

WILL THE USE OF CONCEPTUAL LABORATORY REPORTS AND PRE-  
LABORATORY QUIZZES IMPROVE OVERALL STUDENT GRADES?

by

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July 2014

DEDICATION

I dedicate this paper to my incredible family who have shared this ever so long journey with me, for without their love and support I would never have come this far. I am ever so thankful for my amazing husband Rich. If not for his love and faith in me would I have been able to finish what I started so long ago. And special thanks to Pete and all my friends and colleagues, for their advice and never ending encouragement.

Look mom, we finally did it!

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ABSTRACT

The purpose of study was to determine if overall student success increases by adding a pre-laboratory quiz and assigning conceptual laboratory reports in a college freshman level introductory biology laboratory class. Combined lecture /laboratory grades were analyzed between two groups of students. The study was based on the premise that writing promotes learning thereby increasing students overall success in biology. No strong positive objective outcome was observed although writing skills improved.

## INTRODUCTION AND BACKGROUND

### Project Background

#### Teaching and Classroom Environment

In July of 2005, I was hired as the Science Laboratory Coordinator at Great Basin College, Elko, Nevada. In 2007, I started teaching as a laboratory instructor for a freshman-level major's cell and molecular biology laboratory. I generally teach two classes each semester. I admit that the first couple times teaching I was simply getting students through the activities! I collected grades on daily quizzes, had students write one laboratory report, and administered a mid-term as well as a final laboratory practical. A lack of interest in science is a common characteristic among students that are non-science majors taking the course to fulfill a degree requirement. Frequently, I have observed students trying to prepare for a quiz by reviewing the previous week's material just as they are sitting down in class. Secondly, and more importantly, students exhibit writing skills that need improvement. This becomes apparent when writing a laboratory report. It is quite concerning that students are unable to convey the connection between the laboratory and the science content through scientific writing skills. These are challenges that hinder progression of the labs.

#### Focus Questions

Wanting to raise student comprehension and improve writing skills has led to the focus of my research, *Will giving a pre-laboratory quiz along with writing laboratory reports help students overall achievement?* The following sub-questions then followed:

- Will giving a pre-lab quiz covering new lab content material help students be more prepared for class?

- Will writing short reports for completed lab exercises improve writing skills?

### School Demographics

Great Basin College (GBC) is a small community college located in northeastern Nevada. It serves about 3,450 students from an area covering 86,514 square miles that include Nevada's ten, most rural counties. The college offers traditional two-year degrees and several four-year degrees in a variety of disciplines including nursing, secondary education, and social work. GBC also offers certificates of training in many areas including several in mining technologies. Students are quite diverse in that some are recently high school graduates while others are adults returning to school after being out of the education system for many years. The opening of the Bachelors of Science in Nursing (BSN) program in 2005 followed by an AAS in radiology in 2007 was marked by an increase in women enrolling. Their ages range from 18 to 50. More recently, there has been a trend to more traditional students entering college directly out of high school. Our students are from a variety of cultural and ethnic backgrounds including Hispanic, Native American, Asian, as well as Caucasian.

Elko, Nevada, the home of the primary GBC campus, is located along I-80 between Reno and Salt Lake City and is the largest town (pop. 19,000) for over 130 miles in any direction. Elko's economy is based on gold mining, tourism, and ranching. Elko County is one of the top ten counties of livestock producers nationwide, however, it is better known for its mining. It is, in fact, considered the capital of Nevada's "gold belt." Nevada produces more gold, most of which is mined near Elko, than all but three countries: Australia, South Africa, and China. Newmont and Barrick mining companies operate 18 open pit and eight underground mines. They employ approximately 8,000

people with the highest median income of \$68,000 in the state. Over time, an unskilled worker with only a high school diploma can easily earn as much as \$100,000. As we are predominantly a mining town we experience the boom and bust economy consistent with the rise and fall of gold prices. Student enrollment can fluctuate with the boom and bust cycle as well.

### CONCEPTUAL FRAMEWORK

With the scientific and technological advances of the world today it is imperative that students have a fundamental working knowledge of science and that they are able to effectively communicate that information. In other words, they need to be scientifically literate and writing is a key element. Our rural student base in particular needs this as our economy shifts to higher technologies.

The National Science Education Standards (NSES) definition implies that a scientifically literate person can identify scientific issues underlying national and local decisions, and express opinions that are scientifically and technologically informed. A literate person should be able to evaluate the quality of scientific information on the basis of its source and the methods used to generate it. Students need to be able to understand basic scientific facts and their meanings, to identify and understand scientific issues, and be able to evaluate arguments based on evidence so that they may make informed, sound decisions that will have an impact on society as a whole.

One technique used in science classrooms is based on learning by inquiry. This method of teaching encourages students to discover and learn science in a different way. The National Science Teachers Association (NSTA, 2004) defines scientific inquiry as a powerful way of understanding science content. In this model, students learn

how to ask questions and use evidence to answer them. In the process of learning strategies of scientific inquiry, students learn to conduct an investigation and collect evidence from a variety of sources, develop an explanation from the data, and communicate and defend their conclusions (p.1). Students are encouraged to experience science by engaging in the process of doing science. This is in line with the NSES guidelines that emphasize the process of inquiry being one that describes objects and events, asks questions, tests explanations, and communicates ideas. The goal is to help students develop critical thinking skills and logic, consider alternative explanations, and learn to use science knowledge and logic to acquire further knowledge. The importance of inquiry is clear: “students’ understandings and abilities are grounded in the experience of inquiry, and inquiry is the foundation for the development of understandings and abilities of the other content standards” (NRC, 1996).

With the shift from the more traditional style of teaching comes the need for better assessment methods to evaluate student understanding. The usual test over subject matter contains material that is often memorized or demonstrates the student’s ability to define vocabulary. It doesn’t delineate substantial information as to what, if any, of the material students actually understand. Writing then becomes a very effective way to gain insight into how the student thinks and processes information. Simply stated, students have to reflect on the lab experiment before putting that information into a lab report. By its nature, writing forces students to articulate ideas and reasoning which help to develop and revise their thinking about the subject material.

The common thread throughout the literature is writing has a great impact on a students’ potential to learn. The conflict is what form of writing is the most effective.

Gaining in popularity is a more informal writing style such as journals, cartoons, brief summaries or questions as a way for students to make sense of science matters.

Writing across the curriculum advocates all types of writing, but for science they support a more open-ended, or exploratory style. One such strategy of writing-to-learn is known as Science Writing Heuristic (SWH). SWH is a way to bridge previously acquired knowledge with new knowledge. It helps to make sense of information gathered from different sources such as class discussions, experiments, or reading material. In one case study (Keys, 1999) explored the result of using SWH in an eighth grade laboratory class over an eight-week period. Students' interpretation of the nature of science along with report writing skills was investigated. Results showed evidence of metacognitive thinking. They were better able to link test results with observations and make inferences based on their new knowledge. This outcome supports, in part, the goal of the NSES on scientific literacy.

Cronje, Murray, Rohlinger, and Todd (2011) conducted a study to determine what, if any, impact SWH had on an undergraduate's ability to convey scientific knowledge through formal writing assignments. What they discovered through comparisons of grades was the students that used SWH scored higher overall than those that didn't. It was shown that using the SWH approach helped students to express their lab results logically and with evidential support in writing formal research papers. Papers from the SWH group were significantly ( $P=0.02$ ) more likely to receive a higher score than the control group.

Writing should be thought of as a process not a product. When the focus is on writing being a process it becomes an activity for creative understanding. Knoblauch and

Brannon (1983) explain it this way, “Writing enables new knowledge because it involves precisely that active effort to state relationships which is the heart of learning...It involves the sustained effort to select and order ideas as patterns of connection, and thereby to generate creative insights.” In other words, the process of writing is productive, reinforcing content and promoting inquiry. As one writes, one becomes more aware of what one already knows. Thinking through and organizing thoughts leads to connections uncovering new ideas. Writing in science can encourage students to communicate their thinking to others. The student has a ‘minds-on’ experience while writing about the ‘hands-on’ experience enhancing the learning potential of the lab itself. Communication skills are an absolute necessity in the world today. Writing is the foundation on which to build those skills (NRC,1996).

## METHODOLOGY

My action research project was done over a period of 15 weeks. It involved students in a treatment group that completed a weekly pre-lab quiz. The quiz was designed to be available for one week and allowed students two attempts. It covered material of the upcoming laboratory exercise. The treatment group was also tasked the assignment of writing a conceptual lab report for each lab exercise.

### Participants

My research was done with the participation of my Biol 190 lab students. Students are required to take a 1-credit laboratory class with Biol 190 Introduction to Molecular and Cell Biology course. There were a total of 49 students, of which 14 and 18 students attended one of two afternoon labs while the other 17 were enrolled in the

night lab. Forty-four students were female and five were male. Ages ranged from 18 to 32 years with the majority having graduated high school within the past three years.

### Treatment

Before beginning my project, I met with other instructors from the science department to discuss how I wanted to change the grading scheme and how I intended to implement two changes to the lab course. The study was done in the spring semester 2014.

The first change made was to give a pre-lab quiz (Appendix B) each week for 15 weeks. Each quiz was set up using WebCampus, an on-line learning management system. The quiz would cover material from the upcoming laboratory. Students were given two attempts with the better grade being saved. Each quiz had five questions that were selected at random from a question bank. At the end of the week students were able to see the correct answers for all the questions. This was done to allow them to use the quizzes as study material for the practical exam. My goal was to get students to read through the laboratory exercise before coming to class. I hoped it would be a way to focus their thinking on the upcoming experiment; this in itself would make labs go much smoother.

This approach to quizzes was different from what I had done in the past. In previous semesters, students also completed a quiz each week. However, this was a “post-lab” quiz that was assigned after students completed the lab activity. The quiz was given at the beginning of the next lab class time. This post-lab quiz focused on the content and results of the completed lab activity from the previous week. Students were

able to complete the quiz in approximately 25 minutes however, they were only allowed to take it once.

A non-majors biology laboratory manual (Perry, 2012) was the main source of laboratory exercises. Students were not graded on their participation in lab; however, they had to demonstrate some skills as well as be knowledgeable about the material during the practical exams. Their score was then weighted 25% from lab work with 75% from lecture portion of the class for their overall biology course grade. There were 250 possible points. Previously, those points were derived from ten 10-point quizzes, a 50-point lab report and two tests, a mid-term and a final, both accounting for 50 points each. For this purpose, points were earned as ten 5-point pre-lab quizzes and 5-points for 10 conceptual lab reports along with one traditional lab report worth 50 points and two practical exams worth 50 points each.

The second change I made was to implement additional writing in the form of conceptual reports for each lab exercise. Each conceptual report was worth 5 points and would include a pre lab, in lab and post lab section. A rubric was used so students knew what to include in each section (Appendix C). My intention was to help students become better writers. These new changes were introduced to students on the first day of class in their syllabus. This short laboratory report replaced the post-lab quiz that I had given previously.

### Data Collection Methods

I selected a combination of grades, a student survey, and personal journal to assess my research findings. Except for the changes noted above, the grades from spring 2014 were compared to the identical course from fall 2013 for statistical analysis.

I began by keeping a reflective journal of the class to record information such as student performance, comments made, or any observable change with how labs progressed. This journal has been a valuable tool for observations that might have been forgotten if not recorded right away. The scores from the quizzes, lab reports and practical exams accounted for the quantitative data. Finally, I gave a survey (appendix A) to students at the end of the semester to assess whether they felt they spent more time preparing for class than they would have on their own without a pre-lab quiz. Had they felt they improved their writing skills over the course of the semester and did they have a better understanding of material as a result of writing and doing pre-lab quizzes? Table 1 summarizes the data collection methods used to assess the questions of my research.

Table 1  
*Data Sources*

| Research Questions   | Data Source 1      | Data Source 2      | Data Source 3  |
|--|--------------------|--------------------|----------------|
| 1: Will the use of conceptual laboratory reports and pre-laboratory quizzes improve student overall achievement? | Laboratory Reports | Laboratory Quizzes | Anova Analysis |
| 2: Will giving a pre-quiz help students be more prepared for class?  | Observation        | Laboratory Quizzes | Survey         |
| 3: Will writing conceptual reports improve writing skills?   | Observation        | Laboratory Reports | Survey         |

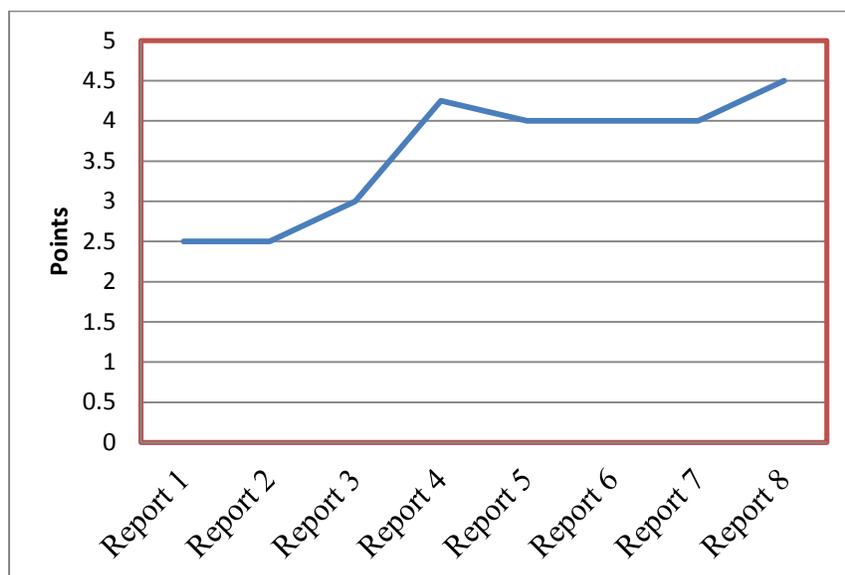
## DATA ANALYSIS

The focus of this study was to determine if students' overall achievement for the Biol 190 course would improve by using pre-laboratory quizzes and the addition of conceptual laboratory reports. To make this determination, I compared student quiz scores, laboratory report scores and final lecture grades for both fall 2013 and spring 2014. Correlation tests between laboratory and lecture components were done using ANOVA to find any statistical significances or trends in the data.

### Impact of conceptual laboratory reports and pre-laboratory quizzes on student overall achievement.

My claim is that the impact of using conceptual laboratory reports and a weekly pre-quiz on students' overall achievement for the Biol 190 course was inconclusive. Support for this claim came from an examination of conceptual lab report scores, exam comparisons, an ANOVA Analysis of collected data, and my student survey.

Support of improved student achievement was found by looking at lab report scores for spring 2014 as shown in Figure 1. The average score was 2.5 on the first and second reports. There was a gradual increase in the report average as the semester continued, ending at 4.5. The line graph in Figure 1 shows the increasing report scores on average over the course of the semester.



*Figure 1. Average Report Scores Spring 2014.*

In order to determine whether the treatments had any impact on student comprehension of scientific principles and therefore overall achievement, I first compared mid-term and final exams of students for each semester. The results are somewhat inconclusive. The fall 2013 mid-term exam mean score was 40 with a coefficient of variance of 15.5%. The mean score dropped to 36 with a coefficient of variance of 17% for the fall mid-term exam. The difference between the two semesters was significant,  $t(59) = 2.5398$ ,  $p = .0137$ . Again the mean score for fall 2013 final exams was higher at 39.5 with a coefficient of variance of 21.5% while the spring 2014 final exam mean was 33 with a coefficient of variance of 20%. The difference for final exams was very significant,  $t(59) = 3.3229$ ,  $p = .0015$ . Both results were statistically significant and unexpected as the average for the final exam had fallen by 5.5 points. However, this decrease in the average did not indicate any impact on students' performance as there was no substantial change in the overall final laboratory or lecture grades. The resulting t-tests were not of statistical importance with differences of fall 2013 and spring 2014

laboratory grades being,  $t(59) = 0.2825$ ,  $p = .7785$  and differences for lecture grades,  $t(59) = 0.801$ ,  $p = .9364$ . Table 2 displays comparisons of test averages of final grades before and after treatments.

Table 2  
*Grade Averages Before and After Treatment*

|                        | Mean 2013 | Mean 2014 | t(df)       | p-value |
|------------------------|-----------|-----------|-------------|---------|
| Mid-term exam          | 40        | 36        | (59)=2.5398 | .0137   |
| Final exam             | 39.5      | 33        | (59)=3.3229 | .0015   |
| Final Laboratory grade | 204.3     | 202.75    | (59)=0.2825 | .7785   |
| Final Lecture grade    | 665.1     | 667.48    | (59)=0.801  | .9364   |

I also completed an ANOVA analysis of the data I collected. Comparisons between the fall and spring semesters, which represent no pre-quiz and pre-quiz treatments respectively, were made on the following variables: overall laboratory score (Laboratory %); overall lecture score (Lecture %); online homework (Home Work); and the four lecture exams that build the Lecture % (Exam 1, 2, 3, and 4). These variables from the two semesters were subjected to ANOVA (Table 3) to see if there were significant differences between the two treatments, and within semester correlation coefficient analysis (Tables 4 and 5) to see if specific components related to overall performance varied between the two semesters.

The ANOVA analysis was somewhat inconclusive in that it did not lend support to the hypothesis that the pre-quiz did improve lecture scores. However, there were interesting hints that student comprehension had increased with the addition of the pre-quiz. This is indicated by the correlation coefficient between Home Work and Laboratory percent becoming highly significant with the pre-quiz (Table 5). This indicates that perhaps the pre-quiz was acting as a unifying or reinforcing factor for student understanding. In other words, the addition of the pre-quiz gave mixed results in that there was no dramatic change in student outcomes as measured by analysis. None the less, addition of the pre-quiz gave many subjective improvements, and real improvement in writing skills.

Table 3  
*Means of Key Score Elements*

|                      | Exam 1 | Exam 2 | Exam 3 | Exam 4 | Home Work | Laboratory % | Lecture % |
|----------------------|--------|--------|--------|--------|-----------|--------------|-----------|
| No Pre-Quiz:         | 84     | 79     | 78     | 82     | 76        | 82           | 80        |
| Pre- Quiz:           | 74     | 74     | 75     | 75     | 79        | 80           | 77        |
| ANOVA p:             | 0.05   | 0.09   | NS     | 0.05   | NS        | NS           | NS        |
| Direction of change: | ↓      | ↓      |        | ↓      |           |              |           |

Table 4  
*Significant Correlation Coefficients Between Key Score Elements for Semester Without Pre-quiz*

|              | Lecture % | Laboratory % | Home Work | Exam 4 | Exam 3 | Exam 2 |
|--------------|-----------|--------------|-----------|--------|--------|--------|
| Exam 1       | 0.73**    | 0.45**       | NS        | 0.65** | 0.53** | 0.48*  |
| Exam 2       | 0.61**    | 0.66**       | NS        | NS     | 0.73** |        |
| Exam 3       | 0.79**    | 0.76**       | NS        | 0.53** |        |        |
| Exam 4       | 0.70**    | 0.61**       | NS        |        |        |        |
| Home Work    | 0.74**    | NS           |           |        |        |        |
| Laboratory % | 0.75**    |              |           |        |        |        |

\* = p of 0.05; \*\* = p of 0.01

Table 5  
*Significant Correlation Coefficients Between Key Score Elements for Semester With Pre-quiz*

|              | Lecture % | Laboratory % | Home Work | Exam 4 | Exam 3 | Exam 2 |
|--------------|-----------|--------------|-----------|--------|--------|--------|
| Exam 1       | 0.66**    | 0.42*        | NS        | NS     | NS     | 0.40*  |
| Exam 2       | 0.59**    | NS           | NS        | NS     | 0.45*  |        |
| Exam 3       | 0.68**    | 0.48*        | NS        | 0.40*  |        |        |
| Exam 4       | 0.63**    | 0.64**       | NS        |        |        |        |
| Home Work    | 0.65**    | 0.58**       |           |        |        |        |
| Laboratory % | 0.79**    |              |           |        |        |        |

\* = p of 0.05; \*\* = p of 0.01

Finally, the last question on my student survey asked how well they thought they would have done without doing the pre-laboratory quizzes and conceptual reports. Seventy-two percent of students thought they would have done worse. Twenty-six percent of students thought they would have done just as well with or without the treatments. One student's opinion was that it took away from his ability to focus on the laboratory exercise itself. Two percent of students said they would have done better if they hadn't have had to do the quizzes. The reason behind this was it made the content more confusing to understand.

Pre-lab quizzes will help students be more prepared for class.

ANOVA analysis gave modest support for the claim that the pre-quiz did help students to be more prepared for class. Referring back to Table 4 and 5, the correlation coefficient between laboratory % and lecture % did slightly increase from 0.76 to 0.79 with the addition of the pre-quiz. It is interesting that in both treatments, the laboratory score is a better predictor of lecture the lecture score than individual lecture exam scores. Laboratory clearly is helping with lecture performance. However the ANOVA analysis

presented in Table 3 demonstrates that there was no significant change in either laboratory score or lecture score between the two groups.

The strongest evidence of students being more prepared for class came from students directly. I had them participate in taking a survey at end of study. I wanted feedback from the students as to whether they thought there was a benefit in taking a pre-lab quiz. Were the quizzes helpful in preparing them for class? Students responded with 80% saying yes, the quiz was helpful. The remaining 20% either had no opinion or simply said no. Students also confirmed my uncertainties as to whether they would read through laboratory activities prior to coming to class if a pre-lab quiz had not been required. These results are shown in Table 5.

Table 6  
*Student Response to Questions, (N=39)*

| Question   | Yes | No  |
|--|-----|-----|
| Did pre-lab quizzes help prepare you for class?                                    | 80% | 20% |
| Would you have read Laboratory exercise before class if pre-lab quiz not required? | 13% | 87% |

Entries in my personal journal reflect my observations that students did seem more prepared for class than in previous semesters. I had not witnessed any student trying to read through the day's material just as they were sitting down for class. It seemed most of them were aware of what the lab subject would be for that class period. I sometimes would hear comments from students hoping that the lab would help clarify or

link subject matter covered in lecture. I took this to be a sign that some were already trying to make connections and thinking of questions they were hoping to answer.

I noted that in my journal, I had made many comments about how smoothly labs went this semester. I have to attribute this change to students having read the material before class. There was a lack of confusion that had been present in previous semesters. The 2014 students seemed to have a much better idea of what the lab exercise was about and how they were going to carry out the experiments. I spent much less time explaining techniques allowing for more time to relate material between lab and lecture.

Writing conceptual reports will improve writing skills.

The final claim, students writing skills did improve by writing conceptual reports was found to be supported by participants answers to survey questions and increasing report grades throughout the study period. I asked questions inquiring about previous experience writing reports to get a better picture of what experience these students had to work with. How much time were they spending on writing assignments? Did the students have a sense of improved writing skills as a result of completing a conceptual report for each lab? Did they have better comprehension of material through their writing? Figure 2 is compilation of questions about lab reports taken from the student survey (Appendix A).

- Before this class, have you written Laboratory reports before? Yes 19 No 20
- If so, how many? Less than five 11 More than five 8
- On average, how long did it take you to write the conceptual report?
- More than 2 hours 1 2 hours 6 1 – 2 hours 16 1hr – 30 min. 7 less than 30 min. 10
- Did writing short reports help prepare you for writing the long report on photosynthesis? Yes 34 No 4 Undecided 1
- Eventually did you find yourself focusing more on the Laboratory exercises with writing the report in mind? Yes 34 No 4 Undecided 1
- Do you feel that your writing skills have improved? Yes 30 No 6 Undecided 3
- Did writing the report help you understand the material? Yes 36 No 3

*Figure 2.* Student Survey Responses, (N=39).

The results show that nearly half the class had little to no experience writing laboratory reports from any previous class including high school. This correlates with the lack in quality of reports being turned in at beginning of study.

Question 2 asks about the amount of time spent writing reports. For 41% of these students, 1 to 2 hours spent on writing reports was about average. 17% spent 30 minutes to an hour. Seven of the 39 students required more than 2 hours to complete an assignment. One of the seven students that needed more time commented that he didn't need as much time to do the report towards the end. It was also stated by another student, "They got easier to write after a few of them."

The majority of the students agreed that doing the short conceptual reports aided in their ability to write a good quality "long" report. The long report was to be more of a

standard science lab report. It was different from the conceptual reports in that it would include an introduction, materials/procedures, data, results, and conclusion sections. Scores for this one report itself were better in comparison to scores for the same type of report in the fall 2013 semester. The mean score in the fall semester was 47.5 of 50 total. There was an increase of the mean for the spring 2014 semester to 49.5 of 50 total. I believe this is a direct correlation that more writing increases the quality of their work while helping to solidify concepts even though statistically it was not a significant change.

When asked if they started doing the lab exercises with writing the reports in mind 87% admitted that they did. They felt they were better able to focus on the outcome of what they were doing as opposed to trying to interpret directions and answer fill in the blank kinds of questions in their laboratory manuals. Four students did not agree and one was undecided. But I still took their comments as a positive sign that they were already beginning their thinking process and how to communicate their ideas to others. This also is a positive step towards improving writing skills and promotes learning.

#### INTERPRETATION AND CONCLUSION

This action research project was intended to demonstrate that implementing a pre-lab quiz and writing conceptual reports would have a positive impact on a student's overall achievement for the Biol 190 course at Great Basin College.

Some very interesting and unexpected observations came from analyzing the data. For instance in spite of large changes made in lab course structure, there was little effect on the outcome of grades. I had expected at least a small significant improvement in the overall grades but that was not the case. Some interesting correlations were also noted.

Although the ANOVA analysis does not lend support to the hypothesis that the pre-quiz will improve lecture scores it does seem to have an effect on the level of student comprehension with the addition of the pre-quiz. The correlation coefficient between Home Work and Laboratory % became highly significant with the pre-quiz (Table 4). This result indicates that perhaps the pre-quiz was acting as a unifying or reinforcing factor for student understanding.

Statistically speaking there was no significant overall change or improvement of grades with the pre-quiz. It did not appear to have any effect on laboratory or lecture grades as a whole. However pre-quizzes were of great value in helping to prepare a student to participate in daily activities. This one aspect alone made much difference in how the labs proceeded. There was much less confusion about what was supposed to be occurring which allowed for questions about science content to emerge instead of questions clarifying the actual procedural steps. For the most part the 2014 students were very supportive of using the pre-quiz. By their own admission it helped them to be prepared for class. Several commented that if it had not been for the pre-quiz, they would not have read the material before coming to class.

Likewise the data really does not support one way or another that writing the conceptual reports had any impact on their overall grade. There is considerable evidence for writing to learn in the literature, but I cannot make the claim that my students learned more about science due to their writing in this study, based on the outcome of their overall grades. The impact was seen in the quality of lab reports being submitted over the course of the semester. To my surprise there was not a lot of complaining about all

the writing assignments. It has been my experience in the past that most students hate writing laboratory reports. Students of the test group wrote a conceptual report for every exercise along with one traditional report. Again, many of the students felt that doing the shorter reports helped to prepare them for writing the traditional report. Within the test group, most students writing skills were much improved. Overall the students were very positive about the changes made in the laboratory.

The positive outcomes of my study were more strongly supported by qualitative evidence than by objective data analysis. The act of writing in itself increases the potential for a student to learn. This is evident with the results of the Keys study (1999) involving eighth grade students that showed improvement in metacognitive skills through writing. Undergraduate students were better able to build on scientific knowledge and communicate results in a logical manner through their writing using SWH techniques in a study conducted by Cronje (2011). The obvious message is that writing is key in increasing the chance of student achievement.

#### VALUE

This project has been such a powerful learning experience for me. I gained instrumental knowledge that I will continue to grow from as an instructor. As I have only been teaching for a relatively short time, I am still developing a teaching philosophy. This project has done more to influence the direction I want to proceed in, than anything else.

I am just beginning to understand the implications of writing-to-learn. The fact that my data showed mixed results does not mean that there is no benefit in making the changes I made to the laboratory curriculum. It has not escaped my attention that there

were some problems in my study. For example, the study would be better if more time had been available to collect data thereby producing more substantial results. Testing over several semesters would have made it possible to have provided a better representation of the student sample. Adding to this was my lack of experience with WebCampus. Up to this point it had only been as a student.

The positive comments and actions of my students are proof enough that there is more that can be done to increase student success. This project has inspired me to do more to help our students become scientifically literate through more ways than just doing laboratory experiments. I want to explore more inquiry style lab exercises combining those skills with writing skills. I truly believe that the traditional style laboratory class needs to change to more inquiry. That, combined with writing assignments, can only enhance the quality of science education our students will receive.

I will share with my colleagues what I have discovered while doing this action research project. I know that I will be a better instructor because of what I've experienced and learned during this study.

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APPENDICES

APPENDIX A  
STUDENT SURVEY

## Student Survey

- Before this class have you written Laboratory reports before? Yes \_\_\_\_\_  
No \_\_\_\_\_  
If so, how many? Less than five \_\_\_\_\_ More than five \_\_\_\_\_
- Did writing short reports help prepare you for writing the long report on photosynthesis?  
Yes \_\_\_\_\_ No \_\_\_\_\_
- On average, how long did it take you to write the short report? \_\_\_\_\_
- Do you feel that your writing skills have improved? \_\_\_\_\_
- Rank the reports in order of most difficult to least difficult.  
Macromolecules \_\_\_\_\_ Enzymes \_\_\_\_\_ DNA \_\_\_\_\_ Microscopes and cells \_\_\_\_\_  
Respiration \_\_\_\_\_ Mitosis and meiosis \_\_\_\_\_ Heredity \_\_\_\_\_ Evolution video \_\_\_\_\_  
Evolutionary agents \_\_\_\_\_
- Eventually did you find yourself focusing more on the Laboratory exercises with writing the report in mind? Yes \_\_\_\_\_ No \_\_\_\_\_
- Did writing the report help you understand the material? Yes \_\_\_\_\_ No \_\_\_\_\_
- Were the pre-quizzes helpful in preparing you for class? Yes \_\_\_\_\_ No \_\_\_\_\_
- In your honest opinion would you have read through Laboratory exercises before class if you had not had to take pre-quiz? Yes \_\_\_\_\_ No \_\_\_\_\_
- Do you think you would have done just as well, better or worse in class without the pre-quiz and reports? Why?

APPENDIX B  
PRE-LAB QUIZ QUESTION BANK  
EXAMPLE

This is an example of a pre-lab question bank. Five questions were randomly selected from the bank for each pre-lab quiz taken. Students had the opportunity to take the quiz twice. Randomly selected questions allowed for a different quiz for each attempt.

**Question Group** 5 questions, 1 pts per question

**Question: If one were to identify the most important compound for sustenance of life, it would probably be**



salt.



sugar.



water.



I<sub>2</sub>KI

**Question: A solvent is**



the substance in which solutes are dissolved.



a salt or sugar.



one component of a biological membrane.



selectively permeable.

**Question: Dialysis membrane**

is selectively permeable.



is used in these experiments to simulate cellular membranes.



has pores that allow passage to specific-sized molecules.



all of these.

**Question: cellular membranes**

consist of a phospholipid bilayer containing embedded proteins.



control the movement of substances into and out of cells.



are selectively permeable.



all of these.

**Question: Specifically, osmosis**

requires the expenditure of cellular energy.



is diffusion of water from lower to higher concentration.



is diffusion of water across a selectively permeable membrane.



none of these.

**Question: Osmosis is a special kind of diffusion.**



True



False

**Question: Diffusion**



is a process requiring cellular energy.



is the movement of molecules from a region of higher concentration to one of lower concentration.



occurs only across selectively permeable membranes.



none of these.

**Question: When the cytoplasm of a plant cell is pressed against the cell wall, the cell is said to be**



turgid.



plasmolyzed.

●  
hemolyzed.

●  
crenate.

**Question: When the cytoplasm of a red blood cell has lost water to its surroundings, the cell is said to be**

●  
isotonic.

●  
burst.

●  
hemolyzed.

●  
crenate.

**Question: A solution having a lower concentration of solute than a cell placed in it is**

●  
isotonic.

●  
hypotonic.

●  
turgid.

●  
hypertonic.

**Question: Cells placed in a \_\_\_\_\_ solution will lose water.**

●  
isotonic

●  
hypotonic

●  
turgid

●  
hypertonic

**Question: At equilibrium.....**

●  
molecules continue to move across a semi-permeable membrane.

●  
the concentration of the diffusing substance in the two compartments is equal.

●  
There is no net change in the concentration of molecules across a semi-permeable membrane.

●  
all of these.

**Question: Into what type of solution would you place red blood cells to see them swell?**

●  
isotonic

●  
blood

- hypertonic

- hypotonic

**Question: \_\_\_\_\_ must be present for either diffusion or osmosis to occur.**

- Tonicity

- Equilibrium

- Concentration gradient

- semi-permeable membrane

APPENDIX C  
CONCEPTUAL LAB REPORT CRITERIA

## Conceptual lab report criteria

| Criteria  | Ratings                |                      | Pts   |
|---|------------------------|----------------------|-------|
| Pre-lab: introduces and explains concept of lab. Provide brief overview of procedure without describing each step.                | Full<br>Marks<br>1 pts | No<br>Marks<br>0 pts | 1 pts |
| In-lab: present and explain results   | Full<br>Marks<br>1 pts | No<br>Marks<br>0 pts | 1 pts |
| Post-lab: conclusion including discussion and evaluation of the whole lab exercise. Demonstrates a clear understanding of the lab | Full<br>Marks<br>1 pts | No<br>Marks<br>0 pts | 1 pts |
| Few to no grammatical errors, uses complete sentences. And is concise.  | Full<br>Marks<br>1 pts | No<br>Marks<br>0 pts | 1 pts |
| Has the student successfully learned what the lab was designed to teach?  | Full<br>Marks<br>1 pts | No<br>Marks<br>0 pts | 1 pts |