

Aiding Undergraduate Students in Understanding the Scientific Research Process through Collaboration of Chemistry Faculty and the Science Librarian

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Abstract

This paper reports on the successes of a collaborative effort between science faculty and a science librarian at the University of Arkansas in order to help freshman chemistry students increase their information literacy skills to the point that it motivated them to pursue scientific research projects. The results of a follow-up survey to identify whether this collaborative arrangement helped the students in their subsequent engagement in research work are presented.

The objectives of this collaboration were two-fold. First, the aims of the science faculty were: 1) to expose honors students in their second semester general chemistry course to the applications of chemical principles across scientific disciplines, and 2) to help the students seek out their professors and discuss with them one of their projects which they had already researched prior to the interview. The intention was to expose the freshman honors students to the wide range of research being conducted at the University and encourage them to get involved with undergraduate research early in their college career. It was felt that getting students hooked on doing scientific research early in their university careers would be beneficial in engaging them in their disciplines. An added advantage was the hope that engaging students early on in their university career would help increase the University's undergraduate retention rate.

Second, the librarian's aims were 1) to foster ties with the science faculty so that they will be amenable to set aside time for information literacy instruction, and 2) to engage the students in learning basic information literacy skills which will have lifelong advantages.

Hypotheses

- (1) If students are comfortable approaching and having meaningful discussions with a faculty member, they might be more inclined to seek out faculty with whom they could get involved with research.
- (2) Becoming comfortable in approaching a faculty member to discuss research requires students to be trained in information literacy skills, and more specifically, in methods of putting context around a search to find information relating to a professor and his/her research.
- (3) If students are exposed to different professors' research projects and their requirements for undergraduate research in their freshman year, students might be more likely to be engaged in research.

Objectives of the Semester-long Honors Drill (included two one-hour Library Instruction Sessions):

To expose the students in this second-semester general chemistry course to the many applications of chemical principles across scientific disciplines

To expose the students to the techniques of finding information

To help the students be successful in applying for and being accepted into a research lab of their choice

Specific Objectives

To help the students acquire the skills necessary to seek out and become comfortable communicating with a professor

To be introduced to the wide range of research that is being conducted at the University of Arkansas in a variety of departments and colleges.

To show students that chemical principles are used not only in research in a chemistry department but throughout the university in various departments and colleges

To introduce information literacy skills to the students

To add context to these skills by teaching them by means of hands-on instruction how to find information on a particular professor and his research which they might find useful in breaking the ice, and for fostering meaningful discussions in interviewing the professor

Description of the Course, Content and Assessment

CHEM 1123H-D001 is a drill for honors students attending University Chemistry II, which meets one hour per week during the semester. The grade for the drill is incorporated into the lecture course grade and points received are equivalent to those earned in one lecture exam. This drill was established as the portion of the honors university Chemistry II class in which honors students can earn honors credit by engaging in activities beyond what is expected of students in the non-honors course.

The professor/instructor in charge of this drill has the freedom to pursue activities of his/her choosing to actively engage the students. After discussions with chemistry department faculty, it became evident that honors students were waiting until late in their college career to begin looking for an active research lab. It was decided to use this drill class as the medium to encourage students early in their college career to explore the different types of active research going on at the University of Arkansas and to strongly encourage them to begin looking now for a position in a research lab of interest to them. If different professors were invited to the drill every week to talk about their research, this would expose the students to approximately 12 professors and their research projects in yet another lecture setting. However, if groups of two or three students in the drill interviewed professors doing active research and presented a short talk about the information gleaned, the drill students would be exposed to the research projects of twenty or more professors. Also, the student were placed in the path of discovery, being actively engaged in obtaining, processing and presenting the information, as well as learning about

resources available and how to use them as efficiently as possible. Small group interviews can also build confidence in the students to the point that they will be more inclined to seek out a professor of interest and be better prepared to have a meaningful one-on-one meeting with him.

Procedure

The following steps were taken to prepare the students to find and interview professors:

Navigating the University's website

The first step was to have the students identify different professors who participate in active research on topics in which the student has an interest. To facilitate this search, students are shown in the drill class how to navigate within the University of Arkansas website to different colleges, departments and professors' websites. Each student was asked to find three professors whose research interested them and to copy the first page of their website to hand in at the next drill meeting. They were also asked to prioritize the three professors with respect to their own interest in the research. Each student was allowed to find only one professor in the department of their major. The other two professors had to be identified from different departments or colleges. In this way the students would get experience navigating through a variety of departmental and professors' webpages and begin to see that there are many research opportunities in other departments/colleges that are cross-disciplinary and applicable to their majors.

Forming groups and deciding upon a professor to interview

In the next drill session the students were required to identify the professor and discipline that they had prioritized as their number one choice. The students were then asked to form groups of a specified number (usually three, depending on the number of students in the class and on the number of drill sessions that can be dedicated to presentations) within a ten-minute time span. For the most part, although there was some chaos, the students have done well in forming their own groups without much help from the professor/instructor of the drill. Once the group has been formed, the students fill out a form with the names of the group members and the top two choices of professors that the group would like to interview.

Scheduling the interview with the professor

Each group was given two weeks in which to schedule an interview with either their first- or second-ranked professor. The students were given a specified three-week period in which to conduct their interview; this period was intentionally set to start after the first library session. General tips on how to obtain an interview were also given in the class.

The Library Instruction information

The library portion of this course consisted of two fifty-minute instruction sessions of blended learning. This included a demonstration followed by hands-on practice. Various information resources and general assistance available to an undergraduate student at the University of Arkansas were covered in the session. At the end of the two information literacy sessions it was hoped that students would be able to: identify the need for information, formulate questions based on an information need, develop successful search strategies using Boolean AND, OR, to identify potentially useful sources of information, and to write citations according to the APA style.

Specifically, in the library instruction sessions, students were trained on the following: how to choose a topic (brainstorming, browsing, etc.), use of encyclopedias and dictionaries to understand a topic, steps in formulating successful search strategies (keywords vs. concepts, Boolean logic, etc.), and techniques for refining a topic (fields and records, subjects, thesaurus and controlled vocabulary).

Web of Science was chosen as the database in order to: 1) demonstrate the concept and structure of a database to find articles on a topic, 2) to find the most cited paper, 3) to find articles published by an author and the author's most cited reference, 4) how to use the references cited, the citing papers, and the related records feature, 5) and to identify useful information for research on any topic. Since the students were not all chemistry majors, they were also shown how the same searching techniques are applicable to other subject areas using other their subject-specific databases. It was hoped that the information presented will not only help the students in finding papers authored by the professors to be interviewed but will also help them in their research and writing in current and future semesters. Assignments related to the material taught in each of the sessions were given by the faculty to be completed after each class. These were graded by the professor and returned.

Developing interview questions

Before the three-week interview period began, each group developed a list of at least fifteen interview questions based on information found while searching in the databases and faculty websites, reading journal articles authored by the professor to be interviewed (each member of the group was to read a different article), and from the requirements for the group paper which was to be handed in towards the end of the semester. A copy of each group's questions was turned in.

Interviewing the professor

Each group had the autonomy to conduct the interview as they saw fit. They were informed that they needed to obtain permission from the professor at the beginning of the interview if they were interested in recording the interview or taking any pictures. Letting the groups explore different ways of interviewing helps the individuals and groups to take control of this part of the project, to learn about interviewing techniques, and then to be able to evaluate the positive and negative aspects of the interview process.

Professor interview presentations

After the interview, each group was required to give a PowerPoint presentation lasting between 4-7 minutes to their colleagues in the drill about the professor they had interviewed. Each student in the group was expected to present on some aspect of the information learned from the interview and to speak approximately the same amount of time as other students in the group.

In previous sessions toward the beginning of the semester, at least two professors (one from chemistry and others from various departments) were invited to the drill to talk about their research. While the research information presented was valuable to the students, seeing a professor giving a presentation was also very beneficial. This gave the students a chance to evaluate what they liked about the presentation that they could emulate in their own presentations.

Professor interview papers—group and individual

Each group was to write a paper with the information learned from the interview. Technical aspects for each paper and the expected minimum content was discussed at the beginning of the project and made available in a handout and posted on Blackboard Learning Systems (a tool for instructors to give students resources and to engage students in learning and collaboration) throughout the semester. To make sure that the student and groups of students have started with the writing process after the interview, a rough draft of each paper was requested two weeks before the final paper was due. If pictures and/or information sources were used in the paper, students were expected to provide citations at the end of the paper in a standardized format.

Early in the semester the director from the University of Arkansas Quality Writing Center (QWC) on campus visited the class to explain who they are and to give details about the services they offer that can help the students in writing papers. The students were free to ask for assistance from this

Center. In some semesters, the QWC director held a writing workshop during one of the drill sessions in which a current group's rough draft of their group paper was critiqued and evaluated by fellow drill students in order to assist all of the drill students in writing good papers.

Results of the Survey and Discussions

Demographics

Table 1: Survey – Questionnaires and Responses

<i>Year</i>	<i>No. of Questionnaires</i>	<i>Year</i>	<i>No. of Respondents</i>	<i>% Respondents</i>
2007	38	2007	10	26
2008	59	2008	28	47
2009	51	2009	30	59
2010	48	2010	30	63
Total	196		98	50

Surveys were sent to 196 students who had participated in the course from Spring 1997 to Fall 2010. Of these, 98 responses were received—a 50-percent response rate (See Table 1 above). Twenty-nine percent of the respondents were sophomores, 34 percent juniors, 30 percent seniors, and 8 percent were classed as “others.” Forty-six percent of the respondents were below 21 years of age, while 52 percent of the respondents were between 21 and 25 years of age. Forty-two percent of the respondents were male and 58 percent were female.

Of the 97 respondents to the question “*do you feel that this course increased your knowledge of how to get involved in research?*” 63 of them (i.e., 65%) answered “yes” or “somewhat” indicating that they have benefitted from this class. Of the students that responded, 64 percent of the sophomores, 70 percent of the juniors, and 67 percent of the seniors found the course increased their knowledge and taught them how to get involved with research. Sixty-eight percent of those who responded were under 20 years of age and 62 percent of them between 21 and 25 years old found this experience to be positive. Sixty-four percent of the females who responded and 76 percent of the males found that this class helped them in some way in their pursuit of research opportunities.

Several students commented on the usefulness of the course in helping them to become aware of resources or assisting them to explore research opportunities now or later. One student succinctly put it: “I learned how to find out what type of research a professor does, how to contact a professor, and [I gained] firsthand experience on questions to ask the professor once I meet him/her.” Another pointed out that “through the class we were able to interview professors involved in research in order to make a name for ourselves amongst professors for later research opportunities.” Another student obtained a referral from his interviewed professor and said “after meeting with Dr. Ralph Henry, I scheduled a follow-up appointment with him and he helped me get involved with my current research advisor Dr. Daniel Fologea.” Another student stated that “I had only a cursory knowledge of research prior to the interview and discussions presented during the drill.” Other students’ comments included: “this course did help me to realize the importance of getting involved in research early,” and “the student panel that came emphasized the urgency of finding a professor to work with.”

Of the 96 respondents to the question “*Do you feel at the end of this course, you could conduct an informative interview,*” 74 percent felt that this course had or may have contributed to their knowledge of being able to conduct an informative interview. Of the 55 female and 40 males that responded to this question, 77 percent and 86 percent respectively felt that they could now conduct an informative interview. The male respondents were more overwhelmingly positive.

Of the 96 respondents who answered the question: “*Do you feel that the interview experience with a professor was informative or productive?*” 74 percent found that the experience was definitely or somewhat useful. Of these, 64 percent of the sophomores, 78 percent of the juniors, 74 percent of the seniors and 71 percent of the others found that the experience with a professor was informative or productive. Seventy-three percent of the females and 73 percent of the male that responded also responded positively. Based on the survey, it seems that more juniors and seniors now appreciate the value of the interview experience because they may have been involved with research for a few years.

One respondent pointed out that “Students rarely get to talk to professors outside of their discipline... but I am not a chemistry student so I enjoyed it.” Another respondent indicated that “Having to go and talk to a faculty member about their research and how to look them up ahead of time was useful.” While others alluded to the usefulness of the class in that it “helped us become aware of the research component of our majors, [this] was a very murky concept before this class,” and “the interview was really good, I remembered most of what we talked about. I can’t remember his name but he really gave some good advice that I have continued to use.”

In order to improve the interviewing experience, it was suggested that a “series of mock interviews should be conducted in class, or even better, students should interview one another in front of the rest of the student body, so as to simulate the natural stress of an actual interview situation. “

Of the 98 respondents who answered the question “*Did your experience(s) from talking with your chosen faculty member make any of the following easier,*” 63 percent felt that it made approaching other faculty members easier; of these, 59 percent were female respondents and 69 percent were males; 48 percent felt that it made selecting a professor to do research easier; of these, 41 percent were female respondents and 59 percent were males; 50 percent felt that this class helped them in getting involved with active research; of these, 43 percent were female respondents and 55 percent were males; 55 percent felt that this class helped them in getting motivated to start research very early in the process; of these, 49 percent were female and 61 percent of them male. Sixty two percent of the respondents felt that this class helped them understand how research is conducted.

Of the 97 respondents to the question, “*if you would need to find information on a research topic, are you comfortable using the library databases?*” 91 percent of the students felt that they were comfortable using library databases to do research. Eighty-two percent of these respondents were sophomores, 94 percent were juniors and 96 percent were seniors. Ninety percent of the male respondents and 90 percent of the female respondents felt that they were comfortable in searching databases. More juniors and seniors felt that they were comfortable searching databases because they would have had several instruction sessions before taking the survey, whereas the sophomores may only have had the benefit of this particular instruction.

To an open-ended question, 43 respondents identified databases by name that they continue to use on a regular basis. Some respondents identified more than one database.

Twenty-six percent of the respondents identified EBSCOHost databases without naming any specific ones, 22 percent identified PubMed, 15 percent SciFinder Scholar, 13 percent Web of Science and Google Scholar, 7 percent JSTOR, and 3 percent PsycINFO. This question sought to identify recall of databases rather than provide a listing. This open-ended question was to gauge whether students would recall the names of databases they were using rather than provide a listing from which to select. It was reassuring to note that not one student mentioned Google as a source used on a regular basis to find information on a research topic. Many students may have identified EBSCOHost as the database they use on a regular basis because this is one database that is prominently displayed on the Libraries' home page and is listed under the top ten databases link. Our library has subscribed to EBSCO Search Premier as a full-text undergraduate database, which makes it easy for students to get the full-text of articles even though it does not have the depth of coverage that the other science-related databases do.

On a later question in the survey, students were given six possible information sources to pick which one(s) they used to find information on faculty's research or any research that they were engaged in. Thirty-eight percent (i.e., 27 students) identified Google, 64 percent (46 students) Google Scholar, 51 percent (37 students) SciFinder, 36 percent (26 students) Web of Science, 31 percent (22 students) identified other students, and 13 percent (9 students) identified other sources. These sources included the University's webpage, talking to faculty and departmental professors, PubMed and PsycINFO. It is informative to note that 31 percent of the students used other students as one of their information sources. It was comforting to learn that many students are still using many of the library's subscription databases as sources to retrieve information.

Of the 98 respondents to the question: *"If you were to approach a faculty member about working with him/her research project, please identify all that you would do before meeting with him,"* 95 were likely to search the departmental website to find out more about the professor and his research. This included 96 percent of the female and 97 percent of the male respondents.

Eighty of the 98 respondents to the above question (82 percent of them—84 percent female and 81 percent male) would search relevant subject databases to find out about a professor's research. Fifty eight percent of them (59% female and 57% male) would use the Web of Science to identify the professor's top papers. This is understandable because the students can use other equally useful databases, such as Google Scholar, SciFinder and PubMed to find useful information for their research. Using Web of Science has the added advantage of being able to identify an author's top cited paper, and a user can use this paper to find many more useful references. Google Scholar can give a user a good indication of an author's top paper also but no capability exists to use this to study the literature in more depth. Web of Science is only one of the many databases that our students can use to find useful papers.

Eighty three of the 98 students (85 percent; 91 percent female and 76 percent male) would make a list of questions to discuss before meeting with a professor. It is hoped that students would use the databases to identify papers from which they will compile their list of questions. This result shows that many of the students who responded may continue to use the information sources to retrieve useful papers and hence make informative decisions. Other methods students said they used in finding a professor for research included talking to other students who have done research or other workers from a particular lab they were interested in.

Since attending this class, 40 percent of the students (n=97, 41 percent of female respondents and 40 percent male) worked on a research project with a faculty member. As is expected, only 11 percent of the sophomore and 28 percent of the juniors have worked on a

research project so far, as compared to 76 percent of seniors and 63 percent of the other category. No doubt more sophomores and juniors will participate in research projects when they become juniors and seniors, respectively.

Forty-two percent of the 98 respondents (41 percent female and 44 percent male) are currently working on a research project with a faculty member. Among these are 25 percent sophomores, 39 percent juniors, 66 percent seniors and 25 percent “other.” This result is expected as seniors still in the honors program is required to submit a theses for graduation. Of the 61 students that responded to the question “*do you believe this course helped you get involved with the research project,*” 54 percent felt that this course helped them in some way to get involved with the project they have worked on or are currently engaged in. As to whether the students would recommend the course to other students, of the 98 students that responded to this question, 64 percent felt that they are likely to recommend this course to other students.

Among the reasons the additional 36 percent of those who responded that they will not recommend the class are: they felt the course is a lot of busy work, many expected to get an easy one-hour credit without having to do assignments and be graded on them, and some were simply not interested in doing research or did not appreciate the relevance of the course to their freshman chemistry class. As one student expresses it “I have recommended this course to students in the past, but mainly because it is an easy way to get honors credit.”

Regarding the question on whether the students would recommend the library instruction sessions to other students, of the 98 students that responded to this question, 64 percent felt that they are likely to recommend this course to other students. Some of the comments from those students who would recommend the course are: “the library sessions provided us with new and useful information”; “I never would have known about the organic chemistry modeling websites if it hadn't been for the library sessions. I also would have still been only using Google Scholar for my research project”; “It was helpful to see what other databases were available and how they were navigated”; “It is important to know how to use the databases when writing research papers or working on your own research project”; “Info sessions in library resources are helpful”; “It's nice to have [the drill in the] freshman year but the time [is at 7:30 am];” and “The library databases are very helpful in research. I have used them for multiple classes, and I feel that every student would benefit from a basic understanding of the database process.”

Among the reasons the additional 35 percent of those who responded said that they will not recommend the class was that they seemed to have had library instruction sessions several times before. The results of this particular question may have been very different if this same question had been asked just after their first instruction session. Sixty-four percent of the students who responded to this survey were juniors and seniors, and 29 percent were sophomores. By now many of the juniors and seniors may have attended several other instruction sessions. As one student commented “I believe I have attended that same library session at least 3 times since coming to the University of Arkansas.” However, this is not necessarily true for the sophomores in the class, who would have been freshman at the time of their instruction.

Conclusion

This survey demonstrates that our hypotheses are largely true for the majority of students who responded that if students are comfortable approaching, and having meaningful discussions with a faculty member, they may be more inclined to seek out faculty to continue research. Indeed, 65 percent of the respondents felt that that the course increased their knowledge of how to get involved in research. Seventy four percent of the respondents felt that the interview experience with a professor was informative or productive.

Overall, 63 percent of the students felt that the class made approaching other faculty members with whom they do research easier, 48 percent felt that it made selecting a professor with whom to do research easier, 50 percent felt that this class helped them in getting involved with active research, 55 percent felt that this class helped them in getting motivated to start research very early in the process, and 62 percent of the respondents felt that this class helped them understand how research is conducted.

We also hypothesized that for students to become comfortable in approaching a faculty member to discuss research they may need to be trained in information literacy skills, and more specifically, how to put context around a search to find information relating to a professor and his research. The results of the survey indicated this to be mostly true. The majority of the students felt that they are now more comfortable using library databases to do research.

Forty-three respondents recalled and identified subscription databases by name that they continue to use on a regular basis when finding information. It was heartening to note that not one student mentioned Google as a source that has been used on a regular basis to find information on a research topic. Ninety five percent of the respondents were likely to search the departmental website to find out more about the professor and his research if they were to approach a faculty member about working with him/her research project.

The majority of students would search relevant subject databases to find out about a professor's research, and would use the Web of Science to identify the professor's top papers, and make a list of questions to discuss before meeting with a professor. It is hoped that students would use the subscription databases to identify papers from which they will compile their list of questions. This result shows that many of the students that responded may continue to use the information sources to retrieve useful papers and hence make informative decisions. Other methods students said they used in finding a professor for research included talking to other students who have already done some research or other workers from a particular lab they were interested in.

Our third hypothesis also proved valid: that if students are exposed to different professors' research and their requirements for undergraduate research in their freshman year, students may be more likely to be engaged in research. Since attending this class, 40 percent of the students from the survey respondents worked on a research project with a faculty member. Forty-two percent of them are currently working on a research project with a faculty member, with many more of the sophomores and juniors currently engaged in research. Half of the respondents felt that this course helped them in some way to get involved with the project they have worked on or are currently engaged in.

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