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Stop Cheating!: An Evaluation of a Scientific Integrity Writing Strategy in General Chemistry I

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STOP CHEATING!: AN EVALUATION OF A SCIENTIFIC INTEGRITY WRITING STRATEGY IN GENERAL CHEMISTRY I

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of the requirements for the degree of
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Abstract

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Cheating in America has become an epidemic, which has unfortunately spread to academia. Researchers have long been interested in the trends in cheating behavior and the factors that influence these trends among undergraduate college students. Though cheating can take on many forms, in science, there is a deep concern about scientific misconduct related to research. Because training for future scientists begins in undergraduate courses, this study investigated the use of scientific integrity writing strategy in General Chemistry I at Wright State University. The goal of the study was to determine if providing scientific integrity and ethics training, while teaching students to write journal article-like laboratory reports, reduced the number of ethical violations committed in General Chemistry I. The investigation was composed of three main parts: 1) Pre-intervention data collection, 2) Intervention Presentations and 3) Post-intervention data collection. Pre-intervention data included a pre-test on the Integrity Principles and Ethics in Scientific Publications and a pre-intervention laboratory report on *Paper Chromatography*. The intervention was a training on the Integrity Principles and Ethics in Scientific Publications during a laboratory period. Post- intervention data included post-tests and the evaluation of the

Analysis of Hydrated Copper Sulfate laboratory report. The evaluation of the laboratory reports was completed using an ethics rubric that focused on six facets of plagiarism. The results showed a statistically significant increase in students' scores on the pre-and post-tests on the Integrity Principles and Ethics in Scientific Publications. When the laboratory reports were evaluated with the ethics rubric, it was found that there was a decrease in the number of ethical violations related to plagiarism. The study also found that students who earned A grades on the laboratory reports had the least number of ethical violations post-intervention. Finally, it was determined that females were less likely to plagiarize than males. Though the results of this study are encouraging, it is clear that additional training is needed in the area of ethics and scientific integrity at WSU.

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Chapter 1: INTRODUCTION

Cheating in America

How do we know that people are telling the truth? Quite simply, we do not. In America, “The Land of Opportunity”, it is understood that sometimes you have to do things that are not completely ethical to “get ahead.” Americans accept the fact that sometimes the rules have to be bent or skirted around for individual success to occur. As a country, we have accepted this culture of cheating. America, a country defined by its morality, has an epidemic. That epidemic is cheating. - It is occurring in a variety of daily situations. In all areas of American life-sports, education, science, business, and medicine, more and more people seem to be taking short cuts and cutting corners in an effort to “get ahead” of the competition.[1]

Consider the example of the CEO of Bausch and Lomb, who claimed to have an M.B.A. from NYU. An investigative reporter writing an article about Ronald Zarrella, found this information to be false and exposed the lie.[1] He is just one of many guilty of padding his resume. The cheating doesn’t stop there though. It permeates society reaching into the financial aspects of life. In 2010, the IRS reported that tax evasion had cost the U.S. Treasury around $337 billion.[2], and that wealthy Americans were the biggest offenders.[1] The entertainment industry has also been affected by this culture of cheating. Americans are downloading music and videos illegally without a second thought. Both cable and satellite services are affected also, with over $6 billion a year of paid programming being stolen.[1]

The above examples are not isolated occurrences. These examples are simply a representation of the widespread cheating that occurs throughout our society. Yet, cheating is hard to document and quantify. The trend toward unethical behavior in the U.S. is increasing. Not only has it been found that Americans are cheating more, but they are feeling less guilty about it than they have in the past.[1] It seems that Americans have adopted the attitude that "everyone else is doing it, why shouldn't I?" Though this attitude may not exclusively belong to Americans, cheating has become an accepted practice, at some level, so much so that sometimes it does not feel like cheating anymore. Unfortunately, this cheating culture has infiltrated our education system, both at the secondary and university levels. In 2009, it has been reported that between 75 and 98 percent of college students surveyed admitted to cheating in high school.[3] This trend appears to continue as they graduate into the college arena.

Research on Collegiate Cheating

Research on collegiate cheating started as early as the 1920's in the fields of education and psychology.[4] Understanding student cheating has become a very important issue to study because research shows that cheating among students is prolific and increasing.[5] Academic cheating is defined as presenting someone else's work as your own.[6] When asked if they agreed with the statement, "Under no circumstances is cheating justified." over 80% of college students answered yes.[7] Yet, most students admit to have cheated at some point during their educational career.[8] A search on Google for "cheating in college" gives a more complete picture, over 64.3 million hits (accessed July 5, 2014) suggests that cheating is truly a topic of interest. Over the past decades, numerous studies[4,5] on cheating have been performed to determine who cheats and what factors affect why a student cheats.

In 1964, Bill Bowers surveyed over 5,000 students from a diverse sample of 99 colleges and universities in the United States. This was the first study that focused on cheating at the college and university level. . He reported, three-fourths of the respondents had participated in at least one incident of academic dishonesty. The same study was repeated over 30 years later, in 1993, by McCabe and Trevino at a total of 31 campuses across America and 9 of the same universities studied by Bowers.[5] McCabe and Trevino had over 6,000 student respondents in the study. Both studies asked about the students' academic dishonesty in two major areas, examinations/tests and major written assignments. These studies presented data on how much and what types of cheating was occurring on college campuses. In the later study, using similar questionable academic behaviors as indicators, McCabe reported that two out of three students admitted to participating in at least one incidence of academic dishonesty.[7]

Taking a closer look at the comparison between 1964 and 1993, the number of students that reported copying from another student on a test/exam went from 26% to 52%. When asked if they had helped another student cheat on a test/exam, the response went from 23% in 1964 to 37% in 1993. The comparisons for written work did not show such a large increase. In 1964, 49% of the students reported that they had copied material without referencing compared to 54% of students from 1993. The number of students admitting to plagiarism was one of the few areas that decreased from 30% to 26%. The other area that showed a decrease was turning in work by another student. Faculty views about academic integrity and training on this topic, as well as, the university's commitment to enforcement of honor codes could explain this decline.[5] Yet, collaboration with another student on assignments that require individual work was the largest area of increase from 1964 to 1993. This cheating behavior went from 11% in Bowers study to 49% in the McCabe and Trevino study. Overwhelmingly, 83% of the students surveyed in 1993 did not think that collaboration was a serious cheating offense. In fact, one in four students did not classify this collaboration as cheating at all.[7]

It seems as though the headlines involving academic dishonesty are never-ending. Publications from universities and academics across the nation continue to examine the apparent rise of cheating and plagiarism and the resulting implications on college campuses. A more recent study on academic dishonesty, cheating and plagiarism conducted by Don McCabe, a professor at Rutgers, looked at cheating among college and university students in North

America. McCabe collected data over a 3 year period using the Internet, which allowed for a very large study population. In all, 83 campuses in the United States and Canada participated in the Web-survey. The study was conducted as a part of an Academic Assessment Project developed at Duke University, in an effort to try to get a feel for academic integrity at participating campuses. In all, over 51,000 undergraduate students from America participated in the online survey. There were also about 9,000 graduate students and 9,700 faculty members who also responded. Two of the areas of academic dishonesty were similar to those studied previously, namely dishonesty on tests/exams and major written assignments. Undergraduate and graduate students were asked to respond whether they had participated in the various areas of academic dishonesty at least once during the most recent academic year. The faculty were asked whether they had observed the acts of academic dishonesty in their courses over the past three academic years. Cheating on tests/exams represented the highest level of academic dishonesty in the area of learning (*i.e.*, what is on a test from someone who has already taken the test.) Both undergraduate and graduate students rated this as their highest area of dishonesty reporting 33% and 17%, respectively. The faculty responded that 41% had observed a student copying from another student on an exam/test without their knowledge. According to the study, roughly one in five undergraduate students admitted to cheating in some way on a test/exam, while one in ten graduate students admitted to the same offense. It is important to remember that these values were self-reported by the students and the actual value is thought to be considerably higher.[9]

Research on Plagiarism

The same study, by McCabe, continues to examine cheating on major written assignments. The results showed that 42% of the undergraduate students (*n* = 63,700) worked with others on an assignment, when requested to do individual work as opposed to 26% of the responding graduate students. When specifically asked about plagiarism, both written sources and internet sources were compared. Around 36% of the undergraduates admitted to paraphrasing or copying a few sentences from the Internet without citing the source, and 38% did the same with a written source. The ambiguity of what constitutes a written source and an Internet source may have skewed the results. Some students classified copying material from a journal article found online to be an Internet source, when in all actuality it is a written source of information.[9] The use of written sources for copying is increasing as students believe that written work is not as easily checked by computerized plagiarism detectors. At least to some degree, the results of the study lead to the observation that almost 67% of undergraduates and 59% of graduate students, who admitted to the “cutting and pasting” form of plagiarism, have taken material from both Internet and written sources.[9]

Some interesting student beliefs arise from the data in McCabe’s study. Students were asked to rate how serious they perceived the different behaviors associated with written work. Around 56% of the undergraduate students admitted that paraphrasing and copying without citation is serious cheating offense. If the work is taken word for word from a source with no citation, 88 % of the undergraduates ranked that as a serious cheating offense. The least offensive form of cheating reported by undergraduates was working with others on individual assignments. Only 32% of the respondents perceived this behavior as a serious form of cheating.

Scientific Misconduct

As is evident by the research that has been presented, plagiarism is of key interest to academic institutions around the United States. Scientific research is not science until it has been shared with others in the scientific community and reviewed by peers in the field.[10]This results in scientific integrity becoming a major concern when writing and reading scientific publications. Students, instructors, and researchers alike must be informed about what constitutes scientific misconduct. Scientific misconduct encompasses three aspects of cheating behavior: the *"fabrication, falsification, or plagiarism in proposing, performing or reviewing research or in reporting results."*[11]   Fabrication is "recording or presenting fictitious data."[12] Falsification is defined as "manipulating data or experimental procedures to produce a desired outcome and to make the research seem valid."[12] "Using someone else's words, ideas or results without giving them credit"[12] is plagiarism. Only two studies were found which included empirical data collected directly from sciences.[9,13] In his Web-based study, McCabe, questioned students about cheating on other assignments, such as laboratory, computer and research data. One in five undergraduate students reported that they had falsified laboratory data and about one in ten admitted to copying someone else's computer code. The study also showed that 8% of undergraduates said that they had fabricated or falsified research data. The faculty responding to the survey noted over the three years of the study, 21% had seen evidence of fabricating or falsifying research and lab data by their students. These results are thought to be understated,also.[9]

Promoting Responsible Conduct of Research

There is a great need for introducing the ethics of science in the academic curriculum. In 1993, Freeman J. Dyson, a physicist published the essay "Science in Trouble." He saw science in trouble on three fronts: personal, local and global. On the personal front, the trouble centers on scientific integrity and how the researcher collects data and reports results. This area is referred to as professional ethics, the rules of conduct that guide individuals in their professional pursuits. If professional ethics are violated it can contribute to the local front which has trouble from public fears about the safety of the science being performed. Society holds scientific researchers to a higher standard of ethical conduct than is expected of ordinary citizens. If the standards of professional ethics are compromised then a tenuous relationship between society and science forms on the global front.[14] Scientific research is built on a foundation of trust. Scientists trust that the results reported by other scientists in journals, books or at conferences are honest and accurate. Society trusts that published results accurately and honestly describe researchers' work. "This mutual trust will last only if the scientific community commits itself to exhibiting and instilling the values associated with ethical scientific conduct."[10] In the late 1970's and early 1980's research misconduct began to be scrutinized by the public. It was not until the late 1980's that a formal education was considered as a way to promote high standards in research. A movement began to promote the responsible conduct of research (RCR), which had been absent due to misconduct being seen as an exception instead of the norm and researchers believing that the standards for responsible research were being taught to new scientist by experienced researchers.[15] It was not until 1989 that it was suggested by the Institute of Medicine that "Universities provide formal instruction in good research practices."[15] This suggestion was based on the pronouncement there was a serious flaw in the training of future scientists in the areas of RCR and research ethics. [15] RCR training became a focus in research institutions, but the wide variation in the way integrity concepts were taught. In the late 1990's there was a bigger push to integrate the explicit teaching of scientific ethics into the college classroom.[15]

Scientific ethics are the codes of behavior adhered to by people pursuing the common goal of scientific knowledge. Among scientists, the internal code of practice is a set of guidelines about how the practices of the profession are carried out, specifically, the scientific method. This method includes guidelines for how data should be collected, reported and shared with society. The public has set high standards for the conduct of professional scientists. Science classes at the university level are the training ground for new scientists. Many aspects of scientific research start the freshman year in any science class. Students perform experiments in which they collect and analyze data. The students then report the results in a journal article-like laboratory report. Students also work collaboratively with their peers and present projects, much like professional scientists. This work should be rooted in the concepts of RCR.[16]

Recently there has been an increased emphasis, by both graduate and undergraduate programs, to integrate ethics and responsible conduct of research into their programs.[17] Though there have been several model of how to implement topics related to RCR into the undergraduate curriculum, it is still a challenging task.[17] McArthur states in his paper on Ethics in Science, if an instructor of chemistry hopes to cover all of the information required for a major's level course, it leaves very little time for the discussion of ethics[18]. The time spent on ethics is time taking away from the important principles needed for success in subsequent courses and future careers.[18] Ethical conduct in the sciences covers a wide range of material. At the graduate level, the topics often address research specific and personal to the researcher. At the undergraduate level, especially in general chemistry, there are few topics that lend themselves to the general chemistry course. In any general chemistry course laboratory the handling of data is a necessity. Students carry out a variety of experiments that require data evaluation, and at most universities, very little guidance is given on appropriate practices in handling data.[19] Thus, linking scientific ethics to laboratory experiences and the writing process needs to be addressed at most of America's undergraduate institutions.

Traditionally, scientific ethics has been taught by example through real-life issues that arise during the research experience. In slower-paced times, this method appeared to work well, but contemporary science is much faster-paced and produces more complicated issues.[14] Often times, research groups become too large, and contact with experienced researchers or the advisor is limited. The economic pressures of the research driven programs require that grant writing be a major focus, which requires results and publications. Therefore, it cannot be assumed that all scientific researchers share the same core values and ethics.[14] Because there is no guarantee that quality ethics education is being passed down to undergraduates in research fields, it is left up to instructors to find a place in their curriculum to address the issue of scientific integrity and ethics. General chemistry seems a logical place to start training future chemists, doctors, biologist and engineers. Training about ethics and scientific integrity should be a greater focus in academia, particularly at the undergraduate level.

After deliberating with the course instructor (also the research advisor of the investigator) and the Director of the Center for Teaching and Learning at Wright State University, it was determined that the major focus of the study was to be plagiarism. Although understanding all of the factors of scientific integrity was seen as important, it was decided that the place where most students would violate the ethics codes, was in the area of plagiarism. English classes have been fighting this battle for many years, and since writing is such a crucial part of science, plagiarism was thought to be a crucial concept to address. With this in mind the following hypothesis was developed.

Hypothesis and Specific Aims

HYPOTHESIS: The hypothesis of this study is that providing scientific integrity and ethics training, while teaching students to write journal article-like laboratory reports, will reduce the number of ethical violations committed in General Chemistry I, one of the general education courses at Wright State University (WSU). Through three specific aims, the hypothesis will be tested.

Specific Aim #1: Development of Evaluation Tools and Collection of Pre-Intervention Data

Specific Aim #2: Intervention: Training on Integrity Principles and Ethics in Scientific Publications

Specific Aim #3: Collection of Post-Intervention Data and Comparative Evaluation of Pre- and Post-Intervention Data

Chapter 2: METHODOLOGY

2.1. Context and Design

As mentioned in introduction, few studies[9,13] focus directly on scientific integrity in writing at the undergraduate level. This study was designed to evaluate the effectiveness of a scientific integrity and ethics training in general chemistry at a four year university. It is expected that providing scientific integrity and ethics training, while teaching students to write journal article-like laboratory reports, will reduce the number of ethical violations committed in a general chemistry course at WSU. Though intervention and data collection were conducted during the course, the original intent of the data was for the instructor, Dr. Sizemore, to evaluate course effectiveness.

As part of addressing Dr. Sizemore's concern about students' abilities to write quality, authentic laboratory reports, discussion between the author and Dr. Sizemore ensued. The author, being an experienced educator of 21 years at both high school and college level, found the consistent plagiarism violations observed while grading laboratory reports from previous semesters of General Chemistry I concerning. Noticing that students seemed unaware of their misconduct, it was proposed by the instructor that training needed to occur on ethics in writing. After lengthy discussions between Dr. Sizemore and her GTA's (including the thesis author), it was determined that pre-and post-tests centered on ethics in writing needed to be developed and evaluated for the purpose of student improvement. Also, representative samples of laboratory reports needed to be collected to both pre- and post-intervention so that Dr. Sizemore could develop better teaching strategies. The collection of laboratory reports by the instructor was intended to be used to evaluate GTA grading inconsistencies and quality of student writing. All tests and collected laboratory reports were collected and stored by the instructor for evaluation at the end of the semester in order to redesign the course as needed.

Following the course, after discussions between the graduate teaching assistants (GTAs) and the course instructor, it was determined that area of scientific integrity needed to be analyzed more thoroughly, thus, the aims of this study were developed. It was at this time that the project switched from a teaching improvement strategy to a research project and thesis. As a result, this study was based on secondary data, which was evaluated after the completion of the course. There was no opportunity for the researcher to collect any additional data.

2.2. Description of the General Chemistry I Laboratory Course

Students enrolled in the General Chemistry I lecture course and the associated laboratory (*i.e.*, the course co-requisite) as a requirement of various science or engineering majors. At WSU, the General Chemistry I lecture (CHM1210) and laboratory in conjunction with a recitation (CHM1210L and CHM1210R) are separate courses. This course was taught during all three semesters of the academic year. Some students were only required to take this first course in the sequence. Others were required to continue onto General Chemistry II. The data for this study was collected from the course taught during the spring semester. Some possible implications related to the spring semester offering were that students who failed the course in the fall semester could potentially have been retaking the course in the spring semester. Another possibility was that students registered for the spring semester course were not mathematically prepared to take the course during the fall semester. Lacking mathematical requirements is a factor with incoming freshman.

Theoretical concepts introduced during the lecture were discussed during the recitation period and emphasized by hands-on experience in laboratory. However, a student could receive credit in one or both, and did not have to be enrolled in the lecture portion of the class to enroll in the laboratory. Students, who had taken and failed either the laboratory or the lecture course, could retake a section (e.g., just take the laboratory) of the class. The course was designed so that there was a one hour recitation, which students were required to attend before coming to the laboratory. The recitation was either taught by the course instructor or an experienced chemistry, graduate teaching assistant. During recitation, concepts incorporated in the upcoming week's lab were presented and discussed. In spring 2013, the first semester of the General Chemistry laboratory comprised the following experiments: "Mass Measurement and Density," "Paper Chromatography," "Analysis of Hydrated Copper Sulfate," "Types of Reactions," "Oxidation-Reduction Reactions," "Spectroscopy and

Atomic Spectra," "Molecular Models: Inorganic Compounds," "Heat of Reaction and Solution," "Gas Behavior," and "Molecular Models: Organic Compounds."

2.3. Participants

Participants in this study were the students (*N* = 211) originally enrolled in the General Chemistry I laboratory (CHM1210L) during the spring 2013 semester. This number decreased throughout the semester, due to students withdrawing from or not attending the class. Science and engineering majors enrolled in this course either had chemistry in high school or completed the Introduction to General Chemistry course (CHM 1010), with a minimum grade of D. The other course pre-requisite is passing the Intermediate College Algebra course (MTH1260) with a minimum grade of D or the WSU Math Placement 04. Most of the participants were enrolled in the lecture course concurrently.

The population was expected to be composed of mostly freshman, due to the nature and placement of the course in the chemistry sequence and WSU curriculum. Yet, the course was made up of 43.6% (*N* = 92) freshman by credit and 56.4% sophomores and above (*N* = 119). It is important to note that this course is taught all three semesters of the academic year. The spring session of the course is the second time during the academic year that the course is offered. This may explain the lower number of freshman enrolled in the course. Because the General Chemistry I course is required for all engineering majors as well as all science majors, there was a large population of engineers which participated in the study (*N* = 62). The population of the study participants based on the students' declared majors can be seen in Figure 1. Only 7 % of the students taking the course were declared chemistry majors, while 31% of the students were declared biology majors. Engineering students accounted for 29% of the study populations, but the largest segment of the population, 37%, was composed of a variety of majors such as science and math, sports science, Earth science, nursing, business and clinical laboratory.

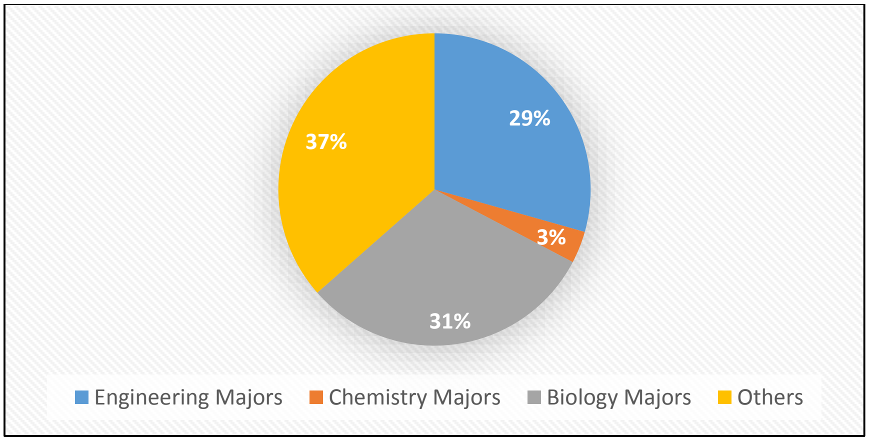

Figure1: Declared majors of the General Chemistry I laboratory students (CHM 1210L and CHM1210R) during spring 2013 semester.

Though declared majors and year of study were obtained, the demographics of the study were limited by the fact that the data was collected and evaluated after the completion of the course. It was determined that males represented 57.3% of the population. Yet, due to the fact that the students' registrations in the course provided little personal information, there were many aspects of the population that were unknown. This study does not include any data about the race, socioeconomic status, or grade point average of the participants. There was also no way to determine if any of the students in the study had attempted the course previously. There is also no way for the investigator to track which majors had a higher number of violations. Another limitation was not being able to identify international students or English as a second language learners.

When it was determined that the information collected as part of routine teaching improvement was going to be used as secondary data, the Institutional Review Board (IRB) was contacted regarding needed "human subjects" approval. The researcher was sent a letter articulating that the study did not qualify for human subjects research and therefore did not require IRB approval.

2.4. General Procedure

There were *N* = 211 students enrolled in CHM 1210L, eligible to complete the course assignments, including the labs reports, and the pre-post tests on plagiarism. Due to absences and withdrawal from the course, not all 211 students participated in the class assignments. As a result, the secondary data and the *N* for each measurement may fluctuate. Table 1 displays the data sources and the population values for each set of data collected.

Table 1: Population values for data evaluation

Item	Number Collected	Usable (N)	Data Source	Paired or Unpaired	Reason
Pre- Test	183	181	Students attending recitation week 5 who took the pre-test.	Paired	Of the 211 students only 183 were present during the class period.
Post-Test	181	181	Students attending lab week 5 who took the post-test. These students also took the pre-test during recitation.	Paired	Of the 211 students only 181 were present both during recitation and lab.
Pre-Intervention Laboratory Report	43	42	Two highest and lowest grades from each lab section.	Unpaired	Not all TAs turned in useable reports.
Post-Intervention Laboratory Reports	44	42	Two highest and lowest grades from each lab section.	Unpaired	Some lab reports were not copied correctly and were unusable.

All of the work produced for this study completed as regular course work required for the completion of CHM 1210 L. The data presented in this study was collected retrospectively and participants' names were removed and replaced with numbers for identification. Each student was registered for one of the five recitation sections, and one of the twelve laboratory sections. Recitations were taught by two chemistry graduate teaching assistants (GTAs), under the guidance of the course instructor, using common class material. The twelve laboratory sections were each instructed by one of six different TAs. Four of the teaching assistants were graduate chemistry students and two were undergraduate science majors, who had successfully completed General Chemistry I lecture and laboratory courses in a previous year.

Several measures were used to ensure that all students were treated similarly. All recitations and laboratory sections were presented with the same training, using the same PowerPoint presentations, and pre-tests and post-tests. The recitation PowerPoint presentations were posted online in advance for student access. All students were expected to have the required laboratory manual, *Laboratory Guide for Chemistry* by D. Grossie and K. Underwood, Sixth edition. This laboratory manual provided brief, written guidelines for how to write a journal article-like laboratory report and a sample laboratory report.

The technical approach employed for the completion of each of the specific aims is described below. Figure 2 is a schematic of the steps taken during this study.

Week of	Exp. #	Experiment Title and #	
Jan. 7th		No Experiments First Week of Semester	
Jan. 14th	1	#22 Mass Measurements and Density (DWR)	
Jan. 21st		MLK DAY Holiday: University Closed-No Labs this week	
Jan. 28th	2	#28 Paper Chromatography (JAR)	**Pre-Intervention**
Feb. 4th	3	# 2 Analysis of Hydrated Copper Sulfate – Part 1	**Post-Intervention**
Feb. 11th	4	# 2 Analysis of Hydrated Copper Sulfate – Part 2 (JAR)	
Feb. 18th	5	**Introduction to the scientific writing process, the literature search, the scientific integrity principles and the ethics in scientific publication**	
Feb. 25th		Spring Break	
Mar 4th	6	#45 Types of Reactions (DWR)	**Post-Intervention Laboratory Due**
Mar 11th	7	#27 Oxidation-Reduction Reactions (DWR)	
Mar 18th	8	#39 Spectroscopy and Atomic Spectra (JAR)	
Mar 25th	9	#24 Molecular Models: Inorganic Compounds (DWR)	
Apr 1st	10	#18 Heat of Reaction & Solution (DWR)	
Apr 8th	11	#15 Gas Behavior (JAR)	
Apr 15th	12	#25 Molecular models: Organic compounds (DWR)	

Figure 2: Laboratory Schedule for General Chemistry I (CHM 1210 L) which shows the order in which this study proceeded.

2.5. Specific Aim 1: Development of Evaluation Tools and Collection of Pre-Intervention Data

2.5.1. Development of Pre- and Post-Intervention Evaluation Tools

Two types of evaluation tools were produced: a) a test on the Integrity Principles and Ethics in Scientific Publication, and b) an ethics rubric for the evaluation of journal article-like laboratory reports. These evaluation tools were utilized pre- and post-intervention, *i.e.*, before and after the Integrity Principles and Ethics in Scientific Publications training.

Development of a Test on the Integrity Principles and Ethics in Scientific Publications

In an effort to determine the participants' prior knowledge about the topics of scientific integrity and ethics in publication prior to intervention, a pre-test was developed by the investigator. The questions were based on the concepts from the recitation presentation, Integrity Principles and Ethics in Scientific Publications, which was also developed by the investigator. The test included ten questions that were either multiple choice or true/false (see Figure 3). Two of the multiple choice questions were scenario driven and related to laboratory procedures the students had already performed (Questions #9 and 10 in Figure 3). The instrument also included definitions of terms used in discussing scientific integrity and applications of those concepts. (Questions # 1-8 in Figure 3). Face validity was established for The Integrity Principles and Ethics in Scientific

Publications Pre-and Post-Tests through two methods. First, the author as a GTA and the course instructor met to determine the structure of the test. Appropriateness of the questions, based on the presentation was established through this collaboration. The second method of validity was established by administering the pre-test to the author's and course instructor's research group, composed of four graduate students and three undergraduate students. All of the aforementioned had experience in General Chemistry I and laboratory research practices. After taking the pre-test, the research group participants discussed the relevancy of the pre-test and evaluated the questions on the test for clarity and appropriateness. Once the validity was established, the test was ready for use in the course. The pre-and post-tests administered to the participants were identical.

Pre-Test: *Integrity Principles and Ethics in Scientific Publications*

Please circle the answer that you consider correct:

1. Is it plagiarism to copy and paste a paragraph of text from a Web site or a book without putting quotation marks around it and referencing the source? YES or NO

2. Is it plagiarism to use ideas from another publication without citing the reference but expressing them in your own words? YES or NO

3. Is it scientific misconduct to write a lab report for CHM 1210 at WSU, and then to transfer to Miami University and turn in the same report for a class there? YES or NO

4. Is it plagiarism to claim work that another student did as your own work? YES or NO

5. Is it plagiarism to incorporate text from another source, changing only a word or two, but including a citation for the source? YES or NO

6. Is it fabrication to remove two data points that did not follow the trend found in the rest of the experiment and to write your lab report as if those two data points did not even exist? YES or NO

7. Recording or presenting fictitious data in a laboratory report is referred to as:

a. Plagiarism c. Falsification
b. Fabrication d. None of the above

8. Is it plagiarism to include an image in your report that you obtained from a Web site and properly cited? YES or NO

9. You submit an article to a journal for publication and state that a certain substance in the experiment must be heated at 75 ^{o}C for 10 minutes. In reality, when you carried out the experiment in lab, you found that heating it only to 55 ^{o}C gave better results. You decide not to report this change in the journal article. This is considered:

a. Plagiarism c. Falsification
b. Fabrication d. None of the above

10. During the Chromatography lab you failed to spot enough of the amino acid, Arg, onto the paper. When you got your chromatograph back out of the oven, all of the other amino acids showed up as dark pink spots, but there was no spot for Arg. When you prepared your lab report, you reported a value for the R_f of Arg. This would be considered:

a. Plagiarism c. Falsification
b. Fabrication d. None of the above

Figure 3: Pre- and post-test on the Integrity Principles and Ethics in Scientific Publication developed for the General Chemistry I laboratory.

Development of an Ethics Rubric for the Evaluation of Laboratory Reports

The investigator, in collaboration with the course instructor, developed a rubric based on six areas of perceived plagiarism, which were discussed during the recitation period. These areas were chosen due to the prevalence of violations in these areas as observed by the TAs during the grading of the laboratory reports. The investigator received face validity by revising the six areas evaluated with the Director for the Center of Teaching and Learning at WSU. These areas are shown in Figure 4, and were evaluated for the Paper Chromatography(pre-intervention) and Analysis of Hydrated Copper Sulfate(post-intervention) laboratory reports (*N* = 42). The first four violations were recorded as a running total. The last two types of plagiarism violations were simply answered with a “Yes” or “No”.

Type of Scientific Misconduct	Specific Violation	Tally	Where?
Plagiarism	The student presented work that is significantly similar to that of his/her lab partner		
	The student directly quoted a source without appropriate citations.		
	The student has failed to reference calculation formulas, which are not common knowledge.		
	The student has paraphrased information without giving credit to the original source.		

Plagiarism	**Specific Violation**	**YES**	**NO**
	The student has included a citation list but is missing in-text citations.		
	The student has included a reference list at the end of the report.		

Figure 4: Ethics rubric focused on plagiarism found in laboratory reports in the General Chemistry I course.

2.5.2. Collection of Pre-Intervention Data

Two types of pre-intervention data were collected: a) a set of journal article-like laboratory reports that were prepared by students during week two of the course (*N* = 42), and b) the pre-test on the Integrity Principles and Ethics in Scientific Publication that was administered during week five of the course (*N* = 183).

Collection of Pre-Intervention Laboratory Reports

During the second week of laboratory work, students had performed experiments centered on the use of paper chromatography to identify unknown amino acids. Students were given no specific training on how to write a journal article-like lab report prior to the assignment. Students were told to use the laboratory manual as a guide and were directed to write a journal article-like laboratory report about the chromatography experiment. Students were also given access to the General Chemistry I Laboratory “Journal Article” - Lab Report Checklist (Figure 5) that was developed by the course instructor or grading by the teaching assistants. Once all laboratory reports were graded by TAs according to criteria given in Figure 5, to obtain a representative sample, the course instructor required that the reports which received the two highest and the two lowest grades from each of the twelve laboratory sections, be turned in by the TAs, copied and stored by the course instructor in a secure file cabinet. There were 43 reports turned in by the TAs that were given to the investigator for this study. One of those reports were copied incorrectly and deemed unusable.

The reports were then regarded by the investigator for standardization purposes, using the provided checklist. These grades were reported as the pre-intervention laboratory report grades (N = 42).

Collection of Pre-Intervention Test on the Integrity Principles and Ethics in Scientific Publication

A baseline had to be obtained in order to determine if improvement occurred after the intervention was performed. This was accomplished by administering the pre-test developed by the investigator, at the beginning of the recitation period, during week five of the semester. Students were made aware of participation in the study and were told that the pre-test would in no way affect the laboratory grade. The pre-tests, made up of multiple choice and true/false questions, were collected (N = 183) and graded by the TAs based on a key provided by the investigator.

General Chemistry 1 Laboratory (10 points) "Journal Article" - Lab Report Checklist[20]

A) Abstract (0.6 points)

i) I have provided an overall summary of the investigation, including

(1) objective, (0.2 points)

(2) significant findings (i.e., key results, but not raw data), and (0.2 points)

(3) major conclusions. (0.2 points)

B) Introduction (2 points)

i) I have described the following key elements

(1) hypothesis/question, (0.5 points)

(2) experimental importance and/or significance, (0.5 points)

(3) theoretical context, and (0.5 points)

(4) techniques and/or procedures intended to solve the problem. (0.5 points)

C) Experimental section (also known as "Materials and Methods" or "Procedures") (1 point)

i) I have provided a narrative of the procedure and materials/instrumentation used. I have also given the stock concentration for all solutions used (e.g., 0.053 M hydrochloric acid) (0.5 points)

ii) I have not written this section in an active-voice "to do" list or "cookbook" narrative; rather, the section is an abbreviated past tense description crafted in sufficient detail so that someone "skilled in the art" could repeat my work. (0.25 points)

iii) I have not included any explanations, rationalizations, or results in this section. (0.25 points)

D) Data and Results (3 points)

i) I have begun the section with text, not with a table or figure. (0.25 point)

ii) I have "walked the reader through the data" via the text, i.e., I am not relying upon the data to speak for itself. Similarly, all of the accompanying tables and figures are referred to in the text. (0.75 point)

iii) I have provided any equations crucial for transforming the raw data to significant results I have included one sample calculation for each type of equation. (0.5 point)

iv) I have not attached a figure from Excel with the accompanying data set on the printed page unless I have also provided a table number and a title for the data. I recognize that for most purposes, the figure is sufficient; the data set does not have to be explicitly shown. (0.5 point)

v) I have numbered (not lettered) all of my tables and figures in order of appearance. (0.2 points)

vi) I have provided titles and captions for all of my tables and figures, respectively. (0.2 points)

vii) I have included the appropriate axis labels and units for all figures. (0.2 points)

viii) I have included units for any quantities in tables. (0.2 points) ix) I have used the descriptor "Figure" not "Graph". (0.2 points)

E) Discussion and Conclusions (3 points)

i) I have considered and discussed in great detail whether the results validate the hypothesis/question. (1 point)

ii) If the hypothesis is not validated, I have provided a new hypothesis/question. (1 point)

iii) I have provided an error analysis, and the proposed reason for any error is consistent with the error trend. Do not just state the error, explain it and rationalize it! For example, "Human error was the reason for having bad results" is not considered sufficient as an explanation of error. (1 point)

F) References (0.4 point)

i) I have provided a reference for any idea or equation not of my own creation, imagination, or derivation. (0.2 points)

ii) I have paraphrased ideas adopted from another's text, and not simply placed the extracted text in quotes. (0.1 points)

iii) I have sought and provided citations for relevant, published results from the primary literature, not only from Websites and the course textbook. (0.1 points)

Figure 5: "Journal article" laboratory report checklist that was developed by the course instructor as a grading rubric for General Chemistry I.

2.6. Specific Aim 2: Intervention: Training on Integrity Principles and Ethics in Scientific Publications

As mentioned in Chapter 1, the proliferation of ethical violations in the scientific community has become a point of interest recently. A number of violations and subsequent retractions have affected many universities and research facilities, WSU included. In an effort to prevent such occurrences, the thesis author, serving as a GTA, and the course instructor, Dr. Sizemore, discussed the need to train students early in the academic experience. It was determined that training should occur as early as the freshman year, during General Chemistry I, since it is a required course for a large number of science and engineering undergraduate students. This course is the start of many students' laboratory experiences at the collegiate level and is the basis for all further scientific training. Early in the spring semester, a Power Point presentation was developed by the teaching team that included an explanation of scientific knowledge and how it has not truly entered the domain of science until it has been shared with the scientific community[21]. The concept of scientific integrity was introduced as a basic foundation of trust between scientist and society. Scientific misconduct was defined as the "fabrication, falsification, or plagiarism in proposing, performing or reviewing research or in reporting results"[22]. Examples of scientific misconduct, which included data fabrication and falsification, as well as plagiarism where included to provide relevance. Finally, the consequences for scientific misconduct at WSU were addressed.

During week five of the spring semester, the laboratory topics were Introduction to the Scientific Writing Process, the Literature Search, and Integrity Principles and Ethics in Scientific Publication. The pre-test on Integrity Principles and Ethics in Scientific Publication was administered at the beginning of the recitation period. After the pre-test was collected, the WSU Science and Mathematics librarian, Mary Lou Baker Jones, gave the **C**urrency, **R**elevancy, **A**uthority, **A**ccuracy, and **P**urpose Test presentation to each recitation section. This presentation focused on currency, relevancy, authority, accuracy and purpose of sources when writing. The librarian explained to students when citations were necessary, how to find dependable and worthy references, and how to list the references using the American Chemical Society notation. The presentation also incorporated past experiments performed by the students as examples to provide relevance. Throughout the recitation period, students remained engaged through the use of TurningPoint and clickers.

After completing the recitation, students attended a 2.5 hour laboratory session. Some students performed the laboratory directly after recitation, whereas others had 1-4 days between the recitation and laboratory sessions. The week five laboratory sessions were devoted to “How to Write in Science.” This involved a training on Integrity Principles and Ethics in Scientific Publications and an Introduction to the Scientific Writing Process. The presentations were prepared by the teaching team which included two graduate students in chemistry, and the professor teaching the course, CHM 1210L. The presentations were disseminated to each TA via weekly meetings and e-mail.

The PowerPoint presentations were presented during each student's laboratory period by the assigned teaching assistant. Discussion questions and answer keys were provided to the TAs to encourage the engagement of the audience and continuity in instruction.

2.7. Specific Aim 3: Collection of Post-Intervention Data and Comparative Evaluation of Pre- and Post-Intervention Data

2.7.1. Collection of Post-Intervention Data

Two types of post-intervention data were collected: a) the post-test on the Integrity Principles and Ethics in Scientific Publication that was administered during week five of the course (N = 181), and b) a set of journal article-like laboratory reports that were submitted by students during week six of the course (N = 42).

Collection of Post-Intervention Test on the Integrity Principles and Ethics in Scientific Publications

At the end of the laboratory session students were given a post-test on Integrity Principles and Ethics in Scientific Publications, which was identical to the pre-test administered during recitation. The post-tests were graded using the same key as used to grade the pre-test. Each TA graded the post-test and reported the scores. The number of students taking the post-test was slightly lower than that of the pre-test resulting in an N =181, due to absence or withdrawal from the course. Since the tests were to be paired, only tests of students taking both the pre-and post-test could be included in the study.

Collection of Post-Intervention Laboratory Reports

In addition to looking at the post-test grades, the application of the knowledge presented during the intervention was evaluated using another journal article-like laboratory report. The laboratory, Analysis of Hydrated Copper Sulfate, was performed during the 3rd and 4th week of the laboratory. Since students received training on writing laboratory reports during the 5th week of lab, it was expected that students would apply the acquired knowledge to the writing of the report for Analysis of Hydrated Copper Sulfate. After the laboratory reports were turned in during week 6 of the semester and graded by TAs, the reports that received the two highest and the two lowest grades from each of the twelve laboratory sections, were collected from the TAs, copied and safely stored by the course instructor. The collection of the lab reports was based on the TAs evaluation of the best and worst according to the score received out of ten points when graded with a common rubric (Figure 5.) As a result, the post-intervention laboratory reports are not paired with pre-intervention laboratory reports. In addition, no demographic characteristics of the laboratory report writers is known. Once the investigator began the study, the names were removed and replaced with numbers for identification purposes. The reports were then regarded by the investigator for standardization purposes, using the provided checklist (Figure 5). Though 44 laboratory reports were given to the investigator for the study, two of those were unable to be used due to only part of each report being present.

These grades were reported as the post-intervention laboratory report grades (N = 42).

2.7.2. Comparative Evaluation of Pre- and Post-Intervention Data

Evaluation of Pre-and Post-Test on Integrity Principles and Ethics in Scientific Publications

All pre-and post-tests were paired (N=181), those without a match were not included in the study. The tests were then numbered in sequential order and the names of students were removed to maintain confidentiality. Scores for each test were recorded and compared. The net change for the tests was calculated.

Assessing Student Plagiarism in Laboratory Reports using TurnItIn

Once all laboratory report grades were standardized, the investigator scanned all reports into a drop box using Pilot, WSU's online learning platform. Once put into a drop box, the reports were submitted to TurnItIn.com, a plagiarism determination program. Turnitin works by comparing the uploaded document to a huge database of over 45 billion pages of digital content, over 337 million student submissions and over 130,000 professional and academic publications. Universities all over the world use TurnItIn for plagiarism detection, resulting in 1.6 million faculty users.[23] In addition to submitting the students' work, a copy of the laboratory directions from the laboratory manual and the recitation notes about the laboratory procedure were uploaded to the drop box to provide these sources for TurnItIn.com to check for plagiarism. TurnItIn.com reported a percentage of similarities to other sources for each laboratory report.

This report was used to help determine instances of plagiarism in both pre- and post-intervention laboratory reports.

Evaluation of Laboratory Reports

After viewing each report from TurnItIn.com, each laboratory report was evaluated using the developed Ethics Rubric (Figure 4). The investigator used notations from TurnItIn.com and personal knowledge of the subject matter, to evaluate each of the six areas listed on the rubric. The first four areas required a running tally, whereas the last two areas simply required a Yes or No answer. Once the laboratory reports were evaluated, the scores for each of the six areas were compiled and evaluated.

In addition to evaluation of number of ethical violations pre-intervention vs. post-intervention, the number of violations committed by males versus the number committed by females in the course was evaluated. The last area explored in this study was the correlation between grade earned on the report and the number of ethical violations.

Statistical Evaluation

In educational research, it is often necessary to determine statistical significance. The significance level of $p \leq 0.05$ was used in evaluating the data, as is the case in most educational studies. To test the null hypothesis, a significance test was used on both the pre-and post-test data. The pre-and post-tests were first paired and then the names of the students were removed. A matching number was assigned to each pre-/post-test pair. After compiling the scores, paired t-test was applied to the data to determine statistical significance. The t-test is used to test for differences between the means of two samples. Likewise, the pre- and post-intervention laboratory scores were evaluated for significance. These were unpaired samples so an unpaired t-test was used to determine significance.

To evaluate the data produced from the Ethics Rubric in Figure 4, two different statistical tests had to be applied. The first four areas of the rubric resulted in quantitative data, which was also evaluated with a t-test. The last two areas on the rubric were categorical data, which required the use of a different statistical analysis. The chi-squared test is used to compare counts of the two areas of categorical data for the two independent laboratory reports. The chi-squared data was determined using $df = 2$ and $p \leq 0.05$.

Chapter 3: RESULTS AND DISCUSSION

Throughout this chapter, the results of the data analysis process will be presented. This study produced quantitative data that will be discussed within this chapter. The first section of the chapter will focus on the evaluation of the results of the tests on the Integrity Principles and Ethics in Scientific Publications, which were taken pre- and post-intervention by the students enrolled in the CHM 1210 L course during the spring 2013 semester. The second section of the chapter will reveal the relationship between the pre- and post- intervention journal article-like laboratory reports. The third section will address the question of ethics. In this section, the results from the ethics rubric will be presented for both the pre- and post- intervention journal article-like laboratory reports.

3.1. Pre-and Post-Intervention Test on the Integrity Principles and Ethics in Scientific Publication: Quantitative Data

The test on the Integrity Principles and Ethics in Scientific Publication was assigned a maximum of 10 points, one point for each of the 10 questions. The mean score on the pre-intervention test was 6.69 (SD of 1.36) with an N = 181. Figure 6a shows that the class scores exhibited a normal grade distribution, which means the mean divides the class scores into two approximate equal halves. This is normal in a general education classes with large populations.

The post-intervention test was identical to the pre-intervention test. Thus, the total score was also out of 10 points, with students being awarded a point for every correct answer. The mean score on the post-intervention test was 7.71 (SD of 1.34) with an N = 181, which corresponds to ~10 % improvement in students' knowledge of the subject. Figure 6b shows that, the grade distribution has shifted approximately one point toward higher values after the class intervention.

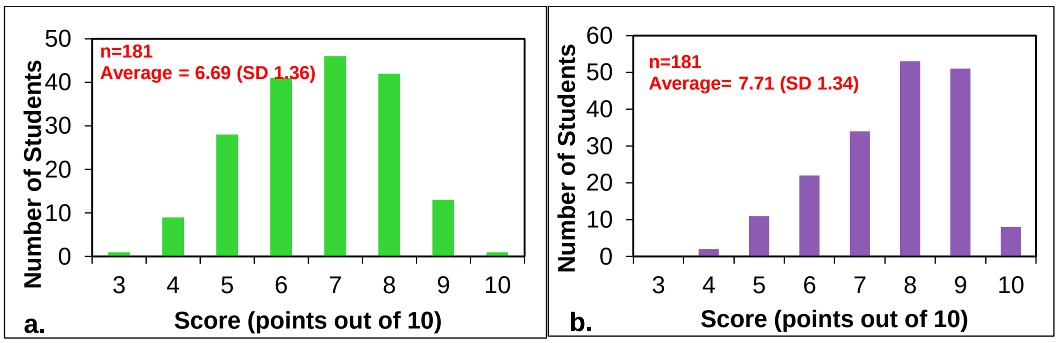

Figure 6: Score distribution from the test on Integrity Principles and Ethics in Scientific Publication in CHM1210L, spring 2013.a) Pre-intervention and b) Post-intervention.

The data can be further analyzed for the evaluation of the net improvement in the scores received. Out of the *N* = 181 participants in the study, 113 students (62%) improved their scores, as seen in Figure 3, with an average improvement of +2.10 (SD of 1.17) points. Figure 7 also indicates that 34 (19%) students saw no change in score, and another 34 (19%) students saw decrease in their score with an average decrease of 1.5 (SD of 0.74) points.

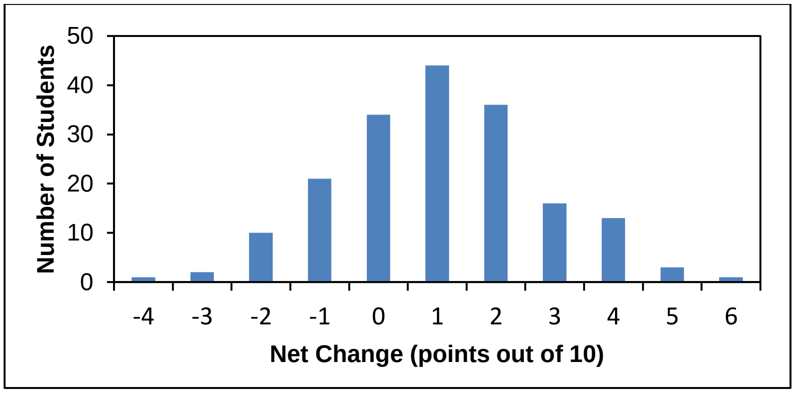

Figure 7: Net change in scores from pre-test to post-intervention tests in CHM1210L, spring 2013.

Because this is an educational study, the concept of statistical significance must be addressed. Even though statistical significance does not show whether teaching one way is better than another or if the results of the study are practical, it does show if there was a difference between the two groups. The statistical significance testing indicates if there was sampling error.[24] The pre- and post-test scores in this study were compared and found to be highly statistically significant by performing a t-Test: Paired Two Sample for Means, t (180)= 7.9 $p \leq .05$. It was encouraging that many students already had some concept of scientific integrity before the training occurred, as showed by an average of over 6 points. The presentation used to train the students was an interactive, lecture style, which is very familiar to college students, so the information was easily assimilated, resulting in a 62% of the students improving their scores. It is interesting to see that 34% of the students saw a decrease in score from pre-test to post-test. This could be explained by fact that the students were given the test at the end of the laboratory session, when they were anxious to leave. It should be noted that those students, who saw no net change, did not miss all of the same questions on the pre- and post-tests. Some students gave correct answers on the pre-test and then after training chose the wrong answer on the post- test. This may be due to lack of effort and participation on the student's part during the training.

3.2. Pre-and Post-Intervention Ethics Rubric Data Evaluation

Integrity in science is what is expected by society. Science is the knowledge obtained through collecting, organizing and interpreting facts. Science assumes a high moral standard and thus, it should be performed by people of integrity.[26] If this is the case, it seems that the scientific community is faced with a quandary. Over the past two decades, the number of scientific misconduct reports has increased and public scrutiny has intensified. This has led to mistrust and concern about training future scientists. The results of this study suggest that this concern is valid. As stated earlier, scientific misconduct is *"fabrication, falsification, or plagiarism in proposing, performing or reviewing research or in reporting results*[27] At the General Chemistry I level, students at WSU have never been exposed to the standards set forth by the scientific community.

Most students have had some sort of training about how to avoid plagiarism in their high school or college English classes. When writing papers, students are required in those classes to cite references and use either American Psychological Association (APA) or Modern Language Association (MLA) citations. So, this concept is not entirely new to students. Yet, when applied to the realm of chemistry, it appears that all bets are off. Students simply do not think that the same rules apply to writing a journal article-like laboratory report. To evaluate this aspect, the ethics rubric described in the Methodology section was used to evaluate the students' application of the scientific integrity training that occurred during the laboratory sessions in General Chemistry I at WSU. The rubric allowed for evaluation in six areas of plagiarism: 1) presenting work similar to that of his/her laboratory partner, 2) directly quoting a source without appropriate citations, 3) failing to reference a calculation, 4) paraphrasing information without giving credit to the original source, 5) providing a citation list but not including in-text citations, and 6) providing a citation list at the end of the report. The ethics rubric did not address fabrication or falsification because at this level of chemistry, most students do not have the chemical knowledge to make up or falsify data appropriately. Also, it is stressed in CHM 1210L that journal article-like laboratory reports are focused more on the process of writing scientific articles, not the accuracy of the measurements collected.

The first four areas where evaluated using a tally system. The plagiarism detector, TurnItIn.com, was utilized to evaluate where text matches occurred. Yet, TurnItIn, although used by hundreds of colleges across the United States, still has limitations. TurnItIn can detect similarities in text, but ultimately, the investigator had to determine if these similarities constituted plagiarism. TurnItIn's other weakness is that it does not detect when passages have been properly cited.[28] These are the downfalls associated with such detection programs, which may give college faculty and administration a false sense of assurance that plagiarism is being detected. For this study, the similarities in text were evaluated and a determination of whether plagiarism had occurred was manually made by the investigator. Each incidence of occurrence was recorded. The sums for each category were calculated and are shown in Figure 8.

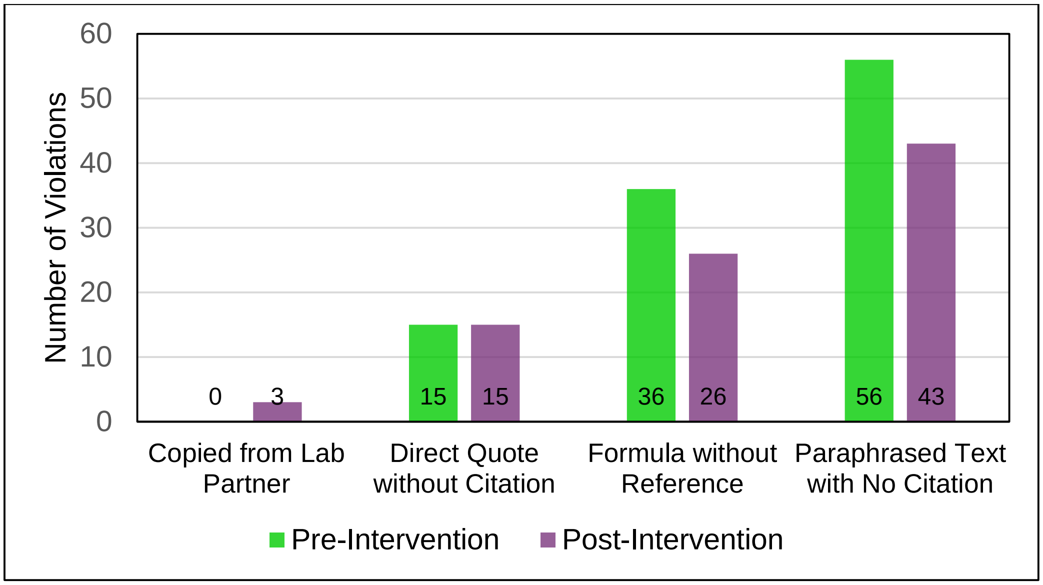

Figure 8: Number of plagiarism violations based on the ethics rubric for pre-and post-intervention lab reports in CHM1210L, spring 2013.

Because dishonesty is a learned behavior and most people want to be honest, the question that arises is “Why are forms of plagiarism continuing to occur?” McCabe’s study of over 6,000 students in the early 1990’s may provide some insight. In this study, students reported that the most common form of cheating was failure to cite sources on written work and second was collaborating on assignments when instructed to not work with others.[29] This may help to explain why there was an increase in the number of students turning in work that was similar to his/her partner (from N = 0 to N = 3). Three does not seem like a lot of students, but when the size of the sample is considered, these cases account for 7% of the evaluated reports. Why would a student risk plagiarism that is so easily detected? First, it is important to note that the original laboratory reports were not run through a plagiarism detector during the course. Any plagiarism had to be detected by the TA. This may have given students the impression that plagiarism was not going to be a focus of the grading. Also, factors of situational ethics come into play. As the semester progressed, students may have feared failure, and resorted to plagiarizing to secure a passing grade.[29] Cheating seems to be easily justified by students, claiming that all of their peers do it, so it must be okay. Cheating keeps the “playing field” even.

Figure 8 shows that the number of violations involving direct quotes did not change post-intervention. During the evaluation of the reports, it was evident that many students knew that it was necessary to put quotations around a direct quote. Yet, some failed to cite the passage with in-text citations. Others simply directly quoted material from the lab manual or recitation notes without any reference to the original source. Most of the plagiarism that occurred in this area transpired in the Introduction portion of the journal article-like laboratory report. This is the section of the report that involves theory and background information. Because this is a first year, undergraduate course, it stands to reason that many students had little or no prior knowledge about the concepts being addressed in the laboratory experiments. This being the case, students seem to have taken information from the two easiest and most accessible sources. Many students do not see a need to reference material when using notes and textbooks as sources. It seems as though they truly do not know that they are cheating.

It is encouraging to see the in two of the evaluated plagiarism categories, the number of violations decreased. The first decrease was seen in the number of students including a formula in their writing without referencing it within the text (from $N = 36$ to $N = 26$). The formulas that were pertinent to these two particular laboratory reports were not common knowledge to those not in the chemistry field. As a matter of fact, these formulas were new to most of the students in the course. Most of the cases of plagiarism of this sort occurred in the Introduction and the Results sections. These two areas make the most sense because the Introduction, as stated before, introduces the theory and formulas that are needed to understand the purpose of the laboratory. The Results section is the portion of the report in which the student processes the data and applies formulas to obtain desired results. Again, it seems as though this type of violation is unintentional. Most students do not look much farther than the laboratory manual to find information about the calculations that are required. To get students to understand that if it was not their thought or formula, they need to cite it, seems to be a big hurdle.

Much of the paraphrasing that occurred in the laboratory reports was done in the first three sections of the report, namely the Abstract, the Introduction, and the Experimental Section. Each of these sections requires students to use information obtained from the manual and the recitations notes. It appears that students did not consider that these resources needed to be referenced. Many students listed the laboratory manual as a reference at the end of the report, but at no point throughout the report did the manual get cited.

Even though there was an improvement in the number of students paraphrasing without citing the source (from $N = 56$ to $N = 43$), there were still 43 incidences of students using another person's ideas without crediting that source. This raises the question "Why?" Are students just too lazy today to take the effort to simply cite where their ideas came from originally? That may be part of the answer, but it is more likely that students do not see it as cheating when they paraphrase text.[3] They simply think that if they have changed a few of the words around, the writing is original. As most people do, college students seek the path of least resistance. When excessive workloads and the pressures to get good grades become too much, students are found to cheat more often. Simply changing a word or two and claiming the work as their own, seems like a good option when time is short and the pressure to succeed is great. Many students just want to get a good grade in the course and are more likely to cheat than those that truly want learn from their studies. It is expected that students, who wish to learn from their studies, cheat less often, even when faced with challenging situations.[13] However, most undergraduate students do not purposefully set their minds on plagiarizing. In this digital age, younger students tend to believe in the free flow of ideas and are not used to giving credit for borrowed ideas.[30] It seems that they are simply unaware of the rules governing how to write scholarly journal articles.[30] Even after the short training on ethics in the writing process was performed, some students were still confused about what plagiarism actually is and how it can be avoided (Figure 8).

The last two areas evaluated by the rubric involved simply answering Yes or No to two questions: 1) Did the writer provide a reference list? and 2) Did the writer provide a reference list and use in-text citations? Most students already knew that they had to provide a reference list at the end of their reports. For many of the students, this list included only the reference of the laboratory manual. Few students (from N=3 to N=8) had more than two references listed. The number of students not having a reference list did decrease post-intervention as seen in Table 2. The chi squared test of independence was used to examine the relationship between the intervention and whether a reference list was provided at the end of the report. The relationship between these variables was found to be not significant, X^2 $(2, N = 42) = 1.37$, $p \geq 0.05$. Though not significant, it is encouraging to see a decline in violations. The small size of the sample limits the significance in this area, but there seems to be another factor involved here. Because most students provided a reference list for the pre-intervention report, there was very little opportunity for improvement. The positive message here is that there was an improvement seen, but over 10% of the sample group did not use references. Again, this comes back to the idea that the text book or laboratory manual is not really a source that needs to be cited. Some students believe that unless it comes from a book or a journal, it does not need to be referenced.

Table 2: Pre-and Post-Intervention data for providing a reference list in CHM1210L, spring 2013. **Bold** marks the observed value, ( ) denotes the expected values, and [ ] represents the chi^2 value.

	Pre-Intervention	**Post-Intervention**
Number of Students Providing a Reference List	**33** (35) [.11]	**37** (35) [.11]
Number of Students Not Providing a Reference List	**9** (7) [.57]	**5** (7) [.57]
Total	**42**	**42**

Though students knew to include a reference list at the end of the report, the data tells a different story about in-text citations. Most American students have written at least one research paper in their high school careers, and are familiar with APA and MLA citations. Still, half of the students did not use citations in their journal article-like reports pre-intervention (Table 3). During the training, students were shown how to use the American Chemical Society (ACS) format for citations and were sent a link to an ACS Quick Guide to help them format citations properly. Unfortunately, the chi squared test of independence, which was used to examine the relationship between the intervention and whether in-text citations were included, showed the relationship to not be significant. X^2 (2, N = 42) = 0.77, $p \geq 0.05$. Over 40% of the students still did not use in-text citations, but did include a reference list at the end. Part of this could be due to simple lack of time or effort. WSU is an open enrollment university that has a large percentage of its population composed of commuters. Many students have jobs, either full- or part-time, families, and other responsibilities.

Time becomes an issue for students. It takes time to reword ideas, cite them and provide a reference list. Many students wait until the last minute to prepare laboratory reports, unfamiliar with the amount of time and effort that such journal-article reports require. When it comes down to content or referencing, students choose content hoping the ethical violations will be overlooked. The truth is that the violations are often overlooked. Not one of the laboratory reports, which was evaluated for this study, was flagged by TAs for plagiarism or other ethical violations during the semester. Yet, the investigator found 137 ethical violations centered around plagiarism on the pre-intervention reports and 109 violations on post-intervention reports. Thus, time is not just an issue for students, it is an issue for instructors and teaching assistants, as well. It takes time to find and report ethical violations. Students are counting on that fact. McCabe, Trevino and Butterfield found that students' understanding of plagiarism and other ethical violations increased, when the university's expectations and penalties for violations are presented and enforced, by incorporating honor codes and training for faculty on academic integrity policies.[5] During the Integrity Principles and Ethics in Scientific Publication training, WSU's expectations and the consequences for scientific misconduct were clearly explained to the students. Yet, from the data collected, it appears that students believe that the rules did not apply to them.

Table 3: Pre-and Post-Intervention data for providing in-text citations in CHM1210L, spring 2013. **Bold** marks the observed value, ( ) denotes the expected values and [ ] represents the chi^2 value.

	Pre-Intervention	**Post-Intervention**
Number of Students Providing In-text Citations and a Reference List	**21** (23) [.17]	**25** (23) [.17]
Number of Students Not Providing In-text Citations but Providing a Reference List	**21** (23) [.17]	**17** (19) [.21]
Total	**42**	**42**

In the end, students are worried about their grades in the course. Whether they decide to plagiarize is decided by two things: motivation and morality. Students come to the course with these two factors already in place. Those who are motivated to learn will more often do what is right and follow the rules and guidelines set forth. Those who seek the passing grade or the elusive A, are more likely to compromise standards and use cheating as a way to deal with a challenging situation.[13] That being the case, it is interesting to look at the relationship between the letter grades earned on the pre- and post-intervention reports and the average number of violations reported (Figure 9).

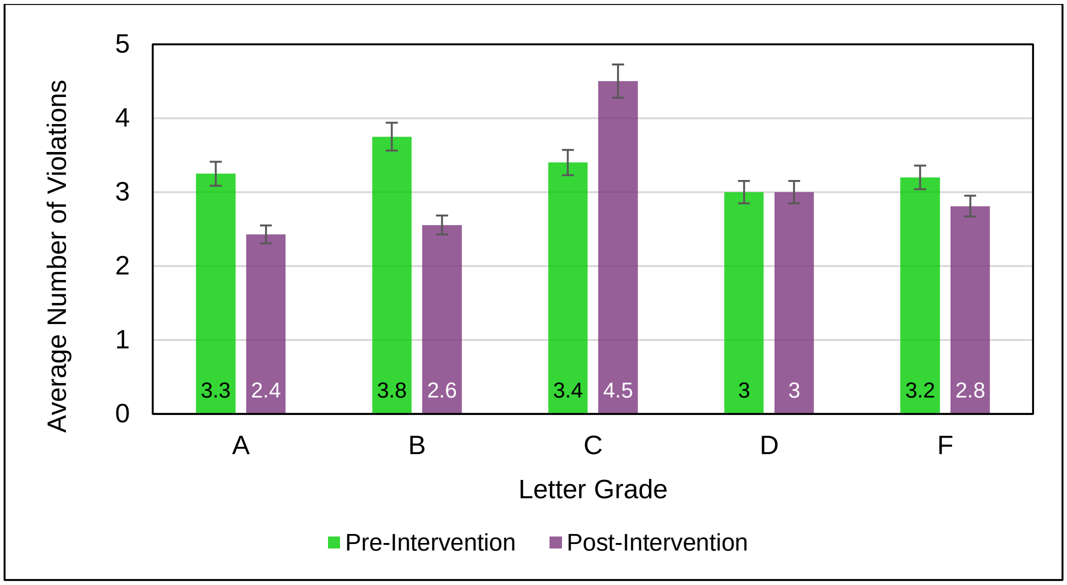

Figure 9: Average number of violations compared to grade earned on laboratory reports pre-and post-intervention in CHM 1210L, spring 2013.

It is promising to see that for the A's, B's and F's there was a decrease in the average number of plagiarism violations post-intervention (Figure 9). Research does support the fact that students that struggle academically are more likely to cheat.[31] This premise appears to be supported by the data collected in this study. Students earning A's and B's had the lowest average number of violations post-intervention (N = 2.4 and N = 2.6). Additionally, students earning F's decreased in the average number of violations. It is important to note here that when evaluating papers which earned F's, some were so incomplete and poorly written that there was no opportunity for plagiarism. The increase in violations found for those reports, which earned C's, is easily explained by the low number of students receiving C's on the reports post-intervention. There were only two students who earned C's and one of the papers had a high number of violations. Again, it is obvious that a larger sample size would give a better picture of a realistic trend.

The final evaluation of data involved looking at the relationship between the number of plagiarism violations, based on the Ethics Rubric, and the gender of the writer (Figure 10). It is evident that females were less likely to plagiarize on the laboratory reports. Both genders exhibited an average decrease in plagiarism violations of 0.5. This data agrees with the considerable evidence presented in literature that suggests that females cheat less than males, but are more willing to admit to cheating.[4,13] Both motivation and morality may come into play here. Female university students have been found to be more intrinsically motivated. They are also thought to have a more highly developed sense of morality.[13] Yet, with the increased number of females enrolled in college, there is convergence of roles among male and female students. Females are feeling the pressure to excel and the culture-conflict theory suggest that if students believe that everyone else in their culture are cheating, they will be more likely to cheat, too.[3]

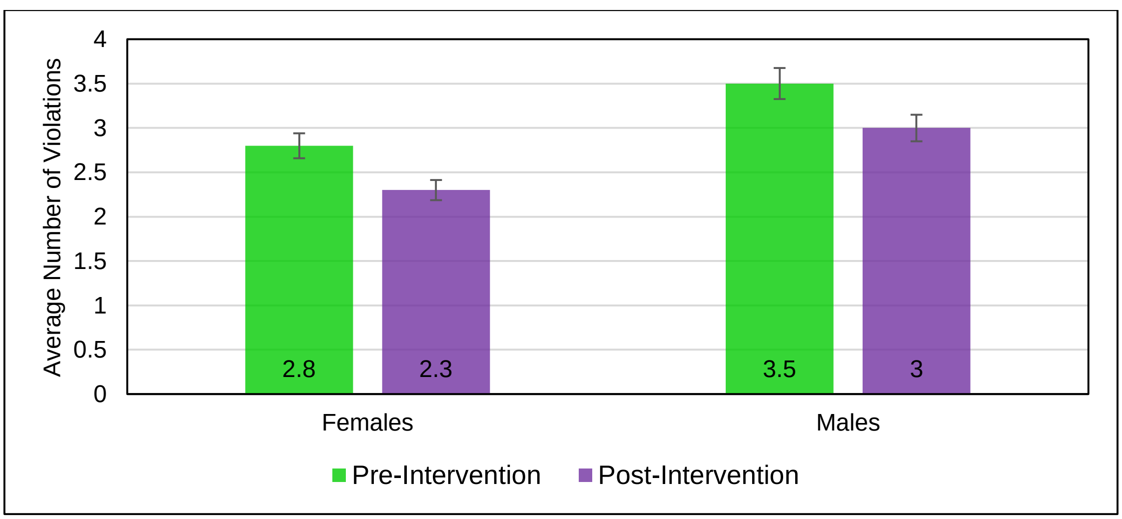

Figure 10: Average number of plagiarism violations based on gender for pre-and post- intervention laboratory reports in CHM 1210L, spring 2013.

Chapter 4: CONCLUSIONS

One of the biggest problems in undergraduate chemistry instruction is that students can complete the course of study and have no knowledge of how to write a journal article or technical report. Scientific integrity is a crucial component any journal article or technical report. Student, instructors and researchers must be informed about what constitutes scientific misconduct. Industry has complained that new chemists have no knowledge of how to write concisely and clearly, while incorporating the aspects of scientific integrity.[32] Thus, there is a growing need for undergraduate training in integrity principles and ethics in scientific writing. In an effort to explore this need, it was hypothesized that providing training in scientific integrity and ethics, while teaching students to write journal article-like laboratory reports, would reduce the number of ethical violations committed in General Chemistry I, one of the general education courses at WSU.

After the pre-and post-tests on Integrity Principles and Ethics in Scientific Publications were compared, it was found that there was a statistically significant increase in scores. This suggests a basic knowledge and understanding of terms and concepts related to scientific integrity. This study also found that the number of ethical violations in the area of plagiarism decreased from pre- to post-intervention, i.e., pre- and post-training in the scientific integrity and ethics. When male and female results were compared, it was found that female writers had, on average, 0.7 fewer ethical violations on both pre-and post-laboratory reports than their male counterparts. . This is not surprising given that prior research suggest that females have a higher ethical standard in academic work compared to their male counterparts.[13]

Prior to the intervention, students made 137 plagiarism violations (defined as either copying from their laboratory partner, failing to reference material that was either directly quoted or paraphrased, not referencing formulas, or failing to include a citation list), while after training 109 violations occurred. Though many of these errors appeared to be unintentional (e.g., not citing a formula used versus copying directly from a Website or purchasing a paper from service), they violate WSU's student conduct code. It is evident that, even after the training session, students still had only a limited understanding of plagiarism. Thus, more training for both students and teaching faculty in this area of academic integrity is needed at the undergraduate level.

Limitations

Because this study involved secondary data, several limitations are present in this study. The project was originally designed as a teaching activity to improve student outcomes, not as a research project. As a result, only the data collected by the faculty member teaching the course and implementing the project, was available to the researcher. Demographic data that may have been helpful in the analysis was not collected for the participants of the study. Only the gender, declared major, and whether the student was a freshman, sophomore, junior or senior, were available to the investigator. In addition, laboratory reports that were evaluated pre-and post-intervention were not paired. This did not allow for any conclusions about individual improvement, trends within a declared major, or comparisons of students from different years of academic study (e.g., freshman vs seniors). Furthermore, this study did not involve a random sample or a control group. This limits the interpretation of the data as it is impossible to determine if the change is related to the training or other factors. That is, the findings of this study could have been influenced by student maturation processes. Students may have been concurrently enrolled in ENG 2100, which discusses the writing process, including how to properly cite sources. Thus, some students could have also had other ethical or integrity violations in the past, which were not known during this study. This could have caused a student to be more cautious and aware of ethical violations and not had any direct link to improvement due to the intervention. Finally, only the two highest and two lowest graded laboratory reports were collected and therefore, evaluated for this study. A full sample of the laboratory report would have provided additional evidence of the student work, and produced a much clearer picture of how often violations were occurring for all students enrolled in the course, both pre-and post-intervention, instead of just the top and bottom two reports from each section.

In addition to the aforementioned limitations, there were methodology shortcomings in this study. First, six different TAs presented the material during the intervention. Though there were attempts made to standardize instruction, a certain degree of variation in the presentation of the material was observed by the course instructor and the researcher. This was attempted to be overcome by training, yet differences in explanations and discussion still occurred. Second, the study took place in the Mid-West U.S. at a regional campus with a particular student profile; as such, readers should exercise caution when generalizing the findings to a different student body population. Finally, it is unknown if the data generalizes to other sciences and engineering. Most of the participants were not chemistry majors. It is unknown what other science laboratory classes students had previously taken, and if the other courses had any type of ethical training.

Future Research

Freshman chemistry is just the start of the future scientist's journey into scientific exploration and writing. Giving students facts in a lecture setting and expecting appropriate application after only one laboratory may not be developmentally achievable. Future research may focus on training students during one laboratory session using a lecture format and then following up with case studies that present ethical dilemmas in science. The cases would present the students with specific real-life problems centered on scientific integrity violations. The discussion of such cases in small groups would stimulate critical thinking and analytical skills. Researchers could use the same methods employed in this study to determine the effectiveness adding case studies to the training.

In addition to extending the training, research may want to explore if there is a link between the number of ethical violations occurring on laboratory reports and 1) overall GPA, 2) declared major, 3) number of attempts at course 4) freshman or upperclassman 5) native or international student, and 6) number of laboratory science classes completed. This would require a collection of demographic data that was not available at the time of the study, but could help target interventions to particular students.

An additional area of investigation would be the retention of knowledge and understanding in terms of scientific writing and ethics. Tracking students from General Chemistry to Organic Chemistry, the typical 2nd year chemistry course, would help determine if the students were still applying knowledge assimilated during General Chemistry I. The study could be expanded to include Physical Chemistry, a senior level course, also. A seminar course for all chemistry majors, in which scientific ethics and professionalism are explored, could be implemented into the major requirements for chemistry, during the second year of the program, to reinforce topics taught during General Chemistry I.

Another area to be explored by further research is to examine faculty attitudes about scientific integrity. All science instructors could be surveyed to determine what is being taught to students. By surveying instructors, gaps in instruction on academic and scientific integrity would become apparent, and new education objectives could be developed to fill in those gaps.

Students with declared science majors could also be surveyed about training received during their educational experience. This research could be expanded to include engineering and medical students, to determine if any generalizations about ethical violations can be made throughout the science disciplines. This is important because scientific research is multidiscipline and develops answers to many of society's problems. As mentioned previously, the relationship between science and the society is based on trust. Society must trust the results that science is reporting are true and accurate. This means that training at the university level must include all future scientists.

Summary

Many undergraduate programs do not address scientific ethics, but count on research settings and peers to teach future chemists the rules. Teaching students how to do scientific literature searches, take notes, paraphrase the text, organize data, and develop a clear understanding of the problem or question being explored, will benefit the college and the scientific community. Providing only one 60 minute training session to students in a General Chemistry I course is just the first step in preparing ethical scientists. Faculty, Departments of Science, and research advisors have a responsibility to do more to teach and model ethical scientific practices. Expanding training on scientific ethics and integrity to upper level courses would provide reinforcement of the rules and guidelines that govern scientific research. If more training is made available, the trust that society has for scientific research will proliferate. Responsible conduct in research and writing is the key to this trust building, and educating students thoroughly at the undergraduate level in these areas is way to build that trust.

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Chapter 9: CURRICULUM VITAE

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Education

Pursuing a Master of Science (M.S.) degree in Chemistry
06/2012-07/2014
Wright State University, Department of Chemistry
Dayton, OH, USA

Master of Education (M. Ed.) in Secondary Science Education
06/1991-05/1996
Miami University, Department of Education
Oxford, OH, USA
Magna Cum Laude

Bachelor of Science (B. S.) in Education (Chemistry Education)
06/1987-12/1990
Wright State University, Department of Education and Human Services
Dayton, OH, USA
Cum Laude

Professional Summary

Highly enthusiastic chemistry instructor with 21 years of teaching experience, specialized in inquiry-based learning and maximizing learning opportunities in diverse classroom settings.

Experience

05/2014-Present
Chemistry Instructor
Cincinnati State Technical and Community College
Cincinnati, OH

Responsibilities and Service

- Teach Introduction to General Chemistry and the corresponding laboratory

01/2014-05/2014
Chemistry Instructor
Clark State Community College
Springfield, OH

Responsibilities and Service

- Teach Introduction to General Chemistry and the corresponding laboratory
- Instruct an on-line laboratory course for Introduction to General Chemistry

08/2012-Present
Graduate Teaching Assistant
Wright State University, Department of Chemistry
Dayton, OH

Responsibilities and Service

- Taught General Chemistry I Recitations (up to 80 students) and Laboratory (24 students)
- Taught Quantitative Analysis Laboratory (15 students)
- Helped develop a new laboratory module (Scientific Integrity Principles and Ethics in Scientific Publications) and assessment tools for General Chemistry I Recitation and Laboratory
- Helped develop evaluation and assessment tools for Experimental Nanomaterials and Nanoscience Laboratory Course
- Helped develop a hands-on laboratory module for 2013 Pre-college Program, Exploring STEMM (Exploring the Nanoworld of Precious Metals)
- Developed and instructed an inquiry-based laboratory module for the green synthesis of noble metal nanoparticles for Experimental Nanomaterials and Nanoscience Class (15 students)

06/2005 to 06/2012
Chemistry Teacher
Yellow Springs High School
Yellow Springs, OH

Responsibilities and Service

- Taught Chemistry for college bound students (up to 40 students each year)
- Developed and taught a general Chemistry course for non-science majors and those not planning on a 4 year college experience
- Taught AP Chemistry and increased AP Chemistry enrollment (from 8 students to at least 15 students each year)
- Created and implemented an inquiry based, hands-on curriculum to promote student interest and receptive learning
- Received high remarks for the creativity of classroom lesson plans and instructional techniques from students, parents and faculty
- Coordinated a new intervention program, Academic Lab, which was created to provided teacher or tutor based intervention during the school day
- Modified the general education curriculum for special-needs students based upon

a variety of instructional techniques and technologies

- Developed interesting lesson plans to meet academic, intellectual and social needs of students, focusing on problems solving and critical thinking through inquiry learning

10/2005 to 10/2011
Workshop Presenter
Ohio Chemistry Technology Council
Columbus, OH

Responsibilities and Service

- Opening Presenter for the annual Teacher, Industry and Environment (TIE) conference for up to 60 teachers (Teaching Chemistry with Toys)

06/1999 to 06/2005
Chemistry and Physics Teacher
Northwester Local Schools
Springfield, OH

Responsibilities and Service

- Instructed Chemistry to college bound 10-12th grade students who were college bound
- Instructed Physics to 11-12th grade students
- Developed and taught a Science II and Science III curriculum to meet the state science requirements for students not planning on attending a 4 year institution

07/1998 to 11/2007
Chemistry Adjunct
Miami University, Center for Chemical Education
Middletown, OH

Responsibilities and Service

- Taught the following courses to elementary through high school teachers (up to 30 students)

    - Health Rich
    - Teaching Chemistry with Toys
    - Teaching Physics with Toys
    - Numeracy through Chemistry
    - Advancing Ohio's Physical Science Proficiency
    - Sporty Science

- Presented hands-on, inquiry based activities to teachers of gifted and talented students for Indiana Public Schools

09/2001 to 12/2003
Science Methods Adjunct
McGregor School Antioch Midwest
Yellow Springs, OH

Responsibilities and Service

- Taught Secondary Science Methods course focusing on inquiry learning and methodology
- Analyzed and critiqued student-developed lesson plans
- Evaluated students on classroom readiness and preparation

06/1998 to 06/1999
Science Teacher
Wilmington City Schools
Wilmington, OH

Responsibilities and Service

- Instructed 10-12th grade students in Chemistry for college bound students
- Taught semester courses in Geology and Astronomy

06/1996 to 06/1998
Science Teacher
Greeneview High School
Jamestown, OH

Responsibilities and Service

- Instructed 9th grade students in Physical Science
- Taught Chemistry to 11th grade, college-bound students
- Taught General Physics to 12th grade, non-science major students

06/1991 to 06/1996
Chemistry Teacher
Vandalia Butler High School
Vandalia, OH

Responsibilities and Service

- Instructed 10-11th grade students in Chemistry for college-bound students
- Instructed 11-12th grade students in AP Chemistry
- Instructed 7th grade students in life science

Publications

Kevin M. Dorney, Joshua D. Baker, Michelle L. Edwards, Sushil Kanel, and Ioana E. P. Sizemore. Tangential Flow Filtration of Colloidal Silver Nanoparticles: A “Green” Nanotechnology Laboratory Experiment. Accepted to *The Journal of Chemical Education*.

Sesha Paluri, Michelle Edwards, Nhi Lam, Elizabeth Williams, Allie Meyerhoefer and Ioana E.P. Sizemore. "Introducing "Green" and "Non-Green" Aspects of Noble Metal Nanoparticle Synthesis: An Inquiry-Based Laboratory Experiment for Chemistry and Engineering Students. Accepted to *The Journal of Chemical Education.*

Research Skills

- Synthesis of colloidal gold and silver nanomaterials
- Physical and chemical characterization of colloidal nanomaterials by Ultraviolet and Visible Absorption Spectroscopy (UV-Vis), Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES), Fluorescence Spectroscopy and Raman Spectroscopy
- Manipulation of colloidal nanomaterials through Tangential Flow Ultrafiltration (TFU)