

Multi-institutional cross-case analysis of student impacts resulting faculty attendance at faculty development workshops by cCWCS

Background

The Chemistry Collaborations, Workshops and Communities of Scholars (cCWCS) program funded by the NSF provides workshops for faculty of different institutions to learn and train in the Course, Curriculum, and Laboratory Improvement program.

Several different workshops were held during the summer of 2009, including the two from which the faculty were selected. Western Wyoming Community College and University of Nevada at Reno faculty attended the cCWCS Forensic Science workshop while Century College, Richard Stockton College of New Jersey, and Central Oregon Community College faculty attended the cCWCS Chemistry in Art workshop. In the cCWCS Forensic Science workshop, some of the specialized fields of forensic science were introduced. Aspects of forensic science involving the examination of physical, chemical, and biological items of evidence were explored. This workshop provided the participants with an opportunity to develop a basic understanding of forensic science and to learn about the application of forensic science to essentially all aspects of undergraduate instruction in chemistry. The cCWCS Chemistry in Art workshop provided participants with a perspective on the role of chemistry in diverse fields, crossing academic disciplines, but with strong foundations in inorganic, physical and analytical chemistry. The course included laboratory experience, and field trips to local museums and conservation science labs.

Methods

The Chemistry Collaborations, Workshops and Communities of Scholars (cCWCS) program funded by the NSF provides workshops for faculty of different institutions to learn and train in the Course, Curriculum, and Laboratory Improvement program. Faculty who were planning to teach exactly the same course during the spring after the workshop as they were teaching during the spring before, were chosen to attend the workshop. Workshops held in the summer of 2009 were attended by faculty from 4 institutions: Western Wyoming Community College (WWCC), University of Nevada Reno (UNR), Central Oregon Community College (COCC), Richard Stockton College of New Jersey (RSCNJ), and Century College (CC). Workshop participants were provided with housing and meals and reimbursed for local transportation and other costs.

The study population was the students of the faculty who attended the workshops, detailed in Table 1.

Table 1. Study Population

Institution	Faculty name	Students 2009	Students 2010
University of Nevada Reno (UNR)	McCullough	23	24
Western Wyoming Community College (WWCC)	Murosky	30	29
Central Oregon Community College (COCC)	Ziegler	24	19
Richard Stockton College of New Jersey (RSCNJ)	Richards	24	24
Century College (CC)	Loomis	144	127

This study is based on entrance and exit surveys in addition to structured interviews with these students. The interview questions addressed the students' background, university, experiences, and interest in the chemistry course. Following the interview, the results of the interviews were collected and transformed into case studies. The interview questions for student evaluation were:

1. What was your favorite part of this course? Why?
2. Were there other things about the course that you liked? Why?
3. What was your least favorite part of this course? Why?
4. Were there other things about the course that you didn't like? Why?
5. What changes could you recommend to improve this course for the future? Why?
6. Were you interested in the material that your professor presented during this course? Why or why not? If yes, was there something in particular that drew your interest?
7. What are your thoughts on the assignments in your course?
 - Do you feel like you learned from completing those assignments?
 - Was there a particular assignment that you feel was especially valuable? If yes, what made that assignment valuable?
 - Do you feel like you understood the way that you were graded?
8. Do you believe that your work in this course relates to your everyday life?
9. Do you believe that your work in this course relates to the "real world"?
10. Do you believe that your work in this course relates to your future career?
 - In what way, if any, has your experience in this course affected your choice of future career?
11. Did you perceive that your professor was interested in teaching this course? Why or why not? If yes, is there anything in particular that gives you this impression?
12. How does this course compare to other chemistry/science courses that you have taken?
13. Would you recommend this course to others? Why or why not?

14. What, in your view, is science? What makes science (or a scientific discipline such as physics, biology, etc.) different from other disciplines of inquiry (e.g. religion, philosophy)?
15. Scientists perform experiments/investigations when trying to find answers to the questions they put forth. Do scientists use their creativity and imagination during their investigations?
 - If yes, then at which stages of the investigations do you believe that scientists use their imagination and creativity: planning and design; data collection; after data collection? Please explain why scientists use imagination and creativity. Provide examples if appropriate.
 - If you believe that scientists do not use imagination and creativity, please explain why. Provide examples if appropriate.
16. Is there anything that we haven't covered that you would like to talk about?

Because the students were not the same, a case study and cross-case analysis approach to data collection and analysis were used (REFERENCE). Case studies were generated for each year at each institution. These were then compared to generate a cross-case analysis for each institution. Finally, a multi-institutional cross-case analysis of the results from the institutional

cross-case analyses was performed in order to understand the effectiveness of the workshops in enhancing the chemistry curriculum and providing a better experience for students.

Case studies were generated for each institution before (2009) and after (2010) the workshops using the student interviews as the data set supplemented with student survey results when necessary. The interviews were transcribed and transcripts were analyzed for generalizations and common trends. Using this information, conclusions were made regarding the teaching style and limitations of the professors, before and after the workshop. Following these case studies, a cross-case analysis was formed for each institution by comparing the content of the two case studies. This cross-case analysis consisted of common trends in the professors teaching, changes made after the workshop, limitations, and the impacts of the professors teaching on the students. A cross-case analysis was formed for each of the five institutions in order to evaluate the effectiveness of the workshop in bringing about a positive impact in the way the professor teaches the class.

Following the four cross-case analyses, a final multi-institutional cross-case analysis was formed comparing the four individual cross case analysis with the intention of finding common trends formed after the workshop, among the different institutions.

Faculty participants' students were approached before attendance of this workshop and were surveyed on their professors' teaching style and skills. The next cohort of students in the same course in 2010 was assessed in the same way. The resulting data were used to create case studies about each year of the course. For example, Dr. McCullough was the faculty participant from the University of Nevada-Reno and attended the Chemistry in Art workshop in the summer of 2009; the case studies for her courses are below.

UNR Case Study, 2009:

The professor teaching this course was very invested in her teaching and made the class very interactive. Several teaching styles such as group discussions, and PowerPoint presentations were integrated into this course. The topics were broken down to pieces based on the most important concepts in the chapter. Students appreciated it when the professor taught with several examples and step-by-step methods on how to solve the problems. The professor had good knowledge on the topics that she taught and expected the students to also come in with a basic understanding of chemistry. Sometimes she was less helpful and didn't seem to make a strong impact on the students. The students felt that the professor did not make the class as enjoyable as she could have

UNR Case Study, 2010:

The professor teaching this course was greatly appreciated by the students for going in depth into specific difficult topics and giving notes to learn from. She also gave several good examples and tried to relate what they were learning to the real world. The professor enjoyed teaching the material and spent extra time to address problems that students were struggling with. However, a lot of the material taught in class did not correspond with the textbook. Hence students found it difficult to go back and look over the material again.

Results and Discussion

In the next step, a cross case analysis of the case studies was performed. The following section of results presents all four cross-case analyses for the participating faculty.

UNR Cross-Case Analysis. Dr. McCullough attended workshop provided by Chemistry Collaborations, workshops & Communities of Scholars (cCWCS) in 2009. Student interviews were collected in 2009 and 2010, before and after the workshop. A cross case study was

conducted to study the change in her course at University of Nevada Reno as a result of the workshop.

The analytical chemistry course taught by Dr. McCullough is a high-level chemistry course that covers complicated chemistry theory, such as spectroscopy and instrumentation in chemistry. This course is mainly for chemistry major/minor students.

According to the student interviews, there are some similar compliments about this course before and after Dr. McCullough attended the workshop. Students liked Dr. McCullough because of her teaching style and course structure. She was always prepared for class and knew the material well. Students had easy access of her whenever they had questions.

Improvements in this course could be seen from several changes. In 2009, students complained that there was too much note taking in class which would detract students and lower study efficiency. Also student suggested that Dr. McCullough should make the course more visual-friendly to those people who were visual learner. Dr. McCullough was very invested in teaching this course. She made the class very interactive and explained the material thoroughly. She explained all the material with examples and her notes went along with the textbook. Hence the students could follow the lecture by reading the textbook after the lecture. The students found it hard to take notes continuously throughout the lecture and wished that the professor covered the material a little slower. After the workshop, the students observed some changed. In 2010, students said that Dr. McCullough wrote out notes on the board with a right pace and also answered all the doubts that the students had. . Most students like the notes on the board because it is more visual. The students felt that this helped them grasp the material better.

For the assignments in this course, in 2009, students complained that some take-home quizzes were too difficult and time-consuming. In 2010, students confirmed that the take-home

quizzes are helpful for tests, and they broke down complicated concepts. In 2009, students complain about that the pre-lab was not clear enough to guide them conducting the experiments. In 2010, students state that the pre-lab assignments are helpful in understanding the lab procedure and expectation.

The students who took this class before the workshop said that the laboratory part of this course was hard. The pre labs took a lot of time and asked several difficult questions. Also, they felt that the material was not explained clearly in lab and they found it difficult to follow. After the workshop, the students said that the pre labs helped them understand material from the course especially in topics such as atomic absorption and gas chromatography. The students also reported that the lab reports were time consuming and not very helpful.

Over the 2 years, all students don't think the course relates with everyday life. However, students believe this course will help them in their future career or academic path, because most students are going towards chemistry related field in the future.

WWCC Cross-Case Analysis. General Chemistry 2, as well as its prerequisite course General Chemistry 1, was taught by Dr. Murosky. Two students who took these two classes were interviewed to evaluate Dr. Murosky teaching approaches. From their feedback, it can be concluded that even though Dr. Murosky's teaching approaches have shown improvements, they are still generally inefficient and ineffective to students.

From the reflections of these two students, the inefficient and ineffective learning processes result from Dr. Murosky's lack of control of pace of teaching, over-expectation of students' self-learning ability, and inefficient use of work sheets. First, Dr. Murosky's teaching speed is too fast for some of his students to digest all the materials he covers. Even under the circumstances where students follow him in solving problems, they find it difficult to solve the

same problems themselves. Second, Dr. Murosky also puts too much expectation into students' self-learning ability. He expects students to prepare the learning materials by reading textbooks themselves while the students commonly do not. The gap between his expectations and students' reaction leads to him showing frustrations in class. Last, students get bored with the work sheets he uses because they repeat the problems they work in classes. Caused by the disadvantages above, students complain that their average grades for this class are low.

However, students do appreciate Dr. Murosky's enthusiasm in teaching and they comment positively on the usefulness of homework assignments and labs. From the feedback, Dr. Murosky endeavors to pass on his knowledge of chemistry and cares a lot of students' performance of his class. He also improved the homework assignments quality by changing them from online assignments to the exercises from the textbook. According to the interviewed students, this improvement not only frees them from computer issues, but makes the homework easier and more relevant to the class materials. They also consider labs a very effective supplement for the class work. They find labs are enjoyable since there are more interactions between instructors and them.

For the evaluation of the usefulness of this course, the interviewers both admit that this class does little help to their future careers. Specifically, they find the math part of this course is unhelpful. However, one of the interviewee does think some materials in this course could be potentially usefully in his future workspace. In addition, they do not recommend this course to other students because they consider it a hard course with little usefulness.

Towards the question about the definition of the science, they define it as the study of the mechanisms of our universe. They distinguish the science with religion and philosophy by their

different focuses: science is focused on the evidences and facts while philosophies and religions are focused on moral issues.

RSCNJ Cross-Case Analysis. Experiential Chemistry, part of the college's General Studies program, taught by Dr. Marc Richard in the Richard Stockton College at New Jersey is an introduction level general education class. This course requires students meet three times a week in laboratory, and there is no separate lecture for this course. It covers a wide range of chemistry related experiments to give students an insight about chemistry. Most students take this class to fulfill general education requirements.

For interviews in each year, students don't think this course relates with their future career path or academic plan, neither does the course have impact on them. Course materials are mostly home-based items, so students think it relates with everyday life. Students state that there are interesting experiments and dull experiments, but they vary in each year and among different students. The most common favorite experiments are bismuth, cornstarch and paramagnetic substance.

Throughout the two years, some improvements have been made in this course, as a result of the workshop. About the lab, in 2009, students complained that most experiments were too easy and there was not much chemistry knowledge involved. In 2010, students confirmed the presence of certain amount of highly-scientific experiments in the course. In 2009, students stated that the course didn't help develop lab skills because two thirds of the experiments didn't require accurate measurements of chemicals.

For the assignments, in 2009, students stated that the written assignments were too easy and are not helpful. Most of the written assignments are not related with chemistry knowledge, such as the Haiku and words. In 2010, students reported the research paper assignment could

help students develop professional paper writing skill, and it also gave students the opportunity to explore their interested area of chemistry. However, over the two years, those easy and non-chemistry-related assignments always exist. In 2009 and 2010, students complained about the textbook, saying that the experiments procedures given in the textbook were not clear. In 2009, students praised Dr. Richard for his engagement in teaching this course. In 2010, students stated that Dr. Richard gave our survey and ask suggestions and feedback from students.

Overall, the effect and impact of the cCWCS workshop can be seen from the improvements of the class stated above. However there are still problems that have not been solved.

2010 Case Study about Chemistry Concept. Lectures were held three days a week and lasted fifty minutes each while the laboratory part of this course was held once a week and lasted three hours.

The students thought that Dr. Loomis was a great teacher. She was very passionate about teaching. She gives several real-life examples of each chemistry concept to help students relate the course material to real life applications. All the students enjoyed lab because it was interesting and provided hands-on experience.

There were several different assignments in this course, including OWL online homework, online quiz and lab sheet. Before the workshop, students complained that the OWL homework was time consuming and it was difficult to type and submit answers. However after the workshop, most students emphasized that the program was a great study resource because it provided detailed solutions. This was because the instructor gives more instruction on using the program in 2010, which made it easier for the students. In 2009, student complained that the lecture was too fast-paced sometimes, making it difficult to digest. They had to take in too much

information in a very little amount of time. However, in 2010, most students agree that the lecture speed was at a good pace and they were able to follow the instructor.

Both before and after the workshop, student agreed that the course related to everyday life because Dr. Loomis usually gives examples related to the topic in lecture to help students understand. They understood its applications in the real world and gained several hands on experiences from it.

COCC Cross-Case Analysis. The General Chemistry class GS 105 consisted of 19 students who were all English-speaking. Most of these students took this class to satisfy their science elective requirements. They did not think that the class affected their future career choices and decisions but they were able to relate what they learned to their everyday lives and recognized its applications to the world.

It was found that particular societal topics such as the ozone layer, global warming, energy conservation and the troposphere interested the students. They enjoyed studying about the atmosphere but the basic chemistry topics covering chemical reactions, balancing equations were found to be dull and uninteresting.

Before the workshop, the students reported that the professor did not make the class enjoyable. The complaint was that she did not address their questions and doubts in the material. However on analyzing student opinions after the workshop took place, they seemed to greatly appreciate the professor's devotion to teaching. She tried to keep everyone on track and addressed the specific problems of students. She explained the material given more clearly with several examples. The class was made more interactive.

The homework given to students helped them learn the material taught in class. It strengthened the concepts that were taught. The students of the class taught after the Dr. Zeigler

attended workshop felt that the homework was too easy. It did not test their knowledge of the subject but it did however give them more practice on what they learned. They also felt that the material taught in class needed to go to deeper levels.

The laboratory part of the course voice several opinions. Before the workshop, students felt that the lab was tedious and unimportant but it did help understand the theory taught in class. However the laboratory equipment was inefficient. Also the help given in lab was also not sufficient. Students had to wait long to ask questions regarding the lab because there was only one student helper per lab. After the workshop, students reported that at times their lab partners did not contribute to the group. They suggested that a few changes be made to improve these problems.

Multi-institutional Cross-case Analysis and Conclusions

Each of these faculty seemed to have been impacted by the art and forensic science workshops. Highly experienced university faculty with significant teaching experience and modeling abilities facilitated the workshops. Hence most of the professors who attended the workshops had positive learning experiences, which in turn reached their students. From the current analysis, it is difficult to conclude if the content of the workshops or the motivation to attend are the driving force in creating change. However, it can be inferred that these couple with each other, generating greater gains than faculty would otherwise have experienced due to intellectual stagnation.

On analyzing the cross-case analysis of each institution, several differences were found in the way the professors taught their classes before and after the workshop. In 2009, students from COCC and WWCC reported that their professors were very fast paced. They expected their

students to read the textbook and understand the material. They were not very helpful and would often not explain material clearly. After the workshop, students from all the institutions except for WWCC reported that their professors were very invested in teaching the course. They also noted that the faculty gave examples to help students understand the material. Dr. Richard from RSCNJ often asked his students for feedback in order to improve his course in 2010. Students from UNR reported that their professor knew her material well. She was easily accessible and they could approach her for questions if they wanted. Dr. Loomis from CC was also reported to have become very passionate about her teaching and gave real life examples in class so that her students would be able to relate the concepts to the outside world. Students from WWCC reported that their professor taught very quickly and they were not able to grasp the material easily. No positive changes were found in the WWCC cross-case analysis. The workshop did not seem to make many improvements in the way the class was taught in WWCC. It should be noted that the professor from WWCC was the only faculty participant to state that he did not include the workshop material in his class in any way due to a busy schedule.

On analyzing the student's interest in the introductory chemistry classes, it was found that several students did not think that this class related to their future careers. In general, most students took the classes to satisfy their electives requirements. They did not feel that the class that they were taking would help them in the real world or in their careers. Students from WWCC reported that this class was ineffective. However, students from CC felt that this class related to their everyday lives. They felt that the skills and experience that they gained in this class would help them in their future careers.

Students from CC initially felt the pre laboratory assignments were hard and took up too much time. They reported that the homework given to them in class was difficult. In 2010, CC

students reported that the homework was a great study resource. It helped them grasp the material they learned in class more easily. Students from UNR in 2009 had reported that take home quizzes were a hassle and were not very helpful. In 2010, they reported that the take home quizzes as well as pre-laboratory assignments helped them break down hard concepts and proved to be good learning material. In terms of laboratory, students from RSCNJ reported that the experiments they performed were too easy and did not provide much of a challenge to them. After the workshop, it was found that highly scientific experiments were included in their laboratory course. This greatly increased student's interested in the laboratory.

Overall, the workshops correlated with marked changes in the way the chemistry course was taught in each of these universities. The professors learned and implemented several teaching styles and techniques that the students appreciated. However, there was not a marked change at WWCC.