

Experiences and benefits of a career development course for undergraduate chemistry students

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Introduction

Most recent graduates with bachelor degrees in chemistry in the USA go on to careers in industry [1], and more than half of those with science, technology, engineering, and mathematics (STEM) doctorates find employment outside academia [2]. Yet, fewer than half of US STEM doctoral institutions have programs that explicitly prepare students for nonacademic careers [2]. The situation is similar in Canada, where 44% of first-year students stated that their most important reason for attending university was to prepare for a specific job or career [3], but only 25% of Canadian seniors felt they knew their career options very well [4]. More concerning, most of their career information had been acquired anecdotally—from talking to their friends or parents [4]. Only 38% of seniors felt their university had contributed significantly to their knowledge of career options [4].

The American Chemical Society (ACS) has recognized the need for career development. Its guidelines for departmental approval state [5]: “In order to prepare students to enter the workforce or postgraduate education, programs must provide experiences that go beyond chemistry content knowledge to develop competence in other critical skills necessary for a professional chemist.”

This article describes a career course developed at the University of Alberta to provide students with easy-to-access

information about career options and professional development. The career course complements an early-opportunity research course and is preparatory for our science internship program [6].

Professional development courses

The career benefits of undergraduate research and work experience are well documented [7–10]. However, even participation in a career seminar can reduce most students’ career decision difficulties [11]. Career courses date as far back as the 1920s, and come in a variety of formats [12]. Career courses may be no-credit to full-credit courses, graded or credit/no-credit courses, and come anywhere within the undergraduate or graduate program. Those courses offered in the first year often serve as introductions to the university [11]—its expectations, support systems, and resources—while also discussing study skills, and sometimes career skills such as resume writing. Some disciplines, such as psychology, also have discipline-specific first- or second-year courses [13–16] that serve as an introduction to the major and course selection, and provide information about careers in the discipline and graduate school. Discipline-specific career courses, that come later in a baccalaureate or in graduate school, typically focus on skills directly related to research and/or job-search skills such as resume writing, interviewing, and networking. For instance, previous articles in this journal have described incorporation of the primary literature [17] and research [18] within the undergraduate curriculum, and have detailed graduate courses on research skills and ethics in chemistry [19] and competencies associated with working in an accredited analytical laboratory [20]. The ACS has also developed an online individual development plan tool (ChemIDP) that assists

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chemistry graduate students and postdoctoral researchers with career planning [21, 22].

Introduction to industrial chemistry course

In developing this course [23], our objectives were to inform chemistry students about the diverse jobs available to them, to raise their awareness of local industry, and to facilitate their development of job-search skills. At the same time, we recognized that the undergraduate program was already very demanding and busy.

The career course is an optional third-year undergraduate course worth 1.5 credits [half the normal credits of a one-semester (13-week) course], with many students taking the course in their final year. The course is a credit/no-credit course, with no graded assignments or tests. A programmatic challenge for many students was to pair this half-course with another half-course, such that together they could make a meaningful contribution to the credits required for degree completion. Our second-year research opportunity course (also a credit/no-credit course and worth half of a one-semester course) [24] was commonly used, but many students liked research so much that they completed two semesters of the second-year research opportunity course. Also, the disconnect between the scheduling of the two courses was problematic. We are now instituting a third-year research opportunity half-course, which will better complement the credits for the career course while providing additional experiential learning opportunities.

The components of the careers in chemistry course are:

- Online resources on the chemistry industry
- Online resources about chemistry careers
- Online resources on job-search skills
- Reflections posted on an online discussion board
- Seminars by local industrial chemists
- Tours of local industry
- Informational interviews
- Career fair and other Career Centre activities
- Workshops on resume writing, interviewing, and LinkedIn
- Mock interview

The course is taught in a blended format with a weekly 1-h seminar complemented by online resources, assignments, and discussion boards coordinated through a learning management system (Moodle). Formal enrollment is currently 7–15 students.

A compilation of the webpages and short (3–5-min) open-access videos is provided in the [electronic supplementary material](#) [25]. Many are from the ACS College-to-Career webpage [26] and the Royal Society of Chemistry YouTube

channel [27]. These resources were used to facilitate students' self-discovery or as preparatory materials for seminars and tours. For instance, a preliminary exercise was to read through a few of the 90 career profiles on the ACS Chemistry Careers webpage [26] and to watch two or more of the 3–5-min career vignette videos, such as [28–31]. Students then posted a short reflection (fewer than 50 words) in the student discussion forum about which job most appealed to them and why. Example student reflections were:

“Working as an analytical chemist interests me the most. Not only do you practice quality control techniques, but you also are able to participate in research and development. This is where lab skills and paying attention to detail really shines through.”

“A job in medicinal chemistry, in the pharmaceutical industry interests me the most because of its nature, scope, and applications. I think entering the field as either an analytical chemist working in method development, or as pharmacologist, researching the pathways, possible target molecules, and drug effects.”

“Jobs in quality control seem to fit my interests quite well as it involves analyzing materials and detecting errors in products. The use of analytical instruments and techniques appeal to me and the different opportunities in industry available is also a benefit.”

The core of the course is the four or five seminars presented by chemists working in local industry. The seminar is ideally an interactive conversation between two presenters. The generalized format of the seminars is:

- Five-minute self-introduction
- Ten-minute introduction of their company and laboratories
- Twenty minutes about some of the science
- Five minutes on careers in their industry
- Ten minutes for questions

Before the seminar, students view the company's website and two or three industry- or career-related videos selected by the instructor from those in the [electronic supplementary material](#). After viewing these resources, students post a question for the speaker. The speakers introduce themselves, as their self-introduction invariably reflects a more circuitous career path than students assume, and tends to emphasize the importance of networking and being ready to seize opportunities when they arise. Ideal speakers are recent alumni from our undergraduate or graduate programs. Students view such speakers as authentic, with relevant and relatable experiences. The speakers are provided with the students' posted questions, and generally weave them into their presentation. Some alumni have provided unexpected and thus most helpful advice.

For instance, one speaker stressed the importance of students having a driver's license! On reflection, many chemistry jobs are at locations without good public transport; hence, the lack of a driver's license can become an impediment to employment. Postseminar reflections from students included the following:

“[The presenter] emphasized employers' preferences for work and lab experience when hiring. She mentioned her lab experience at the [university], and said it was a large part of why she was hired at [company]. This advice seems to be a common theme in the conversations I had over the past week.”

“The importance of having and developing your interpersonal skills was also stressed... It is essential to conduct yourself in a professional manner, dress well and build relationships with as many people as you can.”

“I appreciated their candor when it came to the little things, such as being confident during first meetings, the importance of being prepared, showing some attention to detail (such as spelling, personal appearance) and being open and energetic during the interview process.”

These industrial seminars are broadly advertised and open to all graduate and undergraduate students and to all staff. Typical attendance at the seminars is 30–100 people—for a class with an enrollment of 7–15 students.

A highlight of the career course is always tours of local industries. Four hours is required to accommodate the travel, security sign-in, and tour itself. As for the seminars, students review suggested videos before the tour to familiarize themselves with the company and industry. Typical participation is 20–45 students, well beyond the enrollment of the class and limited only by the capacity of the tour or transportation. After the tour, students share a reflection on aspects of the tour and draft a thank you note [32] to the hosts. The following are examples:

“During the trip, I was surprised by the resources that the company put into the research department. Even though we were told in advance about the pilot plant on site, the difference in scale from an academia lab was still amazing.”

“Industry has a variety of jobs for chemists in all areas. The most valuable thing I learnt during the round table was the type of interview that many companies use.”

“I was surprised by the amount of research done at the [company] facility. That they are constantly trying to find more efficient ways to improve every step in the manufacturing process even if it is just an increase of 1%. Also the impact 1% can make is astonishing.”

“Firstly, thank you for opening your doors to a bus-full of students for an evening. We were welcomed with

enthusiasm and were taken care of very gracefully, and for that you have my appreciation. A special thanks to the tour guides who allowed us to catch a glimpse of their "day in the life". I found them all to be very informative, and very excited about the work that happens at [your company]. Congratulations on having such excellent staff.”

From the seminars and tours, students come to appreciate the importance of networking. But rarely are students shown how to network. Thus, the career course has students do informational interviews. Informational interviews are a powerful networking tool in business, but are under-used by scientists. Informational interviews are an informal meeting in which the future job seeker collects information about a job, career field, company, and the industry [33–36]. Students do up to four informational interviews during the course. They start with a lower-stress interview with a returning co-op or internship student to learn about the companies for which they worked, the type of duties that were expected, and their overall impressions about engaging in work experience. Next the students do an informational interview with a graduate student or on-campus staff who has industrial experience. Students are asked to post who they have contacted to ensure that each student interviews a different chemist. Once they have this experience in hand, they are ready to do an informational interview of an alumnus in the local industry. A listing of interviewees is assembled by the instructor and provided to the students. In future, a LinkedIn group would expedite this process, and allow us to accommodate more students. Students are also encouraged to do an informational interview of a faculty member to learn about possible undergraduate research positions. The following are example comments from students:

“The most important advice he gave me however was how to stay involved. This way you can also meet others in your field and get your name out there. Hopefully I can apply this advice in the future to help my career in chemistry.”

“She made it clear that the university education build skills and knowledge; and may not necessarily mirror the career of your interest. There was an emphasis on exposure to experiences early in one's career, with this remark, she recommended companies that may hire at the entry level position. ”

“My informational interview with [the bench chemist] went great! I learned a lot about what he does at [government laboratory] and the processes that he had to undergo in order to get his position. It was reassuring to hear that there are opportunities for general science undergrads rather than just honors or specialization students. It was interesting to learn that the application

process for [the laboratory] comes with three screenings. The first is the cover letter and resume, where they look at your previous experiences, followed by a written test, which you have to pass in order to move on to the third screening process - the verbal interview. [The chemist] recommended various places for entry-level positions in order to get experience in the field. It was really great of him to offer a tour of the facility. Overall, I learned a lot through the informational interview and I really enjoyed hearing about his experiences!”

Anecdotally, one informational interview led to an internship.

The career course also incorporates events and seminars hosted by the university’s Career Centre [37] and Undergraduate Research Initiative [38]. Such agencies are available on most campuses, but many students are either too busy or unaware to make use of these resources. One assignment was to go to the Career Day and find two companies that hire chemists. This minor encouragement prompts the students to make this valuable first step in their job hunt, and provides additional practice in networking.

The career course culminates with a mock interview. A mock interview is a training exercise where the candidate goes through the full application and interview process for a pretend job posting. Alumni in industry, from different companies, who have volunteered to come in to interview students provide a typical job posting for an entry-level chemist. Students review all of the advertisements, and rank their preference. The instructor assigns to each student one of their preferred job postings, and the student “applies” for that job by responding to the posting with a cover letter and resume. Each company interviews two or three students. The student writes a cover letter and resume tailored to the position, and then does a 30-min interview with the one or two chemists from the company. The interview is conducted in whatever format the company typically uses, and neither the instructor nor the students are informed about that format beforehand. After the interview, the interviewer provides 10–15 min of feedback to the student about what the student did well and what the student could improve on. No feedback is provided to the instructor, other than assurance that the student made a sincere effort. This exercise is formative rather than evaluative. The following are examples of comments from students:

“I found [the mock interview] to be an amazing experience. She gave me some suggestions about the volunteering part in my resume because she believes I can elaborate more.”

”I did my interview with [company]. There were 3 interviewers, with the first one asking about past experiences and the other two asking technical questions. My sentences were probably incomprehensible because I

was so nervous, but I think it will get better with practice. I was not prepared at all for the technical questions, even though they were not that challenging. Overall, it was great to experience what a real interview in the field is like.”

As evident in the quotes above, students are nervous. To support students in advance of this final mock interview, the career course includes a resume workshop and an interview workshop presented by the university’s Career Centre [37]. The Career Centre uses one of the mock advertisements to guide the presentation to illustrate to the students how to direct their resumes and cover letters to a specific position in the chemistry industry. The following are examples of comments from students:

“I really loved the resume and interview session. I brought my resume with me and saw many things that could be improved.”

“I found the presentation to be very helpful in the construction of my resume. Some of the points I found to be the most helpful were... I was unaware that it is better to... Another tip I found very helpful was how they showed us how to tailor our resume for the individual position based off the job position posting, and to include this at the very beginning of the resume so it can be seen under rapid review. Along with other points given during the presentation it made me realize that my resume required much attention.”

Fortuitously, one company contacted about conducting mock interviews was in the midst of a rapid expansion. The company asked if it could do recruitment interviews, in addition to the three mock interviews! Our undergraduate and graduate students enthusiastically responded, with now more than 60 interviews being conducted each year. Nearly all of these non-career-course students participate in resume and interview workshops that the Career Centre tailors for these job advertisements.

The mock-interview process is a mutually beneficial experience for both the student and the employer. Recruiter Matthew Verwey [39] of Gilead explains: “Any organization’s most valuable asset is its people, so the value of this opportunity cannot be understated. Five current Gilead employees were first noticed through this on-campus interview series approximately a year ago. Their careers are stable, flourishing, and they continue to develop as chemists and professionals every day.”

Verwey notes that the experience of interacting with real recruiters is invaluable: “Their familiarity and skill in the interviewing domain can literally mean the difference between employment and unemployment.”

Summary

Some students receive informal career mentoring from a faculty member, relative, or friend, but the advantages of this *hidden curriculum* are available to only a lucky few. The career course described herein formalizes that mentoring and advice so that it is more widely available. The target audience was originally our chemistry undergraduate students, but the seminars, tours, and mock interviews have been equally popular with our graduate students. Thus, although the full online resources and course activities are available only to students enrolled in the course, a broad spectrum of our students benefit from the aspects of the course that are open.

On our embarking on this course, the perceived challenges were the substantial work needed to develop resources for the course and the lack of industrial expertise among our professoriate. Fortunately, societies such as the ACS [26] and the Royal Society of Chemistry [27] already provide a wealth of materials. Links to these resources are summarized in the [electronic supplementary material](#).

But these online resources are truly supplementary because the true resource has been our alumni. Alumni have been extremely generous with their time and their wisdom, and love interacting with our students. To my memory, there has not been an alumnus who has declined—some are not available at the time requested, but are eager to find a time that works for both us and them. The alumni are also delighted to be contacted by the institution for something other than a donation or endowment. Thus, one of the greatest benefits of the course has been to foster a closer relationship between the Chemistry Department and our students with our alumni. And although that relationship is not based on money, it has led directly to jobs for our students and nearing a million dollars worth of donated used equipment.

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