Assessing Graduate and Undergraduate Student Needs to Redesign a Chemistry Seminar Course

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TITLE

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ABSTRACT

The Chemistry Seminar course at Rutgers University-Newark consists of newer graduate students and upper-level undergraduate students. To maximize student learning, the physical sciences librarian and professor assessed the knowledge and needs of both groups at the beginning of the course and utilized the results in course redesign. The course objectives of learning chemical information literacy skills to prepare for an oral presentation and engagement in department seminars remain of utmost importance, but addressing general curriculum gaps is also considered. Post-course assessments show students find the redesigned course highly useful and valuable for their short and long term needs.

KEYWORDS

assessment, library instruction, embedded librarianship, graduate students, upper-level undergraduate students

INTRODUCTION

When students enroll in a course, it is expected they will leave it more knowledgeable, but how can this be assured? Assessing student knowledge at the beginning on the course helps to identify areas related to course goals and objectives where instruction should be emphasized so that the course is seen as relevant and valuable to the students. An evaluation of student needs is especially important if students with diverse educational backgrounds will be enrolled in the same class. Students might be asked to self-assess their skills or answer questions that test their knowledge or skills. Throughout the course, continued assessment via in-class exercises or homework assignments can confirm student learning and allow for more timely responses to student or instructor concerns. End-of-the-semester assessments may include term projects, final exams, and/or post-course assessments. When post-course assessments are closely related to pre-course assessments, comparing them provides insight into both student progress and instructor effectiveness.

This paper describes a successful faculty-librarian collaboration to redesign a Chemistry Seminar course required of both new graduate and upper-level undergraduate students. It shares the various methods of assessment used before, during, and after teaching a Chemistry Seminar course at a public university in the northeastern United States, as well as the results from the assessments.

LITERATURE REVIEW

Although similarly named courses in the United States generally have similar goals and objectives, the Chemistry Seminar course seems to be an exception as it serves varying purposes at colleges and universities around the nation. Content covered may be determined by what level students are enrolled in the course. Most Chemistry Seminars consist of students in their junior or senior year (Blackburn and Wiseman 1990; Bowyer and Kaydos 1997; Wallner and Latosi-Sawin 1999), but they may span several semesters (Bowyer and Kaydos 1997; Delaware et al. 1996; Eklund and McGowan 2007) and even begin during the first year of undergraduate study (Delaware et al. 1996; Tucci 2011). Thus, Chemistry Seminar course content can be rather diverse. Common features of Chemistry Seminar courses are literature searching and oral presentations. In some cases, poster presentations are expected (Eklund and McGowan 2007; Singiser, Clower, and Burnett 2012); whereas in others, writing skills are emphasized (Blackburn and Wiseman 1990; Bowyer and Kaydos 1997; Wallner and Latosi-Sawin 1999). Less commonly, Chemistry Seminar courses may include discussions on ethics, careers, and/or technology, including software (Delaware et al. 1996; Eklund and McGowan 2007; Moody and Freeman 1999; Singiser, Clower, and Burnett 2012; Tucci 2011). Even rarer, topics may be more relevant to the laboratory – such as laboratory safety, scientific research techniques, and Good Laboratory Practices (Delaware et al. 1996; Eklund and McGowan 2007; Moody and Freeman 1999). Perhaps in certain situations, the Chemistry Seminar course serves as a catch-all course where gaps in the general curriculum are addressed.

Chemistry Seminar courses discussed in the literature typical consist of only undergraduate students, but at Rutgers University-Newark, upper-level chemistry majors and new graduate students sit side by side in class. This makes it difficult to decide what content to emphasize so both groups find the course valuable and engaging. Although assessment studies in the past have had students self-assess or answer questions that test their knowledge or skills (Currano 2005; Delaware et al. 1996; Emmett and Emde 2007; Ferrer-Vinent 2012; Gawalt and Adams 2011; Locknar et al. 2012; Mandernach, Shorish, and Reisner 2014; Schepmann and Hughes 2006) there does not appear to be any recent studies that compare the chemical information literacy skills of undergraduate and graduate students in a single class. This study is expected to fill that gap and provide chemistry professors and librarians with an idea of each group's needs and what differences may exist between them.

BACKGROUND

On the Rutgers University-Newark campus, the Chemistry Seminar course is expected to provide students with the experience of giving an oral presentation and to expose them to areas of research that fall outside the scope of the regular curriculum. In preparation for their 20-25 minute presentation to their peers at the end of the semester, students are taught oral presentation skills. To address the latter, students are taught information literacy skills they can use to search the literature for scholarly articles about their presentation topic. In addition, they are required to attend the Chemistry department's weekly seminar series, where scientists from around the world present their current research.

When a different professor began teaching Chemistry Seminar in the Fall semester of 2012, this was seen as an opportunity to re-design the course to further maximize student learning both in terms of content covered and style of teaching. Discussions between the author and the professor resulted in the author becoming much more involved, to the point of being an embedded librarian co-teaching the course. Chemical information literacy skills (e.g., recognizing the important resources in chemistry research and how to make use of them) became a larger part of the redesigned course. In the past, students received instruction on literature searching in either Web of Science or SciFinder, but this covered only a very narrow aspect of being information literate. We felt students would benefit from exposure to chemistry-related resources not yet part of their curriculum and believed this would enhance student abilities to efficiently and effectively find literature relevant to their presentation topics, thus supporting one of the course goals and meeting more of the national standards for information literacy competencies. This includes the Information Literacy Standards for Science and Engineering/Technology (ALA/ACRL/STS Task Force on Information Literacy for Science and Technology 2006) and the Information Competencies for Chemistry Undergraduates (Special Libraries Association 2011).

IDENTIFYING STUDENT NEEDS

In determining what to include in the Chemistry Seminar course, the professor and author assessed gaps in the graduate and undergraduate student curriculum and examined the existing literature to identify resources considered most significant for chemistry students (ALA/ACRL/STS Task Force on Information Literacy for Science and Technology 2006; Fong 2014; Garritano and Culp 2010; Special Libraries Association 2011). A list of possible resources, tools, and even software to address was assembled. The author designed an online pre-course assessment form featuring these items and used it to study student needs and student knowledge on the first day of class. Data gleaned from this assessment helped determine course content.

The student pre-course assessment form is provided as Appendix I. Part A collects general (demographic) information about the students. In Part B, students self-evaluate their confidence levels in performing certain research-related tasks (B1) and using certain resources and tools (B2). An open-ended question allows students to share challenges they faced when looking for or using information. Part C is comprised of 10 choose-all-that-apply questions testing student knowledge of research-related resources and tools. Student answers guided the redesign of the Chemistry Seminar course in Fall 2012 and Fall 2013. Altogether, 13 graduate students and 31 undergraduate from that time period agreed to participate in this study.

Confidence Levels (Part B)

Tables 1 and 2 summarize student confidence scores for Parts B1 and B2 on the first day of class. Each student response was coded 0, 1, 2, or 3 to reflect their answers of “Not confident,” “Somewhat confident,” “Confident,” or “Very confident,” respectively. Averages for the two groups – graduate and undergraduate students – were calculated for each question. Each group’s overall average for Part B1 and B2 are also included. Two-sample *t*-tests were performed to determine whether the averages of graduate and undergraduate students were of statistical significance (i.e., $p < 0.05$).

Although the *p*-values in Table 1 indicate no instances where the averages for the two groups showed statistical significance, the averages themselves do reveal some differences in how they feel about performing research-related tasks. Most notably, undergraduate students expressed greater confidence than graduate students in managing references, staying up to date with new research, and citing sources. In fact, undergraduate students were overall a little more confident about performing research tasks.

Table 2, however, shows graduate students as generally more confident about using specific research resources and tools than undergraduate students – especially where Web of Science was concerned (p <0.05). To a smaller degree, graduate students were also more comfortable with INSPEC and ChemDraw. RefWorks was an exception. Rutgers University subscribes to this reference management and citation generating tool, but the new graduate students may not have used it yet, whereas upper-level undergraduate students were likely exposed to it in a previous course and therefore felt greater confidence with it.

One concern with self-evaluations is they are subjective and may not present an accurate assessment. For example, graduate students felt less confident than undergraduate students about performing research-related tasks in Part B1. However, they were more confident about using specific research resources and tools in Part B2, which happened to be the types of resources and tools required for performing the tasks in Part B1. Perhaps graduate students were more accurate in assessing their abilities in Part B1.

Looking at the confidence scores in Tables 1 and 2, it is clear both groups lack confidence in a number of areas. All low confidence items (i.e., <1.0) were included in lesson plans for the Chemistry Seminar course. Given that the major course requirement was the oral presentation – something students were among the least confident about – we decided to devote a full session to this topic. Students were confident about using Microsoft PowerPoint and Microsoft Excel, so these were not included in the syllabus.

Open-ended responses indicated that 34% of students view finding information as a challenge in literature research. They are unclear about where and/or how to look for information. A few undergraduates were concerned about evaluating information, citations, and how to navigate the library Web site. Undergraduate students were also anxious about not being able to understand the articles they find, synthesize the information, and stay focused on their assigned topic. One graduate student saw patents as an area of difficulty.

Content Knowledge Test (Part C)

Due to the subjectivity of self-evaluations, it was important to also test student knowledge of research-related resources and tools. Table 3 shows the average knowledge scores for graduate and undergraduate students in Part C. For these choose-all-that-apply questions, averages are presented in decimal format rather than percentage format. The *p*-values from two-sample *t*-tests performed indicate no statistical significance between the averages of graduate and undergraduate students, but the averages themselves do highlight some differences in their chemical information literacy knowledge.

Looking at the answers students chose also revealed different strengths and weaknesses between the two groups. Graduate students had a better understanding of where to find properties information and were twice as likely to know that EndNote is a reference management tool (possibly due to having used it at their previous college or university). Undergraduate students, on the other hand, were more familiar with RefWorks. Graduate students did not know SciFinder provides citation counts, but they were almost twice as likely as undergraduates to know that Web of Science does.

The averages on Table 3 – which start at 0.40 (or 40%) – suggest graduate and undergraduate students still have a lot to learn. They were least knowledgeable about where to look up citation counts, do patent searching, and identify chemical suppliers. The confusion about patent searching affirms the lack of confidence students felt about it in Part B. Both groups were weakest in their knowledge of Reaxys and mistakenly believed Web of Science could do much more than it really does. Their trouble with Reaxys is consistent with the low level of confidence they felt for the resource. Students were most knowledgeable about what review articles are and what tools help them manage their references and assist them with in-text citations, but with even these "high" average scores being less than 80%, all topics from Part C were incorporated into lesson plans for the course.

THE REDESIGNED COURSE

The number of Chemistry Seminar class sessions reserved for library research instruction varied based on a number of factors. With higher student enrollment, more time must be reserved at the end of the semester for student oral presentations. When fewer seminar speakers are scheduled in a semester, that allows more class time for library research instruction. All in all, students in 2012 received six library instruction sessions, whereas students in 2013 received seven. Content covered was adjusted each year based on course goals, significance of resources or tools, and pre-course assessments.

Resources & Other Library-Related Topics

All students were taught scholarly communication, basic information literacy skills, basic data management, SciFinder, Reaxys, Web of Science, the Cambridge Structural Database, *CRC Handbook of Chemistry and Physics*, and RefWorks. Only those in 2013 learned about INSPEC and received a full lesson about PubMed. Course structure in 2012 was resource or tool-based, meaning students learned all about SciFinder and then learned all about Reaxys, whereas in 2013, it was purpose-based, meaning students were taught literature searching in SciFinder and Reaxys, then taught structure searching in the two. The change in 2013 was prompted by concern that students were not seeing the similarities and differences between resources. Part of being information literate is realizing it may be possible to perform similar tasks using different indexes or databases, but that this may require varying search methods and/or lead to different results.

To encourage student engagement during library research instruction sessions, the author introduced new activities and assignments into the course. A student response system (iClickers) increased classroom interactivity. In-class exercises were developed to emphasize active learning (see Appendix II). Since Chemistry Seminar at Rutgers University-Newark is a 1-credit course for undergraduate students and a 2-credit course for graduate students, student workload had to be reasonable, so the course focused on in-class work rather than homework assignments. The insistence on practice exercises was based on Fong and Hansen's (2012) previous experience teaching graduate students in a research group on campus about science resources. The exercises provided structure to keep students on task in practicing the skills they just learned. To further increase engagement in department seminars, invited speakers were featured on the exercises. Observations during class (and feedback from students) in 2012 indicated the exercises may have been too long, so they were modified in 2013 to be shorter and more focused. This appeared to satisfy the students, resulting in 100% submission of assignments and also an increase in on-time submissions in 2013. Of course, the clear incorporation of these exercises as being a part of the student course grade in 2013 may have also been a contributing factor (see Table 4).

Oral presentations

In both 2012 and 2013, a full class session was devoted to oral presentations. In 2012, students looked at different resources about oral presentation best practices, and then gathered in small groups to discuss their findings. Unfortunately, students' reluctance to speak in their groups resulted in a not very successful collaborative learning activity. In 2013, we opened up the discussion about oral presentation best practices to the entire class and condensed this portion of the session so that students could also gather in groups of four to practice brief versions of their oral presentations. The hope was that students' comfort level with presenting in front of the class would increase after this experience speaking in front of a sub-group of that same audience. During the practice talks, students were asked to provide useful feedback to their peers using Seminar Evaluation Forms (see Appendix III). This form would be the same one used when evaluating their peers' official presentations, so input offered during practice talks could potentially be quite valuable.

Seminars

Seminar Evaluation Forms were also used during departmental seminar series talks. Students filled one out after each scientist's presentation. It served as a reflective exercise where students would distinguish the characteristics of a good presentation as compared with a poor one. Its other purpose was to keep students engaged in the presentation. Attentiveness during invited talks is not a new challenge. One solution might be to have students complete writing exercises following the seminars (Hamstra et al. 2011), but we wanted to boost student understanding during the seminar. In 2013, we developed a brief (online) Seminar Preparation Form (see Appendix IV) that students were required to complete *prior* to each seminar. Since students were aware of who the speaker would be each week and the research topic s/he would be presenting about, they were asked to find an article written by the speaker about this topic, provide the full citation for the article (following a specific style format), and describe in two-three sentences what they thought the speaker would talk about during the seminar. It was expected that students would perform a quick search for a recently published article and skim the paper to better understand the topic under discussion so they could ask good questions during the seminar.

ASSESSMENT OF COURSE

Students were essentially asked the same B1, B2, and C questions post-course as they were asked pre-course, so data was analyzed in a similar manner. The pre- and post-course scores of both groups were also compared to determine whether there was improvement in students' information literacy skills.

To gain greater insight into how helpful students found the Chemistry Seminar course to be, Part D was added to the post-course assessment (see Appendix V). Students were asked how useful or valuable they felt various aspects of the course to be, what was least valuable, what they found most difficult about the course, and what suggestions they had for improving the course.

Confidence Levels (Part B)

Tables 5 and 6 compare the post-course average confidence scores of graduate and undergraduate students for Parts B1 and B2. There were no instances in which the different averages showed statistical significance (i.e., $p < 0.05$). However, graduate students generally felt more confident post-course than undergraduate students –

The average B1 and B2 confidence scores pre- and post-course for each group are summarized in Tables 7 and 8, along with corresponding *p*-values from paired *t*-tests. Across the board, great improvements in confidence were observed post-course. For graduate students, this change was statistically significant in all cases, except for using Microsoft PowerPoint and giving oral presentations. The largest rise in confidence occurred for using RefWorks and Reaxys, staying up to date with new research, managing references, citing sources, and searching for patent information – areas where they initially struggled. For undergraduate students, there was a statistically significant increase for every question, with the biggest growth seen in using Reaxys and Web of Science.

There were still a couple of areas where student confidence averaged less than 2. More time may need to be devoted to practice talks in order to raise student confidence in giving oral presentations. Based on student feedback in Part D, undergraduate students were particularly interested in just such an opportunity. The relatively low INSPEC averages are understandable given that students in 2012 did not learn about INSPEC. This likely weighed down the average for both groups. Less time was also spent on the Cambridge Structural Database and *CRC Handbook of Chemistry and Physics*, thus resulting in lower averages.

In open-ended answers, students stated they still faced challenges of finding relevant information, obtaining full text, and using Reaxys. Students were also frustrated about the wait for interlibrary loan materials and not being able to find translated versions of non-English documents.

Content Knowledge Test (Part C)

Post-course average knowledge scores (Part C) of graduate and undergraduate students are provided in Table 9. Graduate students ended the course more knowledgeable than undergraduate students. They earned higher scores for all questions except the one about the library catalog. The difference in their overall average scores was statistically significant (i.e., $p < 0.05$) and this was the same case for questions about managing references and generating citations, searching for patents, looking up citation counts, and finding chemical suppliers.

Table 10 compares pre- and post-course average knowledge scores for graduate and undergraduate students, and displays corresponding *p*-values from paired *t*-tests. The overall average knowledge score for graduate students was 0.20 (or 20 percentage points) higher, whereas that for undergraduate students was 0.13 (or 13 percentage points) higher. Both increases were statistically significant, but it is unclear why undergraduates did not do as well. Perhaps graduate students paid more attention because it was a 2-credit, whereas for undergraduate students, it was a 1-credit class.

Post-course scores for individual questions were all higher, with the exception being the question about the library catalog. This is understandable since it was a topic that was not emphasized during the course. There was marked improvement (i.e., *p*-

value < 0.05) in knowing where to determine citation counts, do structure searching, look up synthesis reactions, find chemical and physical properties, locate spectra data, search patents, and for understanding PubMed. Statistical significance was also observed post-course for graduate students in knowing which tools to use to manage references and generate citations.

It was good to see that increases in confidence levels post-course were accompanied by a clear demonstration of more knowledgeable students. In fact, much of the results in Table 10 are in line with those in Tables 7 and 8. One exception was patents. Undergraduate students overestimated their ability to search patents, indicating they felt “Confident” about doing so, but then earned a disappointing average knowledge score of 55%.

Looking at the individual questions and answers, students demonstrated that of all resources and tools taught, they knew Reaxys the best – at least in terms of what it has to offer. Since they were least familiar with Reaxys pre-course, this was where their greatest leap in knowledge was observed. It is interesting to note, however, that they were not as confident about using Reaxys as they were the other resources and tools. Perhaps Reaxys’ unique interface confused students.

Student Evaluation of Course (Part D)

Overwhelmingly, students found the redesigned Chemistry Seminar very useful or useful. Table 11 compares the perceptions of graduate and undergraduate students according to the two-sample *t*-test using groups. Just about all students thought the library sessions were either very useful or useful in helping them meet course requirements such as completing in-class exercises and oral presentations and the course objective of greater engagement with the department's seminar series. The questions about longer term benefits (i.e., helping with the rest of one's educational career or one's professional career), however, yielded noticeably different averages between the two groups. Graduate students felt the library sessions would be much more useful helpful for them beyond the course. They recognize the need to use their new knowledge in coursework and/or research at Rutgers University and in their career. Undergraduate students, though, may be less certain about their career path and might not expect to do more chemical literature searching before they graduate.

Although students in 2012 and 2013 saw the course as similarly useful, there were two noticeable differences. More students in 2013 felt the library sessions were very useful in engaging them with the department's seminar series in 2013. Perhaps the Seminar Preparation Form homework assignments introduced in 2013 aided this perception. Undergraduate students in 2013 were also more likely to find the session very useful for helping them complete in-class exercises. Perhaps this was helped by the more focused 2013 exercises.

In terms of resources or tools students actually used to prepare for their oral presentations, SciFinder was the top choice, used by 90% of students. Approximately 60% of students used RefWorks, with more undergraduates doing so than graduate students. Half the students used Web of Science, with more graduate students preferring it. Only 18% of students used PubMed and all were undergraduates. Reaxys was used by 16% of students, with three times as many graduate students using it than undergraduates. Less than 10% of the students said they used Google or Google

Scholar and all of these were undergraduate students. It was good to know that students really did use the resources and tools taught during the course.

When asked what they found most valuable in the Chemistry Seminar course, students mostly identified resources or tools discussed. As the resource used most often for preparing oral presentations, SciFinder was deemed most valuable to 32% of students. This was followed by RefWorks (20%). Oral presentations were most valuable to 18% of students, with 25% of undergraduate students stating this. Some appreciated the discussion about best practices, whereas others were glad to have had experience giving an oral presentation. Approximately 18% of students responded that “everything” or all the databases were most valuable; 11% found learning about general research methods most valuable. A couple of undergraduate students thought the seminars were most valuable. Responses from 2012 and 2013 were similar, with the most noticeable difference being that undergraduate students in 2013 were much more likely to find oral presentation opportunities most valuable. This is likely due to the practice talk introduced in 2013.

Most students – 67% of graduate and 50% of undergraduate students – either wrote that nothing was least valuable or left this question blank. Of those who did identify something they did not find valuable, the most popular answer was Reaxys (16%). Graduate students in particular felt this was least valuable, with 25% of them stating so. PubMed and Web of Science were each deemed least valuable by 11% of the students. Students may have felt it unnecessary to learn these resources if they were able to find enough articles about their oral presentation topics in SciFinder.

When asked what they found to be the most difficult part of the course, many students (32%) either wrote “nothing” or skipped the question, but of those who did respond, oral presentations was the most frequent answer. One third of undergraduates and 25% of graduate students felt this was most difficult, with a greater percentage of the students from 2013 indicating so. In fact, several undergraduate students that year suggested having more opportunities to present. They appreciated having class time for practice talks and felt more such sessions would be helpful. Another area of difficulty was the confusion about the differences between the databases and knowing when to use which one. Greater emphasis will have to be placed on this in the future. A few undergraduate students found it most difficult to find articles relevant to their topics. A few others thought Reaxys was a challenge, which corresponds to the lower confidence levels previously expressed.

CONCLUSION

The redesigned Chemistry Seminar course appears to be a success. Students now enjoy more opportunities to practice their oral presentation skills, are learning more information literacy skills, and becoming more engaged during departmental seminar series talks. Student post-course assessments revealed both graduate and undergraduate students find the course quite useful and valuable to their immediate and future needs. They are using the resources they were taught – especially SciFinder, Web of Science, and RefWorks – to find scholarly articles to support their oral presentations and their understanding of seminar presentations.

Initial worries of being able to address the needs (and keep the interest) of new graduate students and upper-level undergraduate in the same classroom were eased by a pre-course assessment form that allowed the author and professor to gain a better understanding of student strengths and weaknesses prior to finalizing the syllabus for the course. This information allowed for modifications based on student needs, thereby customizing course content to topics that would be of most benefit to the current students. Contrary to what one might suspect, graduate students were not far ahead of undergraduate students in terms of their knowledge and confidence levels for research skills at the start of the course. However, by the end of the course, they did outpace them.

Post-course discussions between the instructors (i.e., physical sciences librarian and chemistry professor) have been reflective in nature. Their perceptions of the success of the redesigned course are in line with that of their students. Future plans include continuing the collaboration and building on data collected from the each years' multiple format student assessments and instructors' reflective self-assessments to make further improvements wherever possible. Professors and librarians looking to enhance or modify the Chemistry Seminar course at their own college or university may find the ideas in this article helpful. Much of what was done at Rutgers University can easily be adopted for use at another institution, including course content or design, pre- and/or post- course assessment forms, in-class exercises, Seminar Preparation Forms, and Seminar Evaluation Forms. Methods for increasing student engagement through interactivity, active learning, and/or collaborative learning may also be of interest.

REFERENCES

ALA/ACRL/STS Task Force on Information Literacy for Science and Technology. 2006. Information Literacy Standards for Science and Engineering/Technology. http://www.ala.org/acrl/standards/infolitscitech.

Blackburn, J. R., and F. L Wiseman. 1990. Innovative use of seminar courses with low enrollment. *Journal of Chemical Education* 67, 951-953.

Bowyer, W. J., and J. A. Kaydos. 1997. A novel format for seminar during the senior year of the college chemistry curriculum. *Journal of Chemical Education* 74, 184-185.

Currano, J. N. 2005. Learning to search in ten easy steps: A review of a chemical information course. *Journal of Chemical Education* 82, 484-488.

Delaware, D., R. Freeman, A. Moody, and D. VanGalen. 1996. The freshman chemistry seminar. *Journal of Chemical Education* 73, 144-146.

Eklund, A. G., G. J. McGowan. 2007. An effective four-semester, junior-senior approach to a chemistry seminar curriculum. *Journal of Chemical Education* 84, 1299-1300.

Emmett, A., and J. Emde. 2007. Assessing information literacy skills using the ACRL standards as a guide. *Reference Services Review* 35, 210-229.

Ferrer-Vinent, I. J. 2012. Teaching SciFinder basics to organic chemistry students. *Science & Technology Libraries* 31, 164-179.

Fong, B. L. 2014. Searching for the formula: How librarians teach chemistry graduate students research skills. *Issues in Science and Technology Librarianship* 75 (Winter). http://www.istl.org/14-winter/refereed1.html.

Fong, B. L., and D. B. Hansen. 2012. Engaging research groups: Rethinking information literacy for graduate students. *Issues in Science & Technology Librarianship* 71 (Fall). http://www.istl.org/12-fall/refereed2.html.

Garritano, J. R., and F. B. Culp. 2010. Chemical information instruction in Academe: Who is leading the charge? *Journal of Chemical Education* 87, 340-344.

Gawalt, E. S., and B. Adams. 2011. A chemical information literacy program for first-year students. *Journal of Chemical Education* 88, 402-407.

Hamstra, D., J. N. Kemsley, D. H. Murray, and D. W. Randall. 2011. Integrating Webinar and blogging technologies into chemistry seminar. *Journal of Chemical Education* 88, 1085-1089.

Locknar, A., R. Mitchell, J. Rankin, and D. R. Sadoway. 2012. Integration of information literacy components into a large first-year lecture-based chemistry course. *Journal of Chemical Education* 89, 487-491.

Mandernach, M. A., Y. Shorish, and B. A. Reisner. 2014. The evolution of library instruction delivery in the chemistry curriculum informed by mixed assessment methods. *Issues in Science & Technology Librarianship* 77 (Summer). http://www.istl.org/14-summer/refereed3.html.

Moody, A. E., and R. G. Freeman. 1999. Chemical safety and scientific ethics in a sophomore chemistry seminar. *Journal of Chemical Education* 76, 1224-1225.

Schepmann, H. G., and L. A. Hughes. 2006. Chemical research writing: A preparatory course for student capstone research. *Journal of Chemical Education* 83, 1024-1028.

Singiser, R. H., C. E. Clower, and S. C. Burnett. 2012. Preparing ethical chemists through a second-year seminar course. *Journal of Chemical Education* 89, 1144-1147.

Special Libraries Association, Chemistry Division, and American Chemical Society, Division of Chemical Information. 2011. Information Competencies for Chemistry Undergraduates: The Elements of Information Literacy. 2nd ed. http://chemistry.sla.org/wp-content/uploads/cheminfolit.pdf.

Tucci, V. K. 2011. Faculty/librarian collaboration: Catalyst for student learning and librarian growth. *Science & Technology Libraries* 30, 292-305.

Wallner, A., and E. Latosi-Sawin. 1999. Technical writing and communication in a senior-level chemistry seminar. *Journal of Chemical Education* 76, 1404-1406.

White, H. B., III, M. V. Johnston, and M. Panar. 2000. Senior seminar focusing on societal issues related to chemistry and biochemistry. *Journal of Chemical Education* 77, 1590-1593.

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Tables, as a separate file

TABLE 1. Student Confidence Performing Research-Related Tasks, Pre-Course

Part B1 – Questions: How confident are you about doing the following?	Graduate Student Average (± standard deviation)[a]	Undergraduate Student Average (± standard deviation)[a]	Mean difference	*p*-value[b]
B1a. finding books at Rutgers	1.46 (± 0.97)	1.35 (± 0.66)	0.11	0.67
B1b. finding appropriate scholarly articles	1.33 (± 0.89)	1.55 (± 0.72)	-0.22	0.42
B1c. finding (chemical or physical) properties information	1.67 (± 0.98)	1.45 (± 0.93)	0.22	0.51
B1d. finding spectra (IR, NMR, UV) information	1.17 (± 1.19)	1.10 (± 0.98)	0.07	0.84
B1e. searching for patent information	0.75 (± 0.75)	0.61 (± 0.72)	0.14	0.58
B1f. evaluating resources	1.17 (± 0.94)	1.17 (± 0.87)	0.00	1.00
B1g. accessing materials not available at Rutgers (e.g., using interlibrary loan or taking advantage of borrowing agreements)	1.25 (± 1.06)	1.00 (± 0.87)	0.25	0.43
B1h. keeping up to date with research in your field of interest (e.g., setting up alerts, RSS feeds)	0.67 (± 0.98)	1.16 (± 1.04)	-0.49	0.16
B1i. properly citing sources	1.17 (± 0.94)	1.58 (± 1.09)	-0.41	0.25
B1j. managing a large number of references or citations for papers or projects	0.75 (± 0.62)	1.30 (± 0.92)	-0.55	0.06
B1k. managing laboratory research data	1.25 (± 1.14)	1.33 (± 1.03)	-0.08	0.82
B1l. giving oral presentations	1.08 (± 1.00)	0.94 (± 0.77)	0.14	0.61
Overall average of B1a. - B1l.	1.14 (± 0.69)	1.23 (± 0.58)	-0.09	0.66

[a]Scores range from 0 (Not confident) to 3 (Very confident).

[b]A *p*-value < 0.05 indicates statistical significance.

TABLE 2. Student Confidence Using Research-Related Resources & Tools, Pre-Course

Part B2 – Questions: How confident are you about using the following?	Graduate Student Average (± standard deviation)[a]	Undergraduate Student Average (± standard deviation)[a]	Mean difference	*p*-value[b]
B2a. Rutgers University's library catalog	1.15 (± 0.69)	1.20 (± 0.71)	-0.05	0.85
B2b. CRC Handbook of Chemistry and Physics	0.92 (± 0.95)	0.81 (± 0.75)	0.11	0.67
B2c. INSPEC	0.69 (± 0.95)	0.32 (± 0.54)	0.37	0.21
B2d. PubMed	1.00 (± 1.08)	0.71 (± 0.97)	0.29	0.39
B2e. Reaxys	0.62 (± 0.77)	0.26 (± 0.51)	0.36	0.08
B2f. SciFinder	1.15 (± 0.99)	1.29 (± 1.04)	-0.14	0.69
B2g. Web of Science	1.54 (± 0.88)	0.87 (± 0.96)	0.67	0.04
B2h. RefWorks	0.69 (± 0.75)	1.13 (± 1.07)	-0.44	0.19
B2i. Cambridge Structural Database	0.77 (± 0.83)	0.48 (± 0.77)	0.29	0.28
B2j. ChemDraw	1.54 (± 0.88)	1.17 (± 1.09)	0.37	0.28
B2k. Microsoft Excel	2.00 (± 0.74)	1.84 (± 0.93)	0.16	0.60
B2l. Microsoft PowerPoint	2.31 (± 0.85)	2.32 (± 0.75)	-0.01	0.95
Overall average of B2a. - B2l.	1.19 (± 0.63)	1.04 (± 0.53)	0.15	0.40

[a]Scores range from 0 (Not confident) to 3 (Very confident).
[b]A *p*-value < 0.05 indicates statistical significance.

TABLE 3. Student Scores for the Content Knowledge Test, Pre-Course

Part C – Questions:	Graduate Student Average (± standard deviation)[c]	Undergraduate Student Average (± standard deviation)[c]	Mean difference	*p*-value[d]
C1. What kind of titles can you search for using Rutgers University's online library catalog?	0.74 (± 0.15)	0.69 (± 0.17)	0.05	0.39
C2. As part of your lab assignment, you must identify an unknown compound. Where can you find reliable (chemical or physical) properties information?	0.58 (± 0.21)	0.48 (± 0.15)	0.10	0.08
C3. Where should you look to find spectra (e.g., IR, NMR, UV) information?	0.56 (± 0.16)	0.57 (± 0.22)	-0.01	0.88
C4. Your faculty research advisor has given you a drawing of a molecule and asked that you find out what research has been done on it. Where can you go to do some structure searching?	0.62 (± 0.28)	0.60 (± 0.17)	0.02	0.86
C5. Where should you look to find synthesis reactions for making the above-mentioned molecule?	0.65 (± 0.19)	0.61 (± 0.16)	0.04	0.52
C6a. Which of the following can direct you to a supplier selling the above-mentioned molecule?[a]	0.48 (± 0.23)	0.46 (± 0.17)	0.02	0.81
C6b. Which of the following statements are generally true about review articles?[b]	0.78 (± 0.21)	0.76 (± 0.19)	0.02	0.84
C7. Which of the following helps you manage your references and assists you with in-text citations as you write your paper?	0.84 (± 0.11)	0.74 (± 0.16)	0.10	0.05
C8. Your supervisor wants you to find out how many times each of her articles published in 2010 were cited. Where should you go to determine this?	0.40 (± 0.31)	0.43 (± 0.25)	-0.03	0.74
C9. Where can you search patents?	0.48 (± 0.20)	0.46 (± 0.16)	0.02	0.65
C10. Which of the following statements are true about PubMed?	0.65 (± 0.30)	0.59 (± 0.26)	0.06	0.53
Overall average of C1. - C10.	0.62 (± 0.10)	0.58 (± 0.08)	0.04	0.17

[a]Question C6a. was only asked in 2012.
[b]Question C6b. was only asked in 2013.
[c]Scores are in decimal rather than percentage format, so the highest possible score is 1.
[d]A *p*-value < 0.05 indicates statistical significance.

TABLE 4. Chemistry Seminar Course Grade Distribution in 2013

In-class Exercises			10%
Seminar Preparation Forms			10%
Seminar Evaluation Forms			10%
Oral Presentation:			70%
	Content	30%	
	Delivery	30%	
	Visuals	10%	
	Bibliography	10%	

TABLE 5. Student Confidence Performing Research-Related Tasks, Post-Course

Part B1 – Questions: How confident are you about doing the following?	Graduate Student Average (± standard deviation)[a]	Undergraduate Student Average (± standard deviation)[a]	Mean difference	*p*-value[b]
B1a. finding books at Rutgers	2.15 (± 0.55)	2.16 (± 0.77)	-0.01	0.98
B1b. finding appropriate scholarly articles	2.62 (± 0.51)	2.55 (± 0.57)	0.07	0.71
B1c. finding (chemical or physical) properties information	2.46 (± 0.66)	2.45 (± 0.57)	0.01	0.96
B1d. finding spectra (IR, NMR, UV) information	2.38 (± 0.65)	2.03 (± 0.56)	0.35	0.08
B1e. searching for patent information	2.31 (± 0.63)	2.06 (± 0.68)	0.25	0.28
B1f. evaluating resources	2.31 (± 0.63)	2.30 (± 0.53)	0.01	0.97
B1g. accessing materials not available at Rutgers (e.g., using interlibrary loan or taking advantage of borrowing agreements)	2.38 (± 0.77)	2.13 (± 0.88)	0.25	0.37
B1h. keeping up to date with research in your field of interest (e.g., setting up alerts, RSS feeds)	2.54 (± 0.52)	2.13 (± 0.72)	0.41	0.07
B1i. properly citing sources	2.77 (± 0.44)	2.55 (± 0.51)	0.22	0.18
B1j. managing a large number of references or citations for papers or projects	2.46 (± 0.66)	2.45 (± 0.72)	0.01	0.97
B1k. managing laboratory research data	2.46 (± 0.52)	2.33 (± 0.61)	0.13	0.51
B1l. giving oral presentations	1.77 (± 1.09)	1.84 (± 0.86)	-0.07	0.82
Overall average of B1a. - B1l.	2.40 (± 0.41)	2.25 (± 0.39)	0.15	0.27

[a]Scores range from 0 (Not confident) to 3 (Very confident).

[b]A *p*-value < 0.05 indicates statistical significance.

TABLE 6. Student Confidence Using Research-Related Resources & Tools, Post-Course

Part B2 – Questions: How confident are you about using the following?	Graduate Student Average (± standard deviation)[a]	Undergraduate Student Average (± standard deviation)[a]	Mean difference	*p*-value[b]
B2a. Rutgers University's library catalog	2.08 (± 0.49)	2.23 (± 0.62)	-0.15	0.45
B2b. CRC Handbook of Chemistry and Physics	2.00 (± 0.60)	1.90 (± 0.65)	0.10	0.66
B2c. INSPEC	1.69 (± 0.63)	1.65 (± 0.88)	0.04	0.86
B2d. PubMed	2.31 (± 0.75)	2.13 (± 0.73)	0.18	0.48
B2e. Reaxys	2.46 (± 0.52)	2.10 (± 0.70)	0.36	0.10
B2f. SciFinder	2.69 (± 0.48)	2.77 (± 0.43)	-0.08	0.58
B2g. Web of Science	2.46 (± 0.52)	2.52 (± 0.57)	-0.06	0.77
B2h. RefWorks	2.62 (± 0.51)	2.61 (± 0.56)	0.01	0.99
B2i. Cambridge Structural Database	2.08 (± 0.76)	1.77 (± 0.84)	0.31	0.27
B2j. ChemDraw	2.38 (± 0.77)	2.47 (± 0.68)	-0.09	0.73
B2k. Microsoft Excel	2.46 (± 0.66)	2.71 (± 0.53)	-0.25	0.19
B2l. Microsoft PowerPoint	2.62 (± 0.65)	2.86 (± 0.36)	-0.24	0.23
Overall average of B2a. - B2l.	2.32 (± 0.32)	2.30 (± 0.34)	0.02	0.84

[a]Scores range from 0 (Not confident) to 3 (Very confident).

[b]A *p*-value < 0.05 indicates statistical significance.

TABLE 7. Student Confidence Performing Research-Related Tasks, Post-Course *vs.* Pre-Course

Part B1 – Questions: How confident are you about doing the following?	Post-course Graduate Student Average (± standard deviation)[a]	Pre-course Graduate Student Average (± standard deviation)[a]	Graduate Student Mean difference	Graduate Student *p*-value[b]	Post-course Undergraduate Student Average (± standard deviation)[a]	Pre-course Undergraduate Student Average (± standard deviation)[a]	Under-graduate Student Mean difference	Under-graduate Student *p*-value[b]
B1a. finding books at Rutgers	2.15 (± 0.55)	1.46 (± 0.97)	0.69	0.04	2.16 (± 0.77)	1.35 (± 0.66)	0.81	0.00
B1b. finding appropriate scholarly articles	2.62 (± 0.51)	1.33 (± 0.89)	1.29	0.00	2.55 (± 0.57)	1.55 (± 0.72)	1.00	0.00
B1c. finding (chemical or physical) properties information	2.46 (± 0.66)	1.67 (± 0.98)	0.79	0.05	2.45 (± 0.57)	1.45 (± 0.93)	1.00	0.00
B1d. finding spectra (IR, NMR, UV) information	2.38 (± 0.65)	1.17 (± 1.19)	1.21	0.02	2.03 (± 0.56)	1.10 (± 0.98)	0.93	0.00
B1e. searching for patent information	2.31 (± 0.63)	0.75 (± 0.75)	1.56	0.00	2.06 (± 0.68)	0.61 (± 0.72)	1.45	0.00
B1f. evaluating resources	2.31 (± 0.63)	1.17 (± 0.94)	1.14	0.01	2.30 (± 0.53)	1.17 (± 0.87)	1.13	0.00
B1g. accessing materials not available at Rutgers (e.g., using interlibrary loan or taking advantage of borrowing agreements)	2.38 (± 0.77)	1.25 (± 1.06)	1.13	0.02	2.13 (± 0.88)	1.00 (± 0.87)	1.13	0.00
B1h. keeping up to date with research in your field of interest (e.g., setting up alerts, RSS feeds)	2.54 (± 0.52)	0.67 (± 0.98)	1.87	0.00	2.13 (± 0.72)	1.16 (± 1.04)	0.97	0.00
B1i. properly citing sources	2.77 (± 0.44)	1.17 (± 0.94)	1.60	0.00	2.55 (± 0.51)	1.58 (± 1.09)	0.97	0.00
B1j. managing a large number of references or citations for papers or projects	2.46 (± 0.66)	0.75 (± 0.62)	1.71	0.00	2.45 (± 0.72)	1.30 (± 0.92)	1.15	0.00
B1k. managing laboratory research data	2.46 (± 0.52)	1.25 (± 1.14)	1.21	0.01	2.33 (± 0.61)	1.33 (± 1.03)	1.00	0.00
B1l. giving oral presentations	1.77 (± 1.09)	1.08 (± 1.00)	0.69	0.07	1.84 (± 0.86)	0.94 (± 0.77)	0.90	0.00
Overall average of B1a. - B1l.	2.40 (± 0.41)	1.14 (± 0.69)	1.26	0.00	2.25 (± 0.39)	1.23 (± 0.58)	1.02	0.00

[a]Scores range from 0 (Not confident) to 3 (Very confident).

[b]A *p*-value < 0.05 indicates statistical significance.

TABLE 8. Student Confidence Using Research-Related Resources & Tools, Post-Course *vs.* Pre-Course

Part B2 – Questions: How confident are you about using the following?	Post-course Graduate Student Average (± standard deviation)[a]	Pre-course Graduate Student Average (± standard deviation)[a]	Graduate Student Mean difference	Graduate Student *p*-value[b]	Post-course Undergraduate Student Average (± standard deviation)[a]	Pre-course Undergraduate Student Average (± standard deviation)[a]	Under-graduate Student Mean difference	Under-graduate Student *p*-value[b]
B2a. Rutgers University's library catalog	2.08 (± 0.49)	1.15 (± 0.69)	0.93	0.00	2.23 (± 0.62)	1.20 (± 0.71)	1.03	0.00
B2b. CRC Handbook of Chemistry and Physics	2.00 (± 0.60)	0.92 (± 0.95)	1.08	0.00	1.90 (± 0.65)	0.81 (± 0.75)	1.09	0.00
B2c. INSPEC	1.69 (± 0.63)	0.69 (± 0.95)	1.00	0.00	1.65 (± 0.88)	0.32 (± 0.54)	1.33	0.00
B2d. PubMed	2.31 (± 0.75)	1.00 (± 1.08)	1.31	0.00	2.13 (± 0.73)	0.71 (± 0.97)	1.42	0.00
B2e. Reaxys	2.46 (± 0.52)	0.62 (± 0.77)	1.84	0.00	2.10 (± 0.70)	0.26 (± 0.51)	1.84	0.00
B2f. SciFinder	2.69 (± 0.48)	1.15 (± 0.99)	1.54	0.00	2.77 (± 0.43)	1.29 (± 1.04)	1.48	0.00
B2g. Web of Science	2.46 (± 0.52)	1.54 (± 0.88)	0.92	0.00	2.52 (± 0.57)	0.87 (± 0.96)	1.65	0.00
B2h. RefWorks	2.62 (± 0.51)	0.69 (± 0.75)	1.93	0.00	2.61 (± 0.56)	1.13 (± 1.07)	1.48	0.00
B2i. Cambridge Structural Database	2.08 (± 0.76)	0.77 (± 0.83)	1.31	0.00	1.77 (± 0.84)	0.48 (± 0.77)	1.29	0.00
B2j. ChemDraw	2.38 (± 0.77)	1.54 (± 0.88)	0.84	0.02	2.47 (± 0.68)	1.17 (± 1.09)	1.30	0.00
B2k. Microsoft Excel	2.46 (± 0.66)	2.00 (± 0.74)	0.46	0.01	2.71 (± 0.53)	1.84 (± 0.93)	0.87	0.00
B2l. Microsoft PowerPoint	2.62 (± 0.65)	2.31 (± 0.85)	0.31	0.10	2.86 (± 0.36)	2.32 (± 0.75)	0.54	0.00
Overall average of B2a. - B2l.	2.32 (± 0.32)	1.19 (± 0.63)	1.13	0.00	2.30 (± 0.34)	1.04 (± 0.53)	1.26	0.00

[a]Scores range from 0 (Not confident) to 3 (Very confident).

[b]A *p*-value < 0.05 indicates statistical significance.

TABLE 9. Student Scores for the Content Knowledge Test, Post-Course

Part C – Questions:	Graduate Student Average (± standard deviation)[c]	Undergraduate Student Average (± standard deviation)[c]	Mean difference	*p*-value[d]
C1. What kind of titles can you search for using Rutgers University's online library catalog?	0.68 (± 0.21)	0.69 (± 0.19)	-0.01	0.88
C2. As part of your lab assignment, you must identify an unknown compound. Where can you find reliable (chemical or physical) properties information?	0.80 (± 0.24)	0.66 (± 0.22)	0.14	0.06
C3. Where should you look to find spectra (e.g., IR, NMR, UV) information?	0.74 (± 0.21)	0.71 (± 0.20)	0.03	0.71
C4. Your faculty research advisor has given you a drawing of a molecule and asked that you find out what research has been done on it. Where can you go to do some structure searching?	0.89 (± 0.16)	0.79 (± 0.16)	0.10	0.07
C5. Where should you look to find synthesis reactions for making the above-mentioned molecule?	0.88 (± 0.17)	0.80 (± 0.18)	0.08	0.15
C6a. Which of the following can direct you to a supplier selling the above-mentioned molecule?[a]	0.76 (± 0.22)	0.53 (± 0.17)	0.23	0.03
C6b. Which of the following statements are generally true about review articles?[b]	0.91 (± 0.19)	0.78 (± 0.25)	0.13	0.21
C7. Which of the following helps you manage your references and assists you with in-text citations as you write your paper?	0.97 (± 0.09)	0.80 (± 0.14)	0.16	0.00
C8. Your supervisor wants you to find out how many times each of her articles published in 2010 were cited. Where should you go to determine this?	0.87 (± 0.19)	0.69 (± 0.22)	0.17	0.02
C9. Where can you search patents?	0.73 (± 0.15)	0.55 (± 0.21)	0.18	0.01
C10. Which of the following statements are true about PubMed?	0.81 (± 0.23)	0.76 (± 0.24)	0.05	0.55
Overall average of C1. - C10.	0.82 (± 0.12)	0.71 (± 0.10)	0.11	0.00

[a]Question C6a. was only asked in 2012.

[b]Question C6b. was only asked in 2013.

[c]Scores are in decimal rather than percentage format, so the highest possible score is 1.

[d]A *p*-value < 0.05 indicates statistical significance.

TABLE 10. Student Scores for the Content Knowledge Test, Post-Course *vs.* Pre-Course

Post-course Graduate Student Average (± standard deviation)[c]	Pre-course Graduate Student Average (± standard deviation)[c]	Graduate Student Mean difference	Graduate Student *p*-value[d]	Post-course Undergraduate Student Average (± standard deviation)[c]	Pre-course Undergraduate Student Average (± standard deviation)[c]	Under-graduate Student Mean difference	Under-graduate Student *p*-value[d]
0.68 (± 0.21)	0.74 (± 0.15)	-0.06	0.41	0.69 (± 0.19)	0.69 (± 0.17)	0.00	0.97
0.80 (± 0.24)	0.58 (± 0.21)	0.22	0.01	0.66 (± 0.22)	0.48 (± 0.15)	0.18	0.00
0.74 (± 0.21)	0.56 (± 0.16)	0.18	0.01	0.71 (± 0.20)	0.57 (± 0.22)	0.14	0.00
0.89 (± 0.16)	0.62 (± 0.28)	0.27	0.01	0.79 (± 0.16)	0.60 (± 0.17)	0.19	0.00
0.88 (± 0.17)	0.65 (± 0.19)	0.23	0.00	0.80 (± 0.18)	0.61 (± 0.16)	0.19	0.00
0.76 (± 0.22)	0.48 (± 0.23)	0.28	0.21	0.53 (± 0.17)	0.46 (± 0.17)	0.07	0.21
0.91 (± 0.19)	0.78 (± 0.21)	0.13	0.17	0.78 (± 0.25)	0.76 (± 0.19)	0.02	0.82
0.97 (± 0.09)	0.84 (± 0.11)	0.13	0.00	0.80 (± 0.14)	0.74 (± 0.16)	0.06	0.13
0.87 (± 0.19)	0.40 (± 0.31)	0.47	0.00	0.69 (± 0.22)	0.43 (± 0.25)	0.26	0.00
0.73 (± 0.15)	0.48 (± 0.20)	0.25	0.01	0.55 (± 0.21)	0.46 (± 0.16)	0.09	0.03
0.81 (± 0.23)	0.65 (± 0.30)	0.17	0.01	0.76 (± 0.24)	0.59 (± 0.26)	0.17	0.00
0.82 (± 0.12)	0.62 (± 0.10)	0.20	0.00	0.71 (± 0.10)	0.58 (± 0.08)	0.13	0.00

[a]Question C6a. was only asked in 2012.
[b]Question C6b. was only asked in 2013.
[c]Scores are in decimal rather than percentage format, so the highest possible score is 1.
[d]A *p*-value < 0.05 indicates statistical significance.

Part C – Questions:
C1. What kind of titles can you search for using Rutgers University's online library catalog?
C2. As part of your lab assignment, you must identify an unknown compound. Where can you find reliable (chemical or physical) properties information?
C3. Where should you look to find spectra (e.g., IR, NMR, UV) information?
C4. Your faculty research advisor has given you a drawing of a molecule and asked that you find out what research has been done on it. Where can you go to do some structure searching?
C5. Where should you look to find synthesis reactions for making the above-mentioned molecule?
C6a. Which of the following can direct you to a supplier selling the above-mentioned molecule?[a]
C6b. Which of the following statements are generally true about review articles?[b]
C7. Which of the following helps you manage your references and assists you with in-text citations as you write your paper?
C8. Your supervisor wants you to find out how many times each of her articles published in 2010 were cited. Where should you go to determine this?
C9. Where can you search patents?
C10. Which of the following statements are true about PubMed?
Overall average of C1. - C10.

TABLE 11. Usefulness of Library Sessions According to Students, Post-Course

Part D1 – Questions: How helpful do you think the library sessions were/will be for the following?	Graduate Student Average (± standard deviation)[a]	Undergraduate Student Average (± standard deviation)[a]	Mean difference	*p*-value[b]
D1a. helping you complete the in-class exercises?	2.69 (± 0.48)	2.60 (± 0.56)	0.09	0.61
D1b. helping you complete your course project (i.e., the oral presentation)?	2.54 (± 0.52)	2.43 (± 0.77)	0.11	0.66
D1c. making you more engaged with the chemistry department's seminar series presentations?	2.69 (± 0.48)	2.53 (± 0.73)	0.16	0.48
D1d. the rest of your educational career?	2.85 (± 0.38)	2.50 (± 0.63)	0.35	0.07
D1e. your professional career?	2.85 (± 0.38)	2.40 (± 0.72)	0.45	0.01
Overall average of D1a. - D1e.	2.72 (± 0.30)	2.50 (± 0.61)	0.22	0.17

[a]Scores range from 0 (Not useful) to 3 (Very useful).

[b]A *p*-value < 0.05 indicates statistical significance.

APPENDIX I. Pre-course Assessment Form (2013)

A. General Information

A1. What is your study ID number? __________

A2. Which of the following best describes you?

- o freshman (undergraduate)
- o sophomore (undergraduate)
- o junior (undergraduate)
- o senior (undergraduate)
- o graduate student
- o Other: __________

A3. What kind of degree are you pursuing at Rutgers University-Newark?

- o non-ACS Bachelor's degree
- o ACS-approved Bachelor's degree
- o Master's degree
- o Ph.D. degree
- o Other: __________

A4. How many years of study have you completed at Rutgers?

- o 0
- o 1
- o 2
- o 3
- o 4
- o Other: __________

A5. Did you take the Chemistry Writing course (21:160:350) yet?

- o Yes, in Spring 2012
- o Yes, in Spring 2013
- o Not yet, but I will in Spring 2014
- o N/A – I am a graduate student
- o Other: __________

B. How Confident Are You About Your Information Literacy Skills?

B1. How confident are you about doing the following?

	Not confident	Somewhat confident	Confident	Very confident
a. finding books at Rutgers				
b. finding appropriate scholarly articles				
c. finding (chemical or physical) properties information				
d. finding spectra (IR, NMR, UV) information				
e. searching for patent information				
f. evaluating resources				
g. accessing materials not available at Rutgers (e.g., using interlibrary loan or taking advantage of borrowing agreements)				
h. keeping up to date with research in your field of interest (e.g., setting up alerts, RSS feeds)				
i. properly citing sources				
j. managing a large number of references or citations for papers or projects				
k. managing laboratory research data				
l. giving oral presentations				

B2. How confident are you about using…

	Not confident	Somewhat confident	Confident	Very confident
a. Rutgers University's library catalog				
b. CRC Handbook of Chemistry and Physics				
c. INSPEC				
d. PubMed				
e. Reaxys				
f. SciFinder				
g. Web of Science				
h. RefWorks				
i. Cambridge Structural Database				
j. ChemDraw				
k. Microsoft Excel				
l. Microsoft PowerPoint				

B3. What are some of the challenges or difficulties you encounter when looking for or using information?
What (other) skills would you like to learn in this course about doing literature research?

C. Content Knowledge Test

C1. What kind of titles can you search for using Rutgers University's online library catalog?
Choose ALL that apply.

- ☐ articles about a certain topic
- ☐ books about a certain topic
- ☐ book titles
- ☐ journal titles

C2. As part of your lab assignment, you must identify an unknown compound. Where can you find reliable (chemical or physical) properties information?
Choose ALL that apply.

- ☐ CRC Handbook of Chemistry and Physics
- ☐ Reaxys
- ☐ SciFinder
- ☐ Web of Science

C3. Where should you look to find spectra (e.g., IR, NMR, UV) information?
Choose ALL that apply.

- ☐ PubMed
- ☐ Reaxys
- ☐ SciFinder
- ☐ Web of Science

C4. Your faculty research advisor has given you a drawing of a molecule and asked that you find out what research has been done on it. Where can you go to do some structure searching?
Choose ALL that apply.

- ☐ PubMed
- ☐ Reaxys
- ☐ SciFinder
- ☐ Web of Science

C5. Where should you look to find synthesis reactions for making the above-mentioned molecule?
Choose ALL that apply.

- ☐ PubMed
- ☐ Reaxys
- ☐ SciFinder
- ☐ Web of Science

C6. Which of the following statements are generally true about review articles?
Choose ALL that apply.

- ☐ Review articles offer readers an introduction about a topic
- ☐ Review articles summarize the research that has been done for a topic
- ☐ Review articles discuss where research for a topic may be headed in the future
- ☐ Review articles lack references

C7. Which of the following helps you manage your references and assists you with in-text citations as you write your paper?
Choose ALL that apply.

- ☐ EndNote
- ☐ PubMed
- ☐ RefWorks
- ☐ SciFinder

C8. Your supervisor wants you to find out how many times each of her articles published in 2010 were cited. Where should you go to determine this?
Choose ALL that apply.

- ☐ Reaxys
- ☐ RefWorks
- ☐ SciFinder
- ☐ Web of Science

C9. Where can you search patents?
Choose ALL that apply.

- ☐ Reaxys
- ☐ SciFinder
- ☐ uspto.gov
- ☐ Web of Science

C10. Which of the following statements are true about PubMed?
Choose ALL that apply.

- ☐ PubMed includes records from MEDLINE.
- ☐ PubMed is full-text only database.
- ☐ PubMed is put together by the National Library of Medicine.
- ☐ You can search PubMed for biomedical literature.

APPENDIX II. Examples of In-class Exercises (2013)

Week #4: Literature Searching

❖ ***SciFinder***

1) Find all the publications (articles, conference proceedings, and/or patents) written by your assigned seminar speaker (**Dr. Krzysztof Szalewicz**) since 2005.
   a) According to SciFinder, how many CONFERENCE PROCEEDINGS has he done since 2005?
   b) How many JOURNAL ARTICLES has he authored or co-authored since 2005?
   c) Which one was cited the most?
      i) How many times was it cited?
      ii) Provide the citation to that article using the ACS *Biochemistry* journal style.
   d) How many REVIEW ARTICLES has Dr. Szalewicz authored or co-authored since 2005?
   e) Import only the REVIEW ARTICLE citations into the appropriate RefWorks folder set up in Part I. Create a bibliography for these citations following the style used in the ACS *Biochemistry* journal:
   f) Share this subfolder by providing the appropriate RefWorks URL here:
2) What kind of research has your seminar speaker been focusing on these past few years? How did you determine this? (2-3 sentences maximum)

❖ ***Web of Science***

1) Find all the publications written by your assigned seminar speaker (**Dr. Krzysztof Szalewicz**) since 2005.
   a) According to Web of Science, how many CONFERENCE PROCEEDINGS has he done since 2005?
   b) How many JOURNAL ARTICLES has he authored or co-authored since 2005?
   c) Which one was cited the most?
      i) How many times was it cited?
      ii) Provide the citation to that article using the ACS *Biochemistry* journal style:
   d) How many REVIEW ARTICLES has Dr. Szalewicz authored or co-authored since 2005?
   e) Import only the REVIEW ARTICLE citations into the appropriate RefWorks folder set up in Part I. Create a bibliography for these citations following the style used in the ACS *Biochemistry* journal:

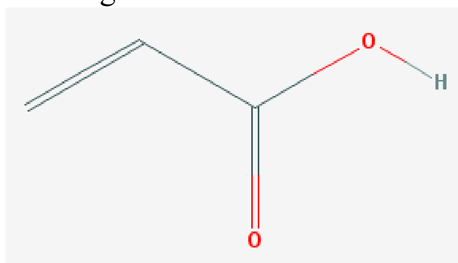
❖ ***Reflection***

1) How did your results from Part II and III compare? If they were different, why do you think that might be? (2-3 sentences maximum)
2) Please note if there was anything about today's session you found unclear. This is also the space to include any additional questions you may have about today's discussion.

Week #5: Structure Searching

❖ ***SciFinder***

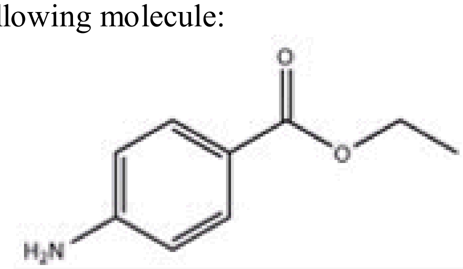
Using SciFinder, identify the following molecule:



a) What is its CAS number?
b) What is the total number of references for this substance?
c) How is this substance generally used?
d) What is one of its experimental melting points?
    i) Cite your source following the ACS *Biochemistry* journal formatting style.
e) Come up with 1 possible way to synthesize the compound where the product yield is at least 95%.
    i) Copy and paste the reaction here:
    ii) Cite your source following the ACS *Biochemistry* journal formatting style.

❖ ***Reaxys***

Using Reaxys, identify the following molecule:



a) What is its CAS number?
b) What is the total number of references for this substance?
c) How is this substance generally used?
d) How many publications are there in Reaxys that reference its melting point?
e) Come up with 1 possible way to synthesize the compound where the percentage yield is greater than 95%.
    i) Copy and paste the reaction here:
    ii) Cite your source following the ACS *Biochemistry* journal formatting style.

❖ ***Reflection***

Please note if there was anything about today's session you found unclear. This is also the space to include any additional questions you may have about today's discussion.

Week #7: PubMed & INSPEC

❖ ***PubMed***

Find everything in PubMed that has your assigned seminar speaker (**Dr. Steven Almo**) listed as an author **in 2013**.

a) According to PubMed, how many items in 2013 has him listed as an author?
b) Of these, how many of them are FREE for everyone to read?
c) Import the citations for *all* of them into an appropriate RefWorks folder and create a bibliography for them following the style used in the ACS *Biochemistry* journal:

❖ ***INSPEC***

Find all the publications in INSPEC written by your assigned seminar speaker (**Dr. Steven Almo**) in **2013**.

a) According to INSPEC, how many JOURNAL ARTICLES has he authored or co-authored in 2013?
b) Import the citations for *all* of them into an appropriate RefWorks folder and create a bibliography for them following the style used in the ACS *Biochemistry* journal:

❖ ***Reflection***

1) How did your results from PubMed and INSPEC compare? If they were different, why do you think that might be? (2-3 sentences maximum)
2) Please note if there was anything about today's session you found unclear. This is also the space to include any additional questions you may have about today's discussion.

APPENDIX III. Seminar Evaluation Form

CHEMISTRY 453 & 601 – SEMINAR ***Presentation Evaluation Form***

Date: ______________________________ Name of Speaker: ______________________________

Title of Presentation: ______________________________ Speaker's Affiliation: ______________________________

	Strongly Agree	Agree	Disagree	Strongly Disagree	Not Applicable
CONTENT					
Enough background information was provided to orient me to the topic					
Information was presented in a logical order					
I was able to follow the main points of the presentation					
Transitions between sections were smoothly executed					
The speaker understood his/her topic well					
Supporting materials were referenced during the presentation					
Supporting materials were of relevant, current, and of high-quality					
The presentation was free of irrelevant information					
The conclusion clearly summarized the content of the presentation					
Questions were repeated and answered in an adequate manner					
I learned something new during this presentation					
VISUALS					
Visuals were appropriate and effectively used to enhance the speaker's presentation					
Visuals were easy to read					
Visuals were free from spelling and grammar errors					
Visuals were displayed for an appropriate amount of time					
DELIVERY					
The speaker spoke clearly and loudly enough to be heard					
The speaker spoke at an appropriate pace					
The speaker made adequate eye contact with the audience and did not just read from his/her slides/notes					
The speaker held my attention well, keeping me interested					

Do you have any additional comments or suggestions regarding this speaker? ______________________________

____

What overall grade would you assign this presentation? A B+ B B- C+ C D F

Print Your Name: ______________________________ Your Signature: ______________________________

Return this completed form promptly to Dr. Lalancette, Olson 010, NO LATER THAN 1:30PM on the day of the seminar.

APPENDIX IV. Examples of a Seminar Preparation Form

Seminar Preparation Form – Dr. Emmanuel Lacôte (Laboratory of Chemistry, Catalysis, Polymers and Process – Lyon, France)

CHM seminar course – Fall 2013

The topic of Dr. Emmanuel Lacôte's seminar talk on 11/1/2013 will be Exploring the Organic/Inorganic Interface. Find an article written by him about this topic. Provide a proper citation below and include 2-3 sentences about what you think this week's seminar talk will be about.

Remember: This form must be filled out BEFORE the seminar talk is given!

Your Last Name: *(Surname)* __________

Your First Name: __________

Article citation:
Follow the style of ACS's Biochemistry journal.

In 2-3 sentences, briefly describe what you think this week's seminar talk will be about.
Base your answer on the article cited above.

APPENDIX V. Post-course Assessment Form (2013)

A. General Information

A1. What is your study ID number? __________

B. How Confident Are You About Your Information Literacy Skills?

B1. How confident are you about doing the following?

	Not confident	Somewhat confident	Confident	Very confident
a. finding books at Rutgers				
b. finding appropriate scholarly articles				
c. finding (chemical or physical) properties information				
d. finding spectra (IR, NMR, UV) information				
e. searching for patent information				
f. evaluating resources				
g. accessing materials not available at Rutgers (e.g., using interlibrary loan or taking advantage of borrowing agreements)				
h. keeping up to date with research in your field of interest (e.g., setting up alerts, RSS feeds)				
i. properly citing sources				
j. managing a large number of references or citations for papers or projects				
k. managing laboratory research data				
l. giving oral presentations				

B2. How confident are you about using…

	Not confident	Somewhat confident	Confident	Very confident
a. Rutgers University's library catalog				
b. CRC Handbook of Chemistry and Physics				
c. INSPEC				
d. PubMed				
e. Reaxys				
f. SciFinder				
g. Web of Science				
h. RefWorks				
i. Cambridge Structural Database				
j. ChemDraw				
k. Microsoft Excel				
l. Microsoft PowerPoint				

B3. What are some of the challenges or difficulties you are still encountering when looking for or using information?
What (other) skills would you like to learn in this course about doing literature research?

C. Content Knowledge Test

C1. What kind of titles can you search for using Rutgers University's online library catalog?
Choose ALL that apply.

- ☐ articles about a certain topic
- ☐ books about a certain topic
- ☐ book titles
- ☐ journal titles

C2. As part of your lab assignment, you must identify an unknown compound. Where can you find reliable (chemical or physical) properties information?
Choose ALL that apply.

- ☐ CRC Handbook of Chemistry and Physics
- ☐ Reaxys
- ☐ SciFinder
- ☐ Web of Science

C3. Where should you look to find spectra (e.g., IR, NMR, UV) information?
Choose ALL that apply.

- ☐ PubMed
- ☐ Reaxys
- ☐ SciFinder
- ☐ Web of Science

C4. Your faculty research advisor has given you a drawing of a molecule and asked that you find out what research has been done on it. Where can you go to do some structure searching?
Choose ALL that apply.

- ☐ PubMed
- ☐ Reaxys
- ☐ SciFinder
- ☐ Web of Science

C5. Where should you look to find synthesis reactions for making the above-mentioned molecule?
Choose ALL that apply.

- ☐ PubMed
- ☐ Reaxys
- ☐ SciFinder
- ☐ Web of Science

C6. Which of the following statements are generally true about review articles?
Choose ALL that apply.

- ☐ Review articles offer readers an introduction about a topic
- ☐ Review articles summarize the research that has been done for a topic
- ☐ Review articles discuss where research for a topic may be headed in the future
- ☐ Review articles lack references

C7. Which of the following helps you manage your references and assists you with in-text citations as you write your paper?
Choose ALL that apply.

- ☐ EndNote
- ☐ PubMed
- ☐ RefWorks
- ☐ SciFinder

C8. Your supervisor wants you to find out how many times each of her articles published in 2010 were cited. Where should you go to determine this?
Choose ALL that apply.

- ☐ Reaxys
- ☐ RefWorks
- ☐ SciFinder
- ☐ Web of Science

C9. Where can you search patents?
Choose ALL that apply.

- ☐ Reaxys
- ☐ SciFinder
- ☐ uspto.gov
- ☐ Web of Science

C10. Which of the following statements are true about PubMed?
Choose ALL that apply.

- ☐ PubMed includes records from MEDLINE.
- ☐ PubMed is full-text only database.
- ☐ PubMed is put together by the National Library of Medicine.
- ☐ You can search PubMed for biomedical literature.

D. Evaluation of Library Sessions

D1. How helpful do you think the library sessions were/will be for...

	Very useful	Useful	Somewhat useful	Not useful
a. helping you complete the in-class exercise				
b. helping you complete your course project (i.e., the oral presentation)?				
c. making you more engaged with the chemis department's seminar series presentations?				
d. the rest of your educational career?				
e. your professional career?				
Overall average of a. - e.				

D2. Which resources did you use to do complete your oral presentation project?
(Please include ALL resources - whether it's databases covered in class or other resources.)

D3. What did you find to be most valuable?
(whether it's specific topics we covered / class format / something else)

D4. What did you find to be least valuable?
(whether it's specific topics we covered / class format / something else)

D5. What was the most difficult part of the course?
And is anything still unclear?

D6. Do you have any suggestions for improvement?
(e.g., Is there anything you would have liked more of? Less of?)

D7. Any additional comments?