that they were part of the cohort pilot project in both semesters.

As a part of the pilot project, surveys would be administered to the relevant student groups to see how participation or lack of participation in the Cohort pilot affected the first year experience for students, including the participation in other support activities such as SLG, career counseling, mentoring program and personal counseling. Additional data analytics would be applied to see whether there was a measurable effect on student success, recognizing that the small sample sizes for the proposed initial pilot groups may not yield conclusive results.

Results:

Semester	# of students	Students who stayed in all 5 cohort sections	Students who stayed in 4 cohort sections	Students who stayed in 3 cohort sections	Students who stayed in 2 cohort sections	Students who stayed in 1 cohort section	Students who did not stay in any section
Fall 2015	22	4	6	2	5	2	3
Winter 2016	22	NA	5	2	2	2	11

The above table illustrates that very few students (4 in the Fall and 5 in the Winter) remained in all of their cohort sections. In the Fall, the primary reasons for not remaining in all sections were mainly switching sections and dropping courses. The same reasons applied in the Winter, but

there were also additional factors, such as failure to obtain prerequisite credits for the Winter courses and program transfer/withdrawal that affected the totals. Additional analytics and surveys were not performed.

Future Steps: The First Year and Common Science Office has been in contact with the Registrar, to begin working out details of a second attempt at a Cohort Pilot for Chemistry Students where students will have the option to opt in to the Cohort when accepting an offer of admission. It is also recommended that additional events be planned for cohort members during (or prior to) Orientation Week, and during the semester, so that participants will be able to get to know each other outside of the classroom environment. Although specific details have not yet been finalized, this second Cohort Pilot project will hopefully be running during the 2017-2018 academic year.

4) Co-operative education option revised model

The Co-operative education options have been revised, effective Fall 2016, to require that only three of the five Co-operative education semesters are completed. This is in keeping with newer Co-operative education program options at Ryerson and elsewhere in the province. It is too early to tell if this will have an impact on the number of students who choose to remain in the Co-operative education options.

5) Renewal of laboratory experiments

Four new IR spectrometers and two new UV-VIS spectrometers were purchased for the undergraduate labs. The new industry standard instrumentation is high-throughput, rugged, and portable, allowing more students to use it in shorter time spans. This was part of a strategic investment in teaching infrastructure and created more efficient space usage, staffing, and scheduling.

Over the past year experiments have been both developed and refined for CHY 113 General Chemistry II, CHY 142 Organic Chemistry I, CHY 330 Atomic and Molecular Spectroscopy, CHY 344 Inorganic Chemistry, CHY 422 Environmental Chemistry, and CHY 449 Inorganic Chemistry II.

CHY 422 was first taught in Fall 2015, so all three experiments that were developed were new to our program. New laboratory experiments were developed and tested for CHY 113, CHY 344, and CHY 449. In addition, two experiments were refined to reflect instrumentation upgrades in CHY 330. We are in the process of developing a new experiment for CHY 113, which we plan to run in the upcoming winter term (Winter 2017). These labs are expository labs which involve learning new skills and making use of new equipment relevant in all areas of chemistry.

For example, in CHY344, a new lab was implemented in Fall 2015 which involved synthesizing a compound, followed by a literature review of interesting and useful related compounds. The synthesis component involved an expository experiment, while the characterization component involved two techniques which were new to the students: nuclear magnetic resonance (NMR) spectroscopy and infrared (IR) spectroscopy. These techniques are widely used in all aspects of synthetic chemistry, and are further developed in the CHY339 course. The literature review component involved various SciFinder searches to expose the student to reliable, peer-reviewed literature, as opposed to typical internet searches which often return questionable information.

In CHY 142, an existing lab was modified to make use of newly acquired IR equipment, which students were asked to use to analyze the success of their synthetic work.

An existing experiment for the CHY 142 course is also being reworked to make it a critical thinking exercise, in which the students must develop the protocol given a goal and parameters that need to be followed.

6) Quantum Physics

The Curriculum Committee met to discuss the fate of PCS 400 Quantum Physics in the Chemistry program. This course currently does not meet the needs of chemistry students and for the last couple of years, many students have dropped this course and/or failed. We determined that a Computational and Quantum Chemistry course would be a better fit for the needs of our students in the workplace. Given that CHY 706 Computational Chemistry has never been offered, we decided the calendar course description and title for this course should be revised and that the resulting course replace PCS 400 as a required course in the chemistry curriculum.

Core Chemistry Concepts and Skills in the Chemistry Curriculum

Sub-Discipline	General Chemistry		Analytical Chemistry		Biochemistry	Inorganic Chemistry		Organic Chemistry		Physical Chemistry	
Concept	CHY 103	CHY 113	CHY 213	CHY 223	BCH 261	CHY 344	CHY 449	CHY 142	CHY 242	CHY 381	CHY 382
Atomic structure		I		R		R	R	R			
Orbitals and bonding		I				B	B	B	B		
Amounts and concentrations	I	I	R	R		R	R	R		R	R
Acidity, basicity, and acid-base reactions	I		R	R	R	B	B	B	B		
Redox reactions and electrochemistry		I	R	R			R	R			
Periodicity and atomic properties		I				R	R	R			
Intermolecular forces		*			R	R	R	R		R	
States of matter	I					R		R		D	D
Kinetics		I			R	R	R	R	R		D
Equilibrium	I		R	R	R	R	R	R	R	D	
Solubility and colligative properties	I		R	R				R		R	R
Entropy		I			R	R	R		R	D	
Enthalpy	I	I			R	R	R			D	
Gibb's Energy		I			R	R	R	R	R	R	
Mathematical models	I	I	R	R		R				D	D
Gas properties	I									D	
Structure-function relationships		I			R	R	R	B	B	R	R
Mechanism		I				R	R	B	B		R

*This topic is taught in the high school curriculum and discussed in CHY 113 only if time permits.

Sub-Discipline	General Chemistry		Analytical Chemistry		Biochemistry	Inorganic Chemistry		Organic Chemistry		Physical Chemistry	
	CHY 103	CHY 113	CHY 213	CHY 223	BCH 261	CHY 344	CHY 449	CHY 142	CHY 242	CHY 381	CHY 382
Taking measurements	n/a	I	R	R	R	R	R	R	n/a	n/a	R
Manipulating glassware	n/a	I	R		R	R	R	R	n/a	n/a	R
Handling chemicals	n/a	I	R	R	R	R	R	R	n/a	n/a	R
Using equipment/machinery	n/a	I		R	R	R	R	R	n/a	n/a	R
Titrations	n/a	I	R						n/a	n/a	
Separation techniques	n/a			I	R	R	R	I	n/a	n/a	
Chemical calculations	I	I	R	R	R	R	R	R	R	R	R
Interpretation of data, trends	I	I				R		R	R	R	R
Use of interpretations and trends to make predictions		I				R	R	R	R	R	R
Designing experiments								I			
Visualization (models, graphs)	I	I	R		R	R	R	R	R	R	R
Accessing, using, and summarizing scientific literature		I			R	R	R	R	R	R	R
Oral communication											
Formal scientific writing		I	R	R	R	R	R	R	R		R
Informal communication (eg in lay language)											

Key:

n/a not applicable (course has no lab component)

I introduction

R in-progress, reinforcement, review

B built upon, extended

D in-depth exploration