Catalyzing the Reaction:

High School Seniors → College Chemists

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Acknowledgments

I would like to thank those who made it possible for me to complete this research. First, to the professors of the UNCP Chemistry Department who agreed to an interview and allowed me to survey their classes, as well as to the high school teachers, thanks so much for taking the time to work with me, this would not have been possible without you. I would also like to thank the students who participated in the survey for giving a few minutes of their time. To Dr. Brian Postek, my mentor on the project, thank you for your guidance and keeping me on track over the duration of the project. Finally, thanks go to Dr. Jennifer Bonds-Raacke for periodically checking in to be sure everything was going smoothly.

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Gender	Number of Participants	Percentage of Participants
Male	26	35.62
Female	47	64.38

Ethnicity	Number of Participants	Percentage of Participants
Caucasian	40	54.79
African American	20	27.39
Asian	6	8.22
Hispanic	0	0
Native American	10	13.70
Pacific Islander	1	1.37

Have you ever written a lab report?	Number of Participants	Percentage of Participants
Yes	52	71.23
No	20	35.61

Table 4. Question #5 of Student Survey. Which of the following are you familiar with? Check all that apply.

Lab Component	Number of participants	Percentage of Participants
Abstract	**27**	36.99
Background	**30**	41.10
Method	**53**	72.60
Results	**47**	64.38
Discussion	**31**	42.47
Conclusion	**51**	69.86

Table 5. Graduation Year of Participants

Graduation Year	Number of Participants	Percentage of Participants
1969	**1**	**1.37**
1990	**1**	**1.37**
1997	**2**	**2.74**
2001	**1**	**1.37**
2003	**3**	**4.11**
2004	**1**	**1.37**
2005	**3**	**4.11**
2006	**5**	**6.85**
2007	**7**	**9.59**
2008	**29**	**39.73**
2009	**15**	**20.55**

LIST OF FIGURES

Figure 1. Question #5 of Student Survey. Which of the following are you familiar with? Check all that apply.

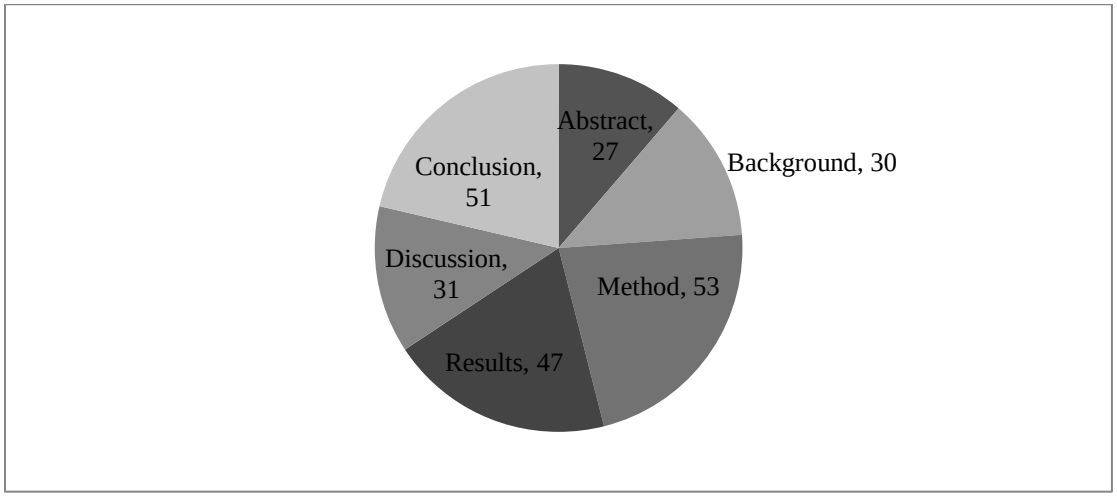


Figure 2. Question #6 of Student Survey. How well do you feel your high school science classes prepared you for the techniques used in your general chemistry laboratory course at
UNCP?

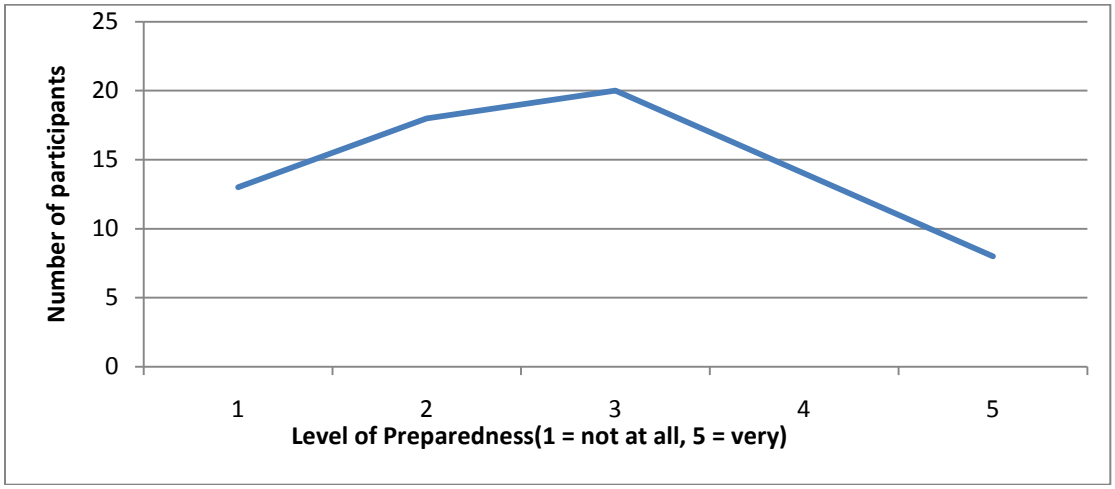


Figure 3. Question #7 of Student Survey. How well do you feel your high school science classes prepared you for writing lab reports in your general chemistry laboratory course at UNCP?

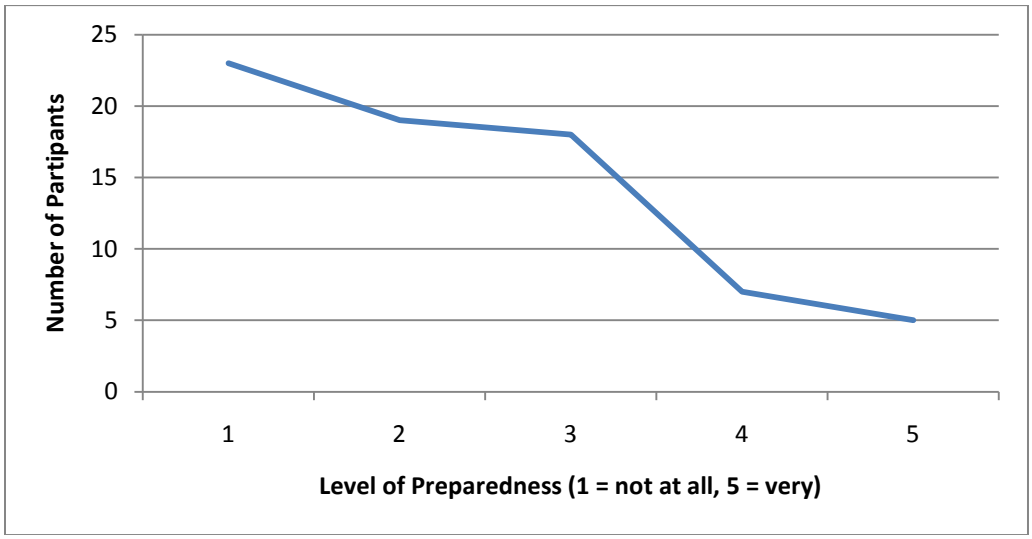
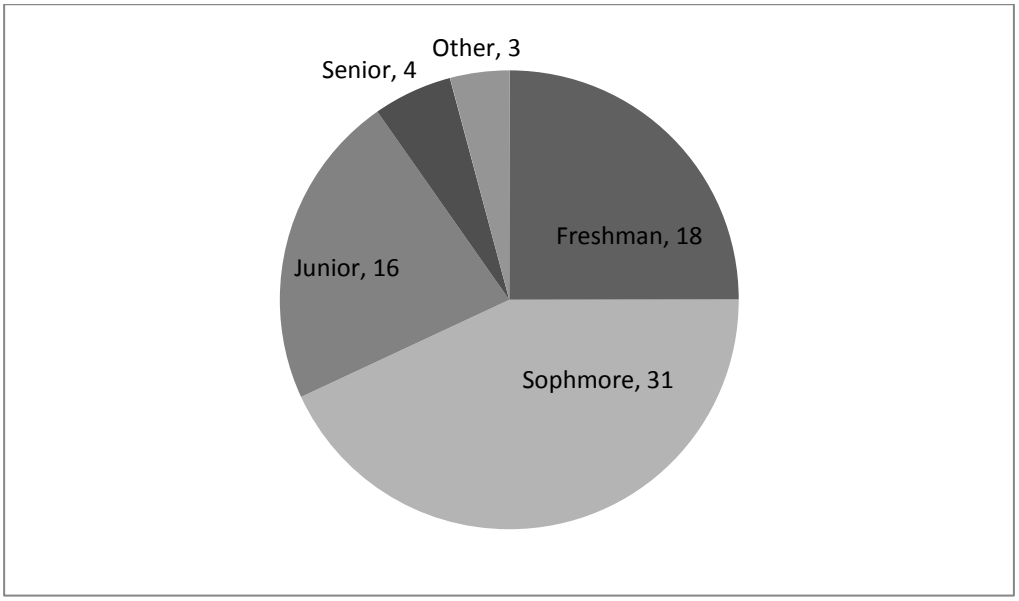


Figure 4. Question #8 of Student Survey. Classification of Participants.



ABSTRACT

Catalyzing the Reaction: High School Seniors → College Chemists

By Kimberly Brassard

Chemistry

The purpose of this investigation was to determine if college chemistry professors feel their students are prepared for the work expected of them, and to determine if introductory students feel they have been adequately prepared by their high schools to complete college-level chemistry work. Data was gathered from professors of the UNCP Chemistry Department regarding their feelings on the level of preparation displayed by their students. From the interview, significant data indicated that the professors felt their students lacked a very general understanding of laboratory practices. A survey was administered to General Chemistry I students to determine if they were prepared for laboratory techniques and for writing lab reports. Results of the survey indicated that students did not feel they were very prepared for college-level chemistry laboratories. It appears that both professors and students do not feel the level of preparation is adequate.

High school teachers were also interviewed, with results indicating that they felt they were not able to prepare students for college chemistry laboratories adequately. Responses included that there were lack of resources and that more time had to be devoted to preparation for the EOC. Ideas as to how UNCP could help high schools are to offer days for high schools to bring their students into a chemistry lab, or for a group of university representatives to travel to the high schools and give demonstrations to chemistry classes.

Introduction

Each year the percentage of high school students entering college rises. In fact, in just the last thirty years, the number of young adults attending college has doubled (2). As the number of students attending college increases, one may ask whether or not they are prepared for college chemistry laboratories, and whether or not professors feel their students are prepared. With more and more students making the choice to attend college, it can be argued that communities should provide more programs that support this decision by offering more college preparation.

At present, many high schools offer honors and advanced placement courses, which provide more stimulating course work than typical classes (1). These courses are specifically geared towards students who plan to attend college, as these courses can replace course work that is seen to be equivalent (1). For example, the University of North Carolina at Pembroke, gives college credit for a number of advanced placement courses in which the student has earned a score of 3 of 5 or better, on the final test (3). Universities also have certain course requirements for admission. In the case of the University of North Carolina at Pembroke, a first time student must have had four English courses, two foreign languages, four mathematics (algebra I&II, geometry, and one higher level math), three science courses (one biological, one physical, and one science laboratory course), and two social studies (one of which must be a United States history) (3). These requirements are put in place so that students will ideally be on a similar level in an introductory class, that the instructors expect and design their classes

around. UNCP also offers summer programs for high school students, both for those who expound and for those looking to expound. "Upward Bound" is one such program where underrepresented high school students are given extra academic support so that they may be better prepared for college courses (5). The program targets freshmen and sophomores in high school, and takes about 65 students a year (5). The initial step of the program takes place during the school year and consists of tutoring sessions for subjects of Science, Math, History, Spanish, and English (5). The second step is a summer program where the students reside on campus and attend six hours of classes (5). Classes offered often include Physics or Chemistry, Literature or English, Foreign Language, Mathematics, Biology, and History (5). Interest courses are also available in Art, Dance, Drama, Physical Education, and Music (5). The first two components of the program offer a stipend to participants (5). After the student graduates, the final phase, "Bridge," takes place during the summer and gives the students a chance to begin earning college credits early, by taking seven hours during one of the summer sessions (5). The Health Careers Opportunity Program also provides outreach to high school students (4). The Summer Enrichment Program takes 25 high school seniors or incoming freshman and allows them to gain experience in Math, Biology, Physics, Chemistry, English, Computer Science, Communication Skills, and basic study skills (4). The program gives priority to those students attending a US high school and who have an interest in attending professional schools, such as Medical School, or Dental School (4).

While UNCP does offer the aforementioned opportunities to students, the outreach is limited. In order to incorporate more students, as those listed above are specifically geared towards a particular group of people, the university could offer more inclusive opportunities. The first would be to host laboratories to high school science classes on campus. This would involve having a professor act as a supervisor or instructor to allow the students to gain hands-on experience performing a college-level experiment in a college laboratory. If this were offered a couple of times a year, there is a potential benefit to the students' future laboratory experience. One such university that offers this experience is Boston University (6). The mathematics department invites local high schools to come out and perform mathematics laboratories and activities (6). This is just one of the many programs Boston University offers to the local high schools (6). The second option would be to take a group of students, possibly from the Chemistry and Physics Club, to the local high schools to give demonstrations or simply talk about the college experience. The Chemistry and Physics Club is a group of students majoring in science who participate in scientific events, such as judging middle school science fairs, in and around the campus community. This particular program of providing outreach is being implemented by many schools around the country. One example is the UCI Chemistry Outreach Program put on by the University of California at Irvine (7). A team of graduate and undergraduate students led by a postdoctoral or graduate student visit local high schools to give demonstrations (7). Demonstration topics include Redox reactions, state of matter, and exothermic and endothermic reactions, to name a few (7). Each demo takes around 20 minutes and is composed of an eye-catching demonstration, a

detailed explanation of the chemistry taking place, and another demonstration in which the students participate (7). This program allows high school students to experience "high-quality presentations" (7) that the high schools are unable to provide due to safety and economical reasons. This is just one example of many universities who participate in outreach programs. This is done not only to give students an idea of what college chemistry laboratories are like, but also to spark interest in science.

Methods/Materials

To determine if university professors feel their introductory students are prepared to handle work at the college level and to determine the level of preparation college laboratory students obtain from high schools, three sources of data were collected: interviews with professors of the UNCP Chemistry Department, interviews with science teachers at three local high schools, and a survey given to General Chemistry I students.

UNCP Professors:

Six professors from the Chemistry Department of the University of North Carolina at Pembroke were included in this study. A series of questions were asked of them pertaining to the students of their general chemistry I laboratories and can be viewed in Appendix A. This was done to get an overall idea of the level of experience professors expect of their introductory students.

High School Teachers:

Three science teachers, each teaching at a different high school, were interviewed. Questions on the science laboratories they conduct were asked. Complete interviews can be viewed in Appendix B. The high schools participating were all in Robeson County, North Carolina.

General Chemistry I Students:

73 introductory students were surveyed as a way to get student feedback. They were asked questions about their chemistry experience in high school. Three General Chemistry Lab I courses, and one General Chemistry I Lecture were surveyed. General Chemistry I Lectures involve the "composition, structure, and properties of matter, including stoichiometry, atomic, and molecular structure and theory, chemical periodicity, and equilibrium"(8). The General Chemistry Laboratory I has labs that are designed to supplement the material taught in lecture (8). A sample survey can be viewed in Appendix C.

Results

Interviews with UNCP Chemistry Professors

Overall, the professors of the UNCP Chemistry Department stated that their students are not prepared for performing laboratory experiments or for writing them up. One professor commented, students are "physically [able], intellectually [unable]. They

are able to follow directions, but do not have the ability to connect lab with lecture. They have trouble with calculations, and other such laboratory techniques." Another professor made the comment however that professors should not expect much from their introductory students as the point of the class is to teach them how to perform in a laboratory setting. They also suggest that UNCP hosts laboratories for the local high schools so that the students are able to obtain laboratory experience. When asked how students could be better prepared, the answer one professor gave was simple, "get them in a lab". For the interviews with the UNCP professors, see Appendix A.

Interviews with High School Teachers

There were differing perspectives on the level of college preparation from the high schools interviewed. One high school teacher felt that the students leaving high school and entering college were not very well prepared for laboratory work. Another high school teacher, however, felt that her high school was able to prepare students to handle the work expected of them upon entering college chemistry laboratories. There was some concordance among the teachers in that most agreed that the high schools could not properly prepare the students due to the lack of equipment and the time constraint of the End-of-Course test.

Survey of General Chemistry I students

Out of the 73 participants, 26 were male and 47 were female (table 1). The average age of the participants was 20.7 years. 40 of the participants were Caucasian, 20

were African American, 6 were Asian, 10 were Native American, and 1 was Pacific Islander (table 2). 52 of the 73, or 71.23% had written a lab report before, and 26, or 35.61% had not written a lab report in the past (table 3). Over half of the students surveyed were familiar with "method," "results," and "conclusion." The component the least number of participants were familiar with was the "abstract" (Figure 1, Table 4).

On a scale of 1-5, the average answer for question 6 "How well do you feel your high school science classes prepared you for the techniques used in your general chemistry laboratory course at UNCP?" was 2.81(Figure 2).

On a scale of 1-5, the average answer for question 7, "How well do you feel your high school science classes prepared you for writing lab reports in your general chemistry laboratory course at UNCP?" was 2.33 (Figure 3).

Questions 6 and 7 were of particular importance as they specifically targeted the insight of the students in their own preparedness. These questions are of the most interest as they provide an answer to the original question of whether or not students are prepared.

Of the 73 participants, 18 were freshmen, 31 were sophomores, 16 were juniors, 4 were seniors, and 3 did not fall into those four categories (Figure 4). The participants graduated from a variety of counties. Participants graduated high school differing years, from 1969-2009, with most having graduated in 2008 (Table 5). All participants were currently enrolled in either CHM 1110 or CHM 1300.

Discussion

Interviews with UNCP Professors

The interviews with the professors of the Chemistry Department of the University of North Carolina at Pembroke support the hypothesis that the students of the General Chemistry Laboratory I courses are not optimally prepared. Bearing in mind that the course is a "General" course, as well as an introductory course, the professors are not so much concerned with the students having knowledge of chemistry concepts, or even how to perform labs. Instead, the skills the professors are most concerned with are that the students are able to read a laboratory procedure and understand what they are reading. This was seen during the interviews when professors stated that they thought it would be beneficial for their students to have other skills, ones that would help the students to learn to perform laboratories, such as following directions. In order for students to do this, they must know laboratory glassware. The unfamiliarity students have with common glassware was noted by many professors. If the student is unable to distinguish a Bunsen burner from a hot plate, or an Erlenmeyer flask from a beaker, then they will have trouble following a lab procedure.

Another basic skill that the students seem to lack is the ability to incorporate the lecture into the lab, and vice versa. Generally, it is recommended that a student take the lecture and lab during the same semester. This helps to cement the curriculum in both a theoretical and practical manner. This is important because repetition helps to cement the concepts. Also, some students have trouble learning through lecture, and concepts are

not covered thoroughly during lab. For these reasons, taking the two courses concurrently allows for more exposure and exposure in different forms.

Overall, the chemistry professors noted the lack of laboratory experience their General Chemistry students display. They state that the students are unsure, and have little confidence in themselves as they work through the lab. This leads to constant double-checking with the professor, and simple labs become quite complicated for the students, as they end up taking far longer to complete the lab than is necessary. Not only does this interfere with a course syllabus, but it also frustrates both the professor and the student in turn resulting in a lack of enjoyment of the lab.

The professors want the students to possess the ability to follow a basic laboratory procedure, but they would also like them to be able to write-up the experiment. This not only ties into knowing what an abstract is, or how to create a graph using excel, but also into concepts such as what a Mole is, and how to calculate percent yield. While it is important that the students understand the basic structure of a laboratory report, they should also understand what they are doing in completing each component. In order to completely discuss the results of an experiment, certain background knowledge is important. In particular, the UNCP professors mentioned that they would be happy to see their students being able to calculate the yield of a substance, both theoretically and experimentally, and from these two obtain the percent yield. The percent yield gives a

representation of how accurate the experiment was. If the student does not recognize this fact, among many others, then the student does not get the full benefit of the laboratory course.

From the information that professors have provided as to what they are looking for in introductory chemistry laboratories, systematic preparation could be implemented. From the interviews with the professors, the best way to prepare the students is to give them experience in a lab. These professors have suggested that in order to help to prepare the students for a college level laboratory, UNCP could host laboratories for the local high schools a few times a year. This may involve high school students taking a field trip to the Oxendine Science Building and performing a lab under the supervision and direction of a UNCP chemistry professor. An experience of this type would potentially allow for more comfort in the lab, as well as more familiarity with laboratory practices.

It is important to note that the professors spoken with do not feel as though the students are incapable of performing a laboratory, nor that all of their General Chemistry students are completely lost in the lab setting. There is a broad spectrum of preparation among the students, and the professors realize that the high schools have done the best they could under the conditions they are provided with. One professor, when asked about the level of preparation that he would like to see in introductory students, responded "somewhere in the middle of the spectrum. One end could be frustrated if they already have a lot of experience. Nice to have been in a lab before and have some hands on

experience. Professors should be happy accepting students with little experience. Get them ready for undergraduate lab work." Basically, the professors are not looking for students with background knowledge of chemistry. Rather, they desire that their introductory students feel comfortable in a lab, are familiar with basic equipment such as glassware, and are able to connect the concepts in lecture to the experiments in lab.

Interviews with High School teachers

From the interviews with the high school science teachers, the general trend that freshman college students are not optimally prepared was present. Two of the three teachers that participated in the interviews stated that it was difficult to take the time for labs due to the looming pressure of fitting in the material that would be tested by the State End-Of-Course Test. Excluding the lack of time available for laboratories, the high schools also lack the accommodations for conducting higher-level labs. Most often, the labs they were able to perform are "box labs." All of the box labs were micro scale, and few actually involve mixing chemicals. The labs that the high schools generally perform cover important chemistry concepts, and include but are not limited to the following: density, molarity, identifying chemicals, biophysical properties, reaction rates, and acid/base labs. When reporting these labs a variety of formats are used. At Fairmont High School, the box laboratories come with report sheets, which the student turns in at the end of the lab. While report sheets are a convenient tool, they do not allow for the student to get experience writing up a report using the scientific method. However, any

non-box labs require a complete write-up following the scientific method, which does afford them the experience they will need to do well in future scientific education.

The importance of using the scientific method early is in the fact that it will be used throughout any scientific education and possibly into careers in science. That high schools implement this method for writing up an experiment shows that the school is interested in preparing the students for future experiences in science. However, the problem with following the "scientific method" is that it appears to differ depending on who you talk to. At one high school, the scientific method they follow is comprised of a Purpose, Hypothesis, Experiment, Data Analysis, and a Conclusion. At another high school, the scientific method they follow is comprised of a Hypothesis, Materials, Procedure, Data, Results (graphs/charts), and a Conclusion. At a third high school, the scientific method used is Problem, General Observations, Hypothesis, Materials, Procedure, Data, and a Conclusion. While the variations may only be in word choice in some cases, and for the most part the core of the report is included in all three, at first glance the three are not all that similar. Furthermore, all three of the school's formats fail to include an abstract, which is commonly called for in college labs, and in higher level scientific writing. By giving a sound base, the students will be able to build strong backgrounds in performing and reporting laboratory work.

The general consensus that the high schools have on college preparation is that there is a need for it, and it is a difficult task to accomplish. Not only do the high schools lack the time and resources to give their students the college level experience they need, they also lack the knowledge of what exactly universities are looking for. As such, they

are not clear on exactly how to teach their students to write a lab report as college professors have varying ideas on what should be included as well. In this matter it would be very beneficial if there was a standard format of reporting lab work that could be given to high school teachers, in fact one teacher questioned if there was a set report that the professors at UNCP used.

From the interviews with two of the three high school teachers, it was clear that there was some interest in working with the university to help to better prepare their science students for college-level laboratories. Both teachers had ideas as to how UNCP could work with them to provide a better experience for the students. One teacher commented that it would be beneficial for the students to visit the UNCP chemistry department, to maybe set up a time to "Possibly take these students to a UNCP lab to see how it college works." It was her opinion that students have a lack of understanding of what college chemistry is about and if they were able to experience it, they may be more excited or interested in the topic.

The concern that by conducting these interviews the teachers would be offended by the questions asked and possible implications of the questions was confirmed in the interview with one of the high schools. The feeling that the teacher was being belittled in her efforts as a teacher by insinuating that she was not doing her job properly was quite clear. That was not the purpose of this investigation and there was no intention of changing their teaching methods, other than assisting them in gaining information as to what is expected at the college level, and possibly offering help with conducting higher level laboratory experiments. Another possible stem of the disinterestedness of the high

school was that it did in fact have the resources necessary to completely prepare their students. Since the high school campus is joined with a Community College, they have more opportunities available to them. The other high schools however, have voiced that they do not have the resources and are therefore interested in possibilities the university could offer.

Survey of General Chemistry I Students

The purpose of surveying the General Chemistry I students was to get a complete view of the level of preparation obtained in high schools. It is not enough to recognize that college professors would like to see more prepared students, or that high school teachers feel they are or are not able to prepare their students. To get a complete idea of what may be lacking, obtaining the opinion of the students was very important. Therefore the survey was given to the general chemistry I students to answer two questions; 1. How prepared they felt they were for performing laboratory techniques, and 2. How prepared they felt they were to write lab reports (the preparation coming from experiences in high school). Both questions were answered using a scale of 1 to 5, with 1 being not prepared at all and 5 being very prepared. The average response to the first question was 2.81. From the answer to this question, I feel that students do not feel their high schools prepared them for performing laboratory techniques typical of a general chemistry I laboratory. The average response to the second question was 2.33. From the answers to this question I feel that it can be concluded that students feel their high schools did not prepare them very well for writing lab reports on the college level. See

figures 2 and 3 for the trends of these questions. Additionally, students were asked which components of a lab report they were familiar with (figure 1). Students were most familiar with the Method, Results, and Conclusion sections. They were least familiar with the Abstract. This data supports the students' opinion that they were not very prepared for writing lab reports, even though most had indicated that they had previously written a lab report. Also important to note was any prior experience in college laboratories the student may have. Most of the students did not have any prior experience. Few participants were second-degree seeking students with previous exposure to labs, with the labs being general chemistry labs, biochemistry labs, and organic chemistry labs.

Limitations

In retrospect, some areas of data collecting could have been more thorough. As an initial study into the level of preparation of the students, there were many errors that were not foreseen. In the interview with the professors of the Chemistry Department, a sample laboratory write-up was not obtained. This would have been useful in determining the variation of components of reports expected, as well as for use in preparation in high schools.

Also, it would have been more comprehensive to have spoken with more high schools. Three high schools out of the seven in the county is not an accurate representation.

Finally, the survey of the general chemistry I students, it would have been more beneficial to have given the survey at the very start of the semester before the students had a chance to become familiar with the laboratory setting. The fact that it was about a month and a half into the semester before the survey conduction was complete could have skewed the data.

The limitations in this study are to be considered and incorporated in continuing work on this project. In the future, I would like to survey more of the high schools in Robeson County, as well as some outside of the county. I would also like to speak with the chemistry department professors about the lab report formats they use. Further, I would like to survey the introductory students on the first day of classes so that they will be unbiased by what they will learn in the course.

Conclusion

The objective of the experiment was to determine if students are prepared for general chemistry I laboratories. This was done by gathering data from three sources, university chemistry professors, high school science teachers, and the students themselves. After reviewing the data, it can be postulated that the general chemistry I students are not prepared for the work expected of them. All three sources have expressed that more preparation could have occurred, which is consistent with the hypothesis that incoming general chemistry students are not adequately prepared for college-level work by high school science classes.

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WORKS CITED

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APPENDIX A

APPENDIX A

Interviews with UNCP Chemistry Professors

Professor A

Q: Do you feel your General Chemistry Lab I students are prepared to handle the work?
A: No, some do not have experience
Q: What level of experience or preparation would you like to see from your introductory students?
A: If they at least knew what beakers, graduated cylinders, thermometers were. How to use glassware.
Q: How do you think that high schools may better prepare students for the college level chemistry lab?
A: More labs. High School classrooms are not set up for labs, as they lack ventilation. If they did labs, simple labs, to them in the mode of thinking. They lack the thought process of completing labs. While high schools prepare them for test taking, they do not receive the instruction for developing laboratory thought processes. They should be able to think on their own.
Q: Do you feel that the instructors at UNCP may help high school students become better prepared for the chemistry lab experience here?
How so?
A:Yes, we could if we get a grant for something like "Science on Wheels" where high school students could get exposure to laboratory settings without having to travel. A mobile unit that could visit the high schools would be beneficial. More summer programs could help too. But need to take the opportunities to the students.

Professor B

Q: Do you feel your General Chemistry Lab I students are prepared to handle the work?
A: Physically yes, intellectually no. They are able to follow directions, but do not have the ability to connect lab with lecture. They have trouble with calculations, and other such laboratory techniques.
Q: What level of experience or preparation would you like to see from your introductory students?
A: Be able to use a balance, volumetric cylinder, and other basic tools. They should be able to balance an equation, and understand the Mole and other units of concentration.
Q: How do you think that high schools may better prepare students for the college level chemistry lab?
A: By doing labs in the high schools.

Q: Do you feel that the instructors at UNCP may help high school students become better prepared for the chemistry lab experience here?
How so?
A: Summer enrichment has been going on; hosting high school chemistry classes here on UNCP's campus. Maybe on an afternoon or weekend. Chemistry club planning outreach by going into classrooms and giving demos. Getting students more interested and excited about science.

Professor C
Q: Do you feel your General Chemistry Lab I students are prepared to handle the work?
A: For General Chemistry I not yet. General Chemistry II yes.
Q: What level of experience or preparation would you like to see from your introductory students?
A: Not expecting them to know anything. It is his job to teach them
Q: How do you think that high schools may better prepare students for the college level chemistry lab?
A: Whatever they can do; possibly getting them started on writing laboratory reports.
Q: Do you feel that the instructors at UNCP may help high school students become better prepared for the chemistry lab experience here?
How so?
A: No, kind of insult to teachers. If High school is interested perhaps teachers assign science projects, and encourage students to make use of UNCP's faculty and facilities.

Professor D
Q: Do you feel your General Chemistry Lab I students are prepared to handle the work?
A: No, they don't know how to write lab reports. Students are confused about basic laboratory tools and techniques because they lack laboratory experience.
Q: What level of experience or preparation would you like to see from your introductory students?
A: First to be able to write a lab report. Read a lab and understand techniques discussed. Know more about glassware and apparatus.
Q: How do you think that high schools may better prepare students for the college level chemistry lab?
A: One would be to look at experience from colleges. If they can visit UNCP during summer to get lab exposure. Any kind of lab exposure would help.

Q: Do you feel that the instructors at UNCP may help high school students become better prepared for the chemistry lab experience here?
How so?
A: HCOP for high school from Health Careers; spend 2 weeks in lab. Create safe labs, workshops or seminars that have similarities to college labs, but with no harmful exposure. Many things can be done, such as molecular molecules, or experiments using water, etc.

Professor E

Q: Do you feel your General Chemistry Lab I students are prepared to handle the work?
A: Depends on school and more students are showing up from home-school. They are unfamiliar with equipment, and overall not very prepared. There are a few with good lab backgrounds, but many are unable to obtain experience due to economics and safety issues.
Q: What level of experience or preparation would you like to see from your introductory students?
A: I have worked with High School students doing research. Would like to see students have any experience, familiarity with equipment.
Q: How do you think that high schools may better prepare students for the college level chemistry lab?
A: Giving them exposure, possibly through science fair projects.
Q: Do you feel that the instructors at UNCP may help high school students become better prepared for the chemistry lab experience here?
How so?
A: Utilizing the Biology, Chemistry, and Physics Clubs here at UNCP to interact with the high school students. This would dispel stereotypes about UNCP and Chemistry in particular. Perhaps go to the school to talk about research so the students can get a better idea as to what chemistry is about. Students are very curious in general chemistry labs because they are unfamiliar.
Other comments:

Students are not very good at math, even though statistically math EOG (EOC) scores are higher than English. Teaching style: high school is interactive, group teaching and learning; college is lecture format. Cookbook procedure of labs does not require any thinking on the student's part, which creates problems in higher level classrooms. Students have trouble connecting the lecture with the lab (due to differing professors for each?).

Professor F

Q: Do you feel your General Chemistry Lab I students are prepared to handle the work?

A: Level of preparation varies widely. Some students, I don't know if it is intrinsic or preparation, but they are sharp as a tack. Others on other end of the spectrum, entirely out of element. May never have been in a science lab.

Q: What level of experience or preparation would you like to see from your introductory students?

A: Somewhere in the middle of the spectrum. One end could be frustrated if they already have a lot of experience. Nice to have been in a lab before and have some hands on experience. Professors should be happy accepting students with little experience. Get them ready for undergraduate lab work.

Q: How do you think that high schools may better prepare students for the college level chemistry lab?

A: Get them in a lab.

Q: Do you feel that the instructors at UNCP may help high school students become better prepared for the chemistry lab experience here?

How so

A: Could hook up with a professor where UNCP hosts lab experience for high schools during regular school hours. Almost like a field trip, but come to UNCP multiple times a year. More collaborative efforts.

APPENDIX B

APPENDIX B

Interviews with High School teachers

High School A

1. Is Chemistry a required course for graduation?
A: No
2. Can you describe the Chemistry Lab work here?
A: Identifying chemicals, biophysical properties, acid/base, density, stoichiometry. Several paper labs where they work in groups.
3. How do students report results?
A: Lab write-ups: Purpose, Hypothesis, Experiment, Data Analysis, and Conclusion
4. What are your thoughts for preparing students for college Chemistry Labs?
A: Definitely need to be prepared. High Schools can only do a minimum because of EOC. Hard to teach details because there are so many concepts for testing.
5. Do you feel your students are prepared for labs at the college level?
A: No. It is difficult because professors all have varying ideas.
6. Do you feel UNCP can help prepare your students for a college level Chemistry Lab?
A: Of course, would love to have someone to come to give a basic lab setup because high school students cannot identify how important it is to do a proper lab write-up.
7. Might you be interested in working with UNCP to develop a systematic approach to college Chemistry lab preparation?
A: Most definitely, would be wonderful.
8. Do you have any questions for me?
N/A
9. Comments
A: Walk through just to get familiar with lab equipment because something high school can't do because of safety issues. Perhaps professors could speak to the classes. Trying to institute a Science Explorers Club, of students who are interested in science. Possibly take these students to a UNCP lab to see how it college works. Very overwhelming for the students when they encounter things they haven't been exposed to previously.

High School B

1. Is Chemistry a required course for graduation?
A: To go to college, yes; they must have a physical science lab credit and Chemistry fills that credit. To go to a two-year institution (RCC for example) students do not need that credit.
2. Can you describe the Chemistry Lab work here?
A: A lot of labs; DNA, starch/sugar, diffusion, osmosis, iodine/carbohydrate labs, motion labs, electricity/circuit labs, density labs, identifying chemical reactions.
3. How do students report results?

A: Lab reports: they use scientific method: Hypothesis, Materials, Procedure, Data, Results (graphs/charts), Conclusion.
4. What are your thoughts for preparing students for college Chemistry Labs?
A: We do a good job at Early College HS. A lot of kids are interns at RCC, Comtech, and UNCP
5. Do you feel your students are prepared for labs at the college level?
A: Yes
6. Do you feel UNCP can help prepare your students for a college level Chemistry Lab?
A: Since students are technically high school, UNCP is doing a much better job with student teaching.

7. Might you be interested in working with UNCP to develop a systematic approach to college chemistry lab preparation?
N/A
8. Do you have any questions for me?
A: No.
9. Comments
N/A

High School C
1. Is Chemistry a required course for graduation?
A: No
2. Can you describe the Chemistry Lab work here?
A: Have not done any yet; usually do box labs ordered from Fischer, all are microscale. Few have chemicals that have to be put together. One or two are made up. They cover density, reaction rate, identifying substance properties, mole lab, identifying chemical reactions.
3. How do students report results?
A: Depends on the lab, the bought labs come with lab sheets the students fill out. The labs from the book also come with lab sheets to be filled out. They write one or two lab reports; Problem, General Observations, Hypothesis, Materials, Procedure, Data, Conclusion.
4. What are your thoughts for preparing students for college Chemistry Labs?
A: Students need to be able to read and understand directions, figure out problems for themselves, and write more lab reports.
5. Do you feel your students are prepared for labs at the college level?
A: Probably not, high schools don't have the equipment.
6. Do you feel UNCP can help prepare your students for a college level Chemistry Lab?
A: Of course. It would help to know what professors want.
7. Might you be interested in working with UNCP to develop a systematic approach to college chemistry lab preparation?
A: I could.
8. Do you have any questions for me?
A: Is there a set lab report for Chemistry professors?
9. Comments
A: Due to EOC hard to cover much because have to stay on schedule.
The hardest part is getting the labs together.

APPENDIX C

APPENDIX C

Survey for General Chemistry I Students

Please answer the following questions

1. Gender
   - o *Male*
   - o *Female*
2. Age_____
3. Ethnicity
   - o *Caucasian*
   - o *African-American*
   - o *Asian*
   - o *Hispanic*
   - o *Native American*
   - o *Pacific Islander*
   - o *Choose not to answer*
4. Have you ever written a lab report?
   - o Yes
   - o No
5. Which of the following features of a lab report are you familiar with? (Check all that apply).
   - o *Abstract*
   - o *Background*
   - o *Method*
   - o *Results*
   - o *Discussion*
   - o *Conclusion*

For questions 6 and 7 please rate your thoughts on a scale of 1-5, where 1 indicates "Not at all prepared" and 5 indicates "Very prepared."

6. How well do you feel your high school science classes prepared you for the techniques used in your general chemistry laboratory course at UNCP?
   Not at all prepared *Very prepared*

   1 *2* *3* *4* *5*

7. How well do you feel your high school science classes prepared you for writing lab reports in your general chemistry laboratory course at UNCP?
   Not at all prepared *Very prepared*

   1 *2* *3* *4* *5*

8. Classification
   - o *Freshmen*
   - o *Sophomore*
   - o *Junior*
   - o *Senior*
   - o *Other*

9. Please indicate any prior college level experience in the chemistry lab you may have:

   _____.

10. In what county did you attend High School?

    _____.

11. What year did you graduate High School?

    _____.

12. Please indicate what course you are currently taking (i.e CHM 1100)

    _____.