THE IMPACT OF RUBRIC USE AND LAB REPORT PERFORMANCE IN BIOLOGY STUDENTS

by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION AND BACKGROUND

Project Background

The research topic chosen is related to the use of rubrics and how using a rubric for scoring lab reports might impact student performance on lab reports. I also wanted to see if rubric use could improve their knowledge of science content as well. I chose this as my topic because for the past 12 years as a science teacher, I have noticed inadequacies in student performance on lab reports. The students seem to enjoy the lab experiments, but when it comes to the lab report there are some obvious deficiencies in lab report writing skills. I have also noticed that students do not seem to make connections between the labs and the science content. For these reasons, I have chosen to research how the use of a lab report scoring rubric might impact student performance.

This topic is significant to me for several reasons. As a teacher, I feel obligated to prepare my students to communicate to others through their writing. Lab reports provide a great opportunity for students to use their writing skills to share what occurred during a lab experiment. Lab reports teach students to use the scientific method in a written manner expressing their findings to others. Lab reports also require students to ask questions, hypothesize, analyze what they learned by interpreting tables and graphs, and form a conclusion that is supported by the data collected. All of these are essential skills in any workplace, and ones that should be stressed in the science classroom. Another reason this topic is important relates to the low scores I have continually seen on lab reports. The students seem to put little effort into the lab report and as a result receive low scores. This is something I would like to see change, and hope that by using a rubric, students will

perform better when writing a lab report. Lastly, I feel that other science teachers could benefit from the results of this research. If rubrics do show a positive influence on student performance and comprehension of science concepts then they should be implemented in all science classrooms. By finding the best method for implementation of a lab report scoring rubric, other teachers may be more likely to use the rubric in their classrooms. In this way many students could benefit and hopefully acquire skills that will carry over into other classes and the real world. For these reasons, I feel that my topic has significance to not only myself, but to my students and my fellow science teachers. So using rubrics and implementing them correctly could be a win-win for all.

Research Questions

The main question I plan to investigate is:

How will using rubrics impact or improve student performance on lab reports and increase understanding of biological concepts at the high school level?

Five sub-questions related to the main research question I plan to investigate:

1. **When is the rubric most beneficial to students, before or after the lab experience and how does this impact their performance on the lab report?**
2. **How will peer evaluations using the rubric impact performance on the lab report?**
3. **How does the use of rubrics affect student attitudes about science experiments and lab reports?**
4. **How will student's knowledge of science content be influenced when lab report rubrics have been used?**

5. **How does the use of rubrics for scoring student lab reports impact my teaching?**

I plan to investigate these questions throughout a semester-long biology class, one a honors biology class and the other a general required biology class. The primary focus of the research questions is to investigate the effect of student exposure to a lab report scoring rubric and how this will impact the students' performances on lab reports. By using the rubrics will the students' attitudes be affected, and if so how? And lastly how will using the rubric to score student lab reports affect my overall teaching?

Support Team

For the past five years, I have taught biology and honors biology at Palisade High School. These are primarily sophomore level classes. To assist me in this process, I have chosen several competent individuals with varying backgrounds. Matt Diers, Palisade High School (PHS) principal, is a valuable asset not only because of his experience as a principal for the past 10 years at PHS, but because he was a high school science teacher prior to being an administrator. He understands the content and the purpose of a lab report, so his insights and advice are invaluable throughout this process. A colleague of mine, Alanna Piccollo is also a critical friend whose insights and advice have been tremendously helpful. Alanna completed the MSSE program this past June and offers advice on everything from how to format a paper to what would be the best tables to use. The last two members of my support team are my daughters. Kaela Hellmann, a graduate of Saint Mary's College in South Bend, IN with a BA in Mathematics. I chose Kaela because of her strengths in math and statistics. She has been able to give me information in how to best display my data and how to show my results statistically. She also was

valuable in helping to design some of my survey questions, developing insightful questions to glean important information from my students. Jessica Hellmann will be my editor and sounding board for ideas. Jessica received a BS in English from the United States Air Force Academy and will earn a master's degree in American Literature from Colorado State University in August. She has been essential as a proofreader of my drafts and helping me with citations. All four of these individuals bring different types of support to my capstone, and have been invaluable in terms of constructive criticisms that have helped make my project a success.

CONCEPTUAL FRAMEWORK

As we are all aware, our nation has been falling behind in many areas of education, science being one of them. Are some of these deficiencies related to how science is taught in the average science classroom? As I reviewed literature in relation to my AR topic of using rubrics to impact student performance on lab reports, I came across two pieces of literature in particular that tackle the issue of science education. Specifically, *America's Lab Report: Investigation in High School Science* (Singer, Hilton, & Schweingruber, 2005) explores the importance of labs in the science classroom. The other article, "Beyond Grading" (Siegel, Halverson, Freyermuth, & Clark, 2011) discusses how the use of specific rubrics can impact student performance with respect to science assignments.

The National Science Foundation to the National Research Council (2005) has conducted a study that analyzed the role of science labs and included a vision of the future role of science laboratories in high school science education. The reason this

publication grabbed my attention was because it investigated the role of the lab experience in a high school classroom. Since I researched the effectiveness of rubrics in relation to student performance on lab reports, I felt this study provided valuable information about the importance of lab experiences and their role in a high school student's science education. The study's focus was on the goals of labs in the high school science classroom. The committee found that researchers and educators disagree on how to define high school labs, and that participating in lab experiences has the "potential to enhance students understanding of the dynamic relationship between empirical research and the scientific theories and concepts that both result from research and lead to further research questions" (Singer, Hilton, & Schweingruber, 2005, pp. 2-3). It is important as a science educator to know what the purpose of lab experiences are or should be. Taking the committee's findings into consideration it was apparent there needs to be a better understanding of lab experience significance in the high school classroom, which I have explored through my research. The committee formulated a definition related to labs stating that, "labs give students opportunities to directly interact with the material world, using the tools, data collection techniques, models and theories of science" (Singer, Hilton, & Schweingruber, 2005, p. 3). This was important to remember in the high school setting and something that should be emphasized and fit well into my research topic. The committee's views were that science education should include learning about the methods and processes of science. It should also address the knowledge gained through the process. Chances to learn about processes and science content should also be a part of science education and lab experiences can provide this (Singer, Hilton, & Schweingruber, 2005). Once again, it is evident from this particular research that lab experiences are

important to high school science and definitely have a place in the teaching of science at this level. One of my goals was to communicate to students through the use of rubrics, the importance of a lab and its ability to enhance their learning experience in the science classroom.

Rubrics are used in classrooms all the time and there are many various types to be used depending on what is being assessed. A series of rubrics were developed for use in general and AP Biology classes to assess performance on specific assignments. Three main ideas were addressed: foster learning through the use of rubrics, clarify learning goals by using rubrics, and build complex understandings and encourage intellectual risk-taking through the use of rubrics. The purpose was to look at the use of specific rubrics on a written assignment related to an investigation on stem cells. The rubric used was developed over time and was specific to the research paper assignment (Siegel, Halverson, Freyermuth, & Clark, 2011). Since I used one type of rubric to assess lab reports; this information supported my plan and provided insights into what rubric types were the best for different reasons. The students in the study were assessed using several types of rubrics including a check-list rubric, task-specific rubric and a generic rubric. It was found that the task-specific rubric was the most beneficial for this particular assignment. This rubric was also used on an evolution assignment when students had to provide an argument for evidence of evolution (Siegel, Halverson, Freyermuth, & Clark, 2011). As I looked over the three types of rubrics presented in this article, I chose a task-specific rubric because it was best suited to my research. A task-specific rubric can be designed to assess lab reports focusing on individual aspects of the lab. The authors of this article specifically used the series of rubrics mentioned above for assessing two

specific written assignments in the science classroom. After applying the rubrics to a report on stem cells and one on evolution the authors found that "clarifying learning goals, builds complex understanding and encourages intellectual risk-taking" (Siegel, Halverson, Freyermuth, & Clark, 2011, p. 30). These were exactly the types of results I hoped to achieve by using rubrics for assessing my biology students during my research. This article solidified my dedication to my AR knowing that others have used rubrics for various science activities to improve student performance and comprehension. Siegel stated, "Rubrics must be a part of the fabric of the class, in such a way that the philosophy of enhanced learning is brought to life" (Siegel, Halverson, Freyermuth, & Clark, 2011, p. 33). This quote sums up the focus of the article and the focus of what I hoped to accomplish through my AR.

Theoretical Framework

When developing a theoretical framework for my AR, I reviewed two pieces of literature which provided different ideas related to the scientific method and rubric use for grading. In a Readers' Forum titled, "The Scientific Method: Critical yet Misunderstood" the presentation of the scientific method is addressed and the fact that there is a lack of knowledge in relation to the scientific method and an understanding of the scientific method among science educators (Eastwell, 2010). This is pertinent to my AR because I researched how lab reports can impact student performance. Lab reports follow a lab experiment where the scientific method has been followed. The premise of the article was if a more explicit use of the scientific method were used would it improve scientific education research and learning in the classroom (Eastwell, 2010)? The focus of this idea was to look at the scientific method as it is used by research scientists.

Through observing how these scientists do their work, a better understanding of the scientific method can be gained. It was found that “scientists use a variety of methods and approaches when conducting research” (Eastwell, 2010, p. 8) and that most follow a general plan, even if they don’t do it intentionally. It appears that there is a scientific method called hypothetico-deductive (HD) approach (Eastwell, 2010).

The HD approach is composed of five basic steps that appear to be similar to those of the scientific method that most of us teach in our science classrooms. HD Steps: puzzling observation, casual question, hypothesis, prediction and conclusion. The HD approach emphasizes the forming of and testing of a hypothesis. It is more of a cyclic process that is “quite intuitive and common sense” (Eastwell, 2010, p. 9), and still revolves around the idea of an if-then statement with a therefore type of reasoning. It is important to note the similarities of the scientific method proposed by the HD approach versus the scientific method we are more familiar with and teach in the classroom. The basic premise is that students understand that the scientific method in the researcher’s world of science does not follow such a clear-cut pathway. This is important to consider with my AR, and I attempted to make my students aware of the HD approach to the scientific method. According to the article, science instruction could be improved by implementing the HD approach in the science classroom. It also looked at how most student investigations in the school setting are basically “cookbook recipes” (Eastwell, 2010, p. 11) which students follow without making any real connections to the true science investigation or research. If educators were to provide students with more of a sense of purpose for the investigations done in the classroom, and a more authentic lab experience, then better connections would be made and students would benefit. The basic

idea is to use casual and non-casual questions when introducing material or an activity. By doing this, you use questions that lend themselves to scientific investigation and the use of the HD method (Eastwell, 2010).

The idea of using casual and non-casual questions gave me new ideas about how to design or introduce material for a lab experience. It was suggested that these types of questions can be teacher-generated, making sure to lead students to a true investigation which could employ the HD method (Eastwell, 2010). This approach has been worthy of consideration as I designed a rubric to use with respect to specific lab investigations and reports. So in general, this particular article opened my eyes to using a different approach to the scientific method which has had an impact on my AR. More research needs to follow in reference to the HD method and the validity of using this approach when teaching the scientific method in the high school classroom.

In 2002 Elaine Cooney presented a report titled, “Laboratory Report Grading Rubrics: What High School Teachers are Doing” at a conference and exposition for the American Society for Engineering Education. The purpose of the report was to look at the advantages of using rubrics for grading student work. Rubrics are usually used by teachers as a means to grade student work, and allow for less time to be spent on grading. In a rubric each element to be graded is already determined and point values are assigned on what is being evaluated. There is also more consistency in grading when the rubric is applied to all student work being assessed (Cooney, 2002). By using rubrics, it is easier for a teacher to grade the assignment based on the criteria set forth in the rubric.

There are advantages for students when rubrics are used for grading assignments. Students receive better grades when they receive a copy of the rubric before the

assignment begins. The students know what is expected by the teacher and what is important within the parts of the assignment. If rubrics are developed early on in the assignment they can go hand in hand with the objectives for the assignment (Cooney, 2002). This information affirmed my AR topic and provided encouragement for the possibility of positive results from using rubrics on lab reports.

Another area of focus from Cooney's report was how college instructors are impacted by students who enter their classes from various science backgrounds. Most high school students have been exposed to different types of grading on lab reports. What was an A at one school might have earned a C at another. College instructors need to be cognizant of this and need to develop lab report rubrics that ensure student success at the college level (Cooney, 2002). It was stated by Cooney that Carl Wenning of Illinois State University suggested using scoring guides containing elements that assess observable behavior (Cooney, 2002). I found the continuation of the rubric discussion to the college level interesting and something that high school teachers should be aware of as well. We are preparing our students for the next level of education, and if as science teachers we can familiarize our students with rubrics and lab reports this could increase their success at the next level.

In the report, suggestions were given which describe rubric types and use tools like Rubistar, as a rubric "wizard" to create rubrics specific to lab reports. When developing rubrics it is important to consider what the rubric is assessing. Most of the rubrics considered in Cooney's report were used to "grade the report not the lab assignment" (Cooney, 2002, p.4). Instructors need to determine what they want the rubric to assess, the lab report as a written document of the lab results and skills. For this

reason, it is important to include different types of criteria to assess actual lab results and skills. It is possible to weight the more important aspects of the lab report such as the conclusion, and put less weight on something like participation (Cooney, 2002). In this way, students will realize the importance of one aspect of the lab report over another: that more emphasis or effort should be given in certain areas and that just writing the report isn't enough. The student actually has to understand and explain what they did and participate in the whole lab experience. This information helped me to adapt a rubric that was specific to several aspects of the lab report with more points awarded to the data and conclusion section of the lab report. Hopefully, the students realized from this the importance of their data and the data analysis as presented in their conclusions.

Both of these resources assisted in providing a theoretical framework for my AR. I tried to introduce the idea of the HD approach, making students aware that in the real world science is different than science in the classroom. The report by Cooney solidified my research topic of why using a rubric is important; that rubrics can help to improve student performance. Rubrics do have a value to students and are a tool students need to be familiar with as they progress through the hallways of science.

Research Methodologies

Several papers reviewed were applicable to methodologies, both addressing ways rubrics could be used in the classroom. One related to the use of a common rubric in the college setting, and another referred to the use of rubrics in middle school science. Another paper discussed how to design rubrics to generate positive effects in the classroom and how to use a rubric to assess a rubric (metarubrics). This report focused on rubrics as a tool for assessment and improvement in student learning. Both of these had

parts that were valuable to the development of my AR and the implementation of various methodologies.

A study was conducted by the College of Micronesia in which they implemented the use of a common rubric for assessments for written lab reports. They borrowed the idea from Capital Community College. Capital Community College had used common assessments in their general education program and had found them to be successful, so the science faculty for the College of Micronesia was asked to use common assessments on lab report assignments in the hopes of achieving similar results (Summary of Science Lab Report scored with common rubric General Education Assessment 2009-2010). The methods employed by the science faculty involved several aspects. First the faculty would collect lab reports written in the fall semester. These would be collected from four different campuses in two different classes for a total of eight various locations. The reports were scored with a common rubric by science faculty who did not teach the course. The teachers instructed students to pick one lab experiment from the semester to write a lab report on. The students had one week to complete the assignment and no comments or revisions were to be made before completion and grading. Two copies were made, one to be given to the assessment team which would be anonymous, and one copy the instructor would keep for their own assessment purposes (Summary of Science Lab Report scored with common rubric General Education Assessment 2009-2010, 2010). During this study, data was collected from 156 students from five different campuses. A 90% confidence interval was used and a total of 61 lab reports were actually scored. The analytical rubric used scored four criteria metrics: scientific procedures and reports; strategies; scientific communication using data; and scientific concepts and related

content. Eight points were possible for each for a total of 32 points. Each report was scored by two readers, then scores were added together for a total score for each criteria overall (Summary of Science Lab Report scored with common rubric General Education Assessment 2009-2010, 2010).

The results from this study were as follows: average score 14.95/32 possible points. The averages for each of the four criteria were: Scientific procedures & reasoning 3.89, Strategies 4.05, Communication 3.38, and Concepts & Related Concepts 3.64. The college showed a breakdown of the scores per campus and related this to subject areas such as physics, biology, and chemistry. This appeared to be an appropriate way to breakdown and display the data collected. Since the college was trying to get an assessment that showed students' abilities in several areas, they chose a rubric that measured these attributes and gave them data that was significant to making changes. The target areas were: scientific reasoning, abilities to define and explain scientific concepts and theories, and also performing experiments using the scientific method through inquiry (Summary of Science Lab Report scored with common rubric General Education Assessment 2009-2010, 2010). I also found the breakdown of the scores by rubric criteria to be helpful, and felt this would benefit not only the teacher but also the student. By looking at the lab reports in this way, one is able to see the strengths and the weaknesses of the student lab reports and be able to address the weak areas specifically. This method of data collection and analysis has been helpful to me as I collected data from my own students' lab reports. I was able to break down scores by sections of the rubric and look at the Purpose, Hypothesis, Methods/Materials, Results and Discussion/Conclusion as

individual sections. In this way, I was able to determine the strengths and weaknesses of the students' lab reports.

Another area that was assessed for this report was the student's confidence in completion. Students rated how confident they were with the assignment and their completion of the assignment. Only 50 of the students responded: 25 felt very confident, 8 mostly confident and 9 were confused, very unsure or nervous about the assignment (Summary of Science Lab Report scored with common rubric General Education Assessment 2009-2010, 2010). I found this to be an interesting addition to the study and not sure how beneficial this actually is to the instructors at the college. It may have given them insights into why they had such low scores on average for the lab reports and ideas of where they can start to remediate the problem. However, I found it interesting that 50% of the 50 who responded were confident in their completion of the assignment when the average score was less than 50% for the lab report assignment itself. This is something I would like to see further data on, which could be collected through an individual interview process or more extensive questionnaire. Because of the information in this report, I used student surveys and interviews during my data collection to see what the students thought about science experiments and how confident they were in writing lab reports.

The conclusions for the study done by the College of Malasia, as indicated by the data collected, showed that the overall ratings were low in all criteria. The rubric was designed to assess in a general sense and the criteria were general enough to be used with any lab report for any science discipline. The criteria did address areas that any lab report should include such as: scientific procedures and reasoning (formulating a hypothesis),

methodology, collecting data, report in an understandable format, and drawing conclusions (Summary of Science Lab Report scored with common rubric General Education Assessment 2009-2010, 2010). This is important to note, since the study was designed to assess these attributes. This was also of importance to my AR since I used a rubric in the same manner, not only to help improve student performance, but as a tool to collect data. Again, I used a rubric that addressed similar criteria. Knowing that others have used rubrics to collect data in this manner added validity to my research plan.

After the completion of the study, the college had several recommendations related to the results which included students writing more than one lab report per semester (3/semester). Students should meet in the lab at least 15 times a semester. The faculty needs training to get students ready to write lab reports and the expectations for lab report writing should be communicated to other departments in the college, so there can be collaboration between the expository writing and science writing (Summary of Science Lab Report scored with common rubric General Education Assessment 2009-2010, 2010). These appeared to be relevant and doable recommendations. From the results of their study it is obvious that the College of Malasia needed to address some deficiencies in student lab reports. It appeared that they have found several methods to do this, and would need to continue to use the rubrics and scoring method applied in this study to collect data to determine if their treatment worked. I found the data collection method and analysis to be one that I based my own methods on to collect data for my AR.

Dr. Judith Arter presented a paper at the American Educational Research Association Annual Meeting in April of 2000. The purpose of the study and presentation

was to look at the impact of rubrics to define important student outcomes and to discuss the use of rubrics in the classroom as a tool to assess and improve student learning. The study also addressed the two uses of rubrics which are: to gather information to plan instruction, track student progress and report progress, and to help students increase proficiency on performance. Rubrics according to Dr. Arter's paper would be used to boost the quality of student performance. The methodology addressed throughout the paper referred to the use of different types of rubrics and the development of rubrics that are right for the material being assessed. Examples of holistic or analytical rubrics were given, as well as task-specific or general rubrics. Suggestions for how to develop these types of rubrics were given and examples of each were provided. The rubrics in this case were specific to math and 6-trait writing but there were elements that could easily be modified for science lab reports. I found the task-specific rubric design the type of rubric that worked best for my AR and data collection. A metarubric was mentioned as a tool to be used to assess a rubric itself. A metarubric looks at four traits; content, clarity, practicality and technical soundness (Arter, 2000). This metarubric can be used to evaluate the quality of a rubric and was considered as a tool when designing the rubric I used during my AR.

Another method studied by Dr. Arter was student self-assessments. By using rubrics for self-assessments, students can learn what to look for in their own work and decide what needs to be improved and know how to improve it. Teachers will need to learn how to teach or guide students with these self-assessments. There are seven strategies to use to implement this type of self-assessment in the classroom. Dr. Arter suggested that certain conditions must be in place for the strategies to work. The

conditions are making sure a high-quality rubric is in place, students are asked to develop criteria with the teacher's guidance (metarubric used), and lastly don't over-rubric. Make sure to pick and choose the products and skills that would benefit from rubric use (Arter, 2000). The seven strategies are as follows: teach students the vocabulary needed to think and talk like a problem solver, practice scoring anonymous samples of student work, practice focused revisions, share professional examples for assessment, model it yourself as the teacher, give students many opportunities to show what they know, and focus lessons on traits and qualities that are being assessed (Arter, 2000). These strategies all seemed reasonable; some, I have used in my own classroom. During my research I implemented two of these strategies specifically as treatments. The students scored anonymous student lab reports, using the rubric and worked on revisions after peer evaluations. It appears that Dr. Arter spent time on her study of rubric use and the relation to student performance. I found common themes between her work and other studies I have perused throughout this process, so I felt confident in the methodologies presented and integrated some of these into my own AR. The development of rubrics is essential to a successful AR, so knowing how to use a metarubric was helpful as I designed and reviewed rubrics for use in my research. The seven strategies also played a role in how I implemented treatments to improve student performance on not only lab reports, but also student comprehension of the science content.

METHODOLOGY

Treatments

To gather information pertaining to my research questions, I chose a non-treatment lab report and three other treatments which involved the use of the same rubric just with different methods of rubric use. The treatments I chose for investigating the research question and sub-questions are as follows. To gather baseline data, a non-treatment lab report was assigned after a lab experiment called the Catalase Lab. The lab was conducted and students wrote a lab report following guidelines they received during the first weeks of class. I scored the lab reports using the lab report scoring rubric designed for my research (Appendix A). These scores were recorded and used as a means of comparison throughout the rest of the research. Again, students had not seen the lab report scoring rubric at this point, and followed the basic guidelines for a lab report and their prior knowledge.

The lab investigations chosen for the non-treatment and treatments varied in difficulty. After consulting with my colleagues the labs were ranked on a scale of 1 to 5, 1 being easy and 5 being most difficult. The non-treatment Catalase lab was a ranked a 4. The Investigating Osmosis Lab was a 3 and Osmosis: The Effects of Temperature and Solute Concentration Lab ranked a 4. Both were used for treatment one. Treatment two included Fermentation: Temperature vs. Sugar Lab which ranked a 4 and DNA Extraction Lab which ranked a 3. For treatment three, the Teddy Grahams and Natural Selection Lab were ranked a 4 and the Infectious Diseases and Populations Lab ranked a 3. During the treatments students had used the rubric as a reference, as a critiquing tool, and for peer editing.

Treatment One

During the first treatment, the students were given the lab report scoring rubric prior to the lab experiment. The rubric was discussed in class going over all the sections and how each section would be scored. This same rubric was used throughout the research to gather data on student performance. The students kept the rubric in their notebooks for future reference throughout the semester. The next lab we conducted was Investigating Osmosis. The lab experiment was conducted over a two-day period and students were assigned the lab report which was due three days later. The lab report was collected and scored using the rubric.

As before the students used the rubric as a reference, after another lab titled Osmosis: The Effects of Temperature and Solute Concentration was conducted. The lab took place in a block period and the students had five days to complete the lab report. Again, the lab reports were scored using the rubric and the students had the rubric at their disposal as a reference.

Treatment Two

Treatment two required the scoring of four examples of anonymous student lab reports using the rubric. With a partner a non-exemplary lab report and an exemplary lab report were scored. All lab report samples were from past IB Biology students. The scoring took place during four separate class periods and the students had approximately fifteen minutes to score the lab report with a partner. As a class, we discussed the scores given and why. I shared how I scored the lab reports as well.

The next week we conducted another lab called Fermentation: Temperature vs. Sugar. The lab was done in a block period and the students had two days to complete the

lab report. The lab reports were scored once again with the rubric. Again the lab report was assigned, after the students had scored sample lab reports using the rubric following class discussions.

Treatment Three

Treatment three involved the students peer editing classmates' reports using the rubric. This treatment occurred after a lab experiment titled, Teddy Grahams and Natural Selection. We spent one class period conducting the lab and the students had three days to write a rough draft of their lab report. On the third day, the students had two to three peers read and edit their rough draft lab reports. The students had approximately a week to make corrections due to the Thanksgiving break. The revised lab reports were then turned in for grading and assessed using the rubric. This treatment was again used after the Infectious Diseases and Populations Lab. The students had the weekend to write their rough draft and then peer editing took place, before the lab reports were turned in for a final grading.

Research Methods

For my research I chose an Honors Biology class, which had 32 students and was composed of freshman and sophomores and a general required biology class. The general biology class was composed of sophomores, juniors and seniors and had a total of 18 students. Both these classes were chosen because of the biology content, which lended itself to lab experiments that generated adequate material for lab reports. Also these were the two common classes I taught, allowing adequate numbers for data collection.

Table 1
Class Demographics, (N=50)

Males	Females	Freshmen	Sophomores	Juniors	Seniors	IEP/ILP	Gifted/ Talented
18	32	12	32	3	3	4	16

Grade point averages for the combined classes ranged from 31 students with a 3.0 GPA or higher and 19 students between a 2.9 and a 2.0 GPA. Fifty percent of the school population was at or below 50% free and reduced lunch. The demographics of these classes were quite diverse and offered a unique look at how rubrics can impact student performance. At this point in their education the students had been exposed to writing lab reports in a freshman Geophysical science class; however, not much emphasis was placed on lab reports during this class. Some of the students came to high school with experiences from middle school science fairs, where report writing is essential to the process. Close to half of the students came to high school from various middle schools both public and private, so their experiences with lab report writing was varied and not that extensive.

Data Collection Instruments

A student attitude survey, a student questionnaire, student personal interviews and graded lab reports were used to collect data. Questions relating to the science content associated with the labs conducted were assessed on unit exams, and those scores were used to assess increases in science content knowledge. Included in Appendices A, B, C, D, E and F are examples of the lab report scoring rubric, questionnaire, and surveys that were used, as well as the personal interview questions used. A personal journal was also kept to record observations throughout the treatments, paying attention to student

attitudes and behaviors. The journal illustrated the impact the treatments had on my teaching. Below is a research matrix and timeline that was followed throughout the research process.

Matrix

Table 2
Data Triangulation Matrix

Research Questions	Data Source 1	Data Source 2	Data Source 3
Lab Report Scores w/o Student Exposure to Rubric (Non-treatment)	Student Questionnaire	Report Scores	Student Attitude Survey- Likert Scale
Lab Report Scores w/Student Exposure to Rubric (Treatment 1)	Student Survey – Likert Scale	Report Scores	Summative Assessment Scores
Student Scoring Lab Reports Using Rubric (Treatment 2)	Student Survey – Semantic Difference	Journal Entries	Lab Report Score Comparison (Student Score vs. Teacher Score)
Lab Report Scores After Peer Evaluations (Treatment 3)	Student Survey – Personal Interviews	Report Scores	Summative Assessment Scores & Quarter Grades
Science Concept Knowledge/Understanding	Journal Entries	Report Scores	Summative Assessment Scores & Quarter Grades

Table 3
Time Table of Data Collection

Date	Data Collection Method Used
9/14	Student Attitude Survey/Likert Scale (before treatments)
9/19	Nontreatment: Catalase Lab Report
10/14	Student Attitude Survey/Likert Scale (after Treatment One)
10/10	Treatment One: Investigating Osmosis Lab Report
10/18	Treatment One: Osmosis: Effects of Temperature and Solute Concentration Lab Report
10/21	Unit 3 Assessment
10/25	Treatment Two: Fermentation Lab Report
10/26	Semantic Differential Survey (after Treatment Two)
11/14	Treatment Two: DNA Extraction Lab Report
11/11	Unit 4 Assessment
11/28	Treatment Three: Teddy Grahams & Natural Selection Lab Report
12/2	Student Attitude Survey/Likert Scale (after Treatment 3)
12/12	Student Personal Interviews
12/16	Treatment Three: Infectious Diseases Lab Report
12/20	Unit 6 Assessment

The student attitude surveys were given at the beginning of the research to gather information about the students' feelings related to science lab experiments and their confidence levels with relation to writing a lab report. A Likert scale was used because a

number value could be used, corresponding to the responses for data collection purposes and analysis. The surveys were given three times once before treatment and then again after treatment one and treatment two. A semantic differential survey was used after treatment two which obtained information about the usefulness of grading student lab report samples from the students' perspective. The semantic differential used a scale of negative to positive numbers to rank a response to a specific question. By using the semantic differential, I gathered number data that lent itself to better analysis and comparisons with the Likert scale surveys.

The main tool for data collection was the lab report scores. Each lab was graded using the lab report scoring rubric (Appendix A). This instrument allowed data to be gathered with respect to student performance on lab reports. Unit assessments were used as a method to observe student performance on test questions relating to science content from labs and lab reports. Lastly, a journal was kept making note of attitudes, behaviors and general information pertaining to the implementation of the treatments. All of these instruments provided useful amounts of data. Before using the lab report rubric it was shared with my colleagues and minor adjustments were made to fit our needs as a science department. By consulting with my colleagues, the validity and reliability of the instruments used were ensured. I also spent time developing questions for the surveys and questionnaires after discussing my plans with two of my fellow teachers. When deciding what treatments to use and how to implement them, I spent time bouncing ideas off of my mentor biology teacher. He helped me decide which treatments would work the best. After sharing my ideas and getting input from my department, I felt I had developed sound data gathering instruments. Also by triangulating the data I have ensured the

reliability and validity of the data I collected throughout the research. The instruments used and the research methods used were approved by the Institutional Review Board (IRB) ensuring that all instruments were used properly and ethically throughout the research process.

DATA AND ANALYSIS

Several data collection techniques were used in addressing the AR questions. Various student surveys were given throughout the semester; once in September, at mid-term of the first quarter in October and then again in December. The students had been involved in several lab experiences, and had completed five formal lab reports by the time the last survey was given. The surveys were given to ascertain the students' attitudes about science experiments, confidence levels in writing lab reports, past experiences with lab reports, and experiences with rubrics. For a detailed example of the surveys used see Appendices C, D and E. The student attitude survey's first question asked students if they enjoyed lab experiments. Questions 2-6 asked students about their confidence in writing various aspects of a lab report, and question 7 pertained to experiences or helpfulness of rubrics.

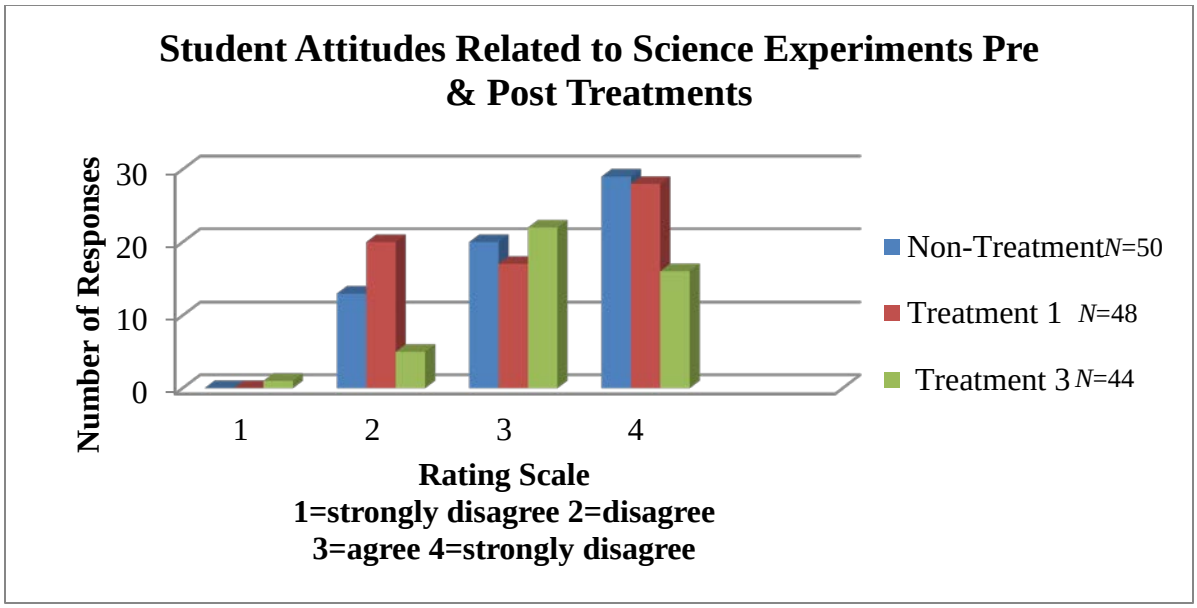

Figure 1. Student Attitudes Related to Science Experiments Pre & Post Treatments, (*N*=50, *N*=48, *N*=44).

After reviewing the data, as displayed in Figure 1, it is evident the majority of students agreed or strongly agreed that they liked to do science experiments. Ninety-eight percent (49/50) agreed or strongly agreed they liked doing science experiments before any treatment implementation. After treatment one (rubric alone), 96% (46/48) agreed to liking science experiments, after treatment three (peer editing), 86% (38/44) agreed that they liked science experiments. The students had various amounts of experience with lab experiments and written lab reports. Since this is a sophomore biology class, they have been exposed to labs in freshman geophysical science and also at the middle school level. Some students had experience competing in middle school science fairs or attended schools that had different requirements for lab reports. Taking into account the varying experiences with labs, it appears from the survey results that the students like and enjoy lab experiments.

Following question one, the students were asked to give a reason why they felt this way. Forty-eight percent (23/48) said “labs are fun.” Another comment was, “cause they are fun and you get to see what happens for real.” Others liked the hands-on experiences with 21% (10/48) responding with comments like; “….a hands on way to learn,” and “… I learn best through hands-on activities.” Other responses were that labs are, “better than taking notes,” “labs help me understand,” and a few 17% (8/48) thought they are, “too much work” and they “don’t like the write ups.”

By looking at these results it is easy to see that a 4 (strongly agree) and a 3 (agree) response were chosen the most. It appears that overall the students liked science labs. A 1(strongly disagree) and a 2 (disagree) had very few responses both non-treatment and after treatments one and treatment two. It is nice to know that student attitudes stayed fairly consistent after the treatments were implemented. From past experiences I would say students tended to enjoy doing labs because of the hands-on aspect, which was substantiated by the survey results. Obviously, adding the lab report component was not a deterrent, at least at this point in time.

Figure 2 shows survey results relating to confidence levels in writing lab reports. Before treatments the students appear to feel confident in their lab report writing skills with 80% (160/220) responding with a 3 (agree) or 4 (strongly agree). After treatment one, rubric alone, the students responded to questions pertaining to confidence in writing lab reports, 83% (198/240) felt confident about writing a lab report. The questions addressed student confidence levels regarding various aspects of a lab report such as; constructing tables and graphs, writing a hypothesis, identifying variables and controls and writing a solid conclusion. The survey was given again after treatment three and this

time students responded with 79% (175/222) choosing a 3 or 4 and 21% (47/222) feeling less confident.

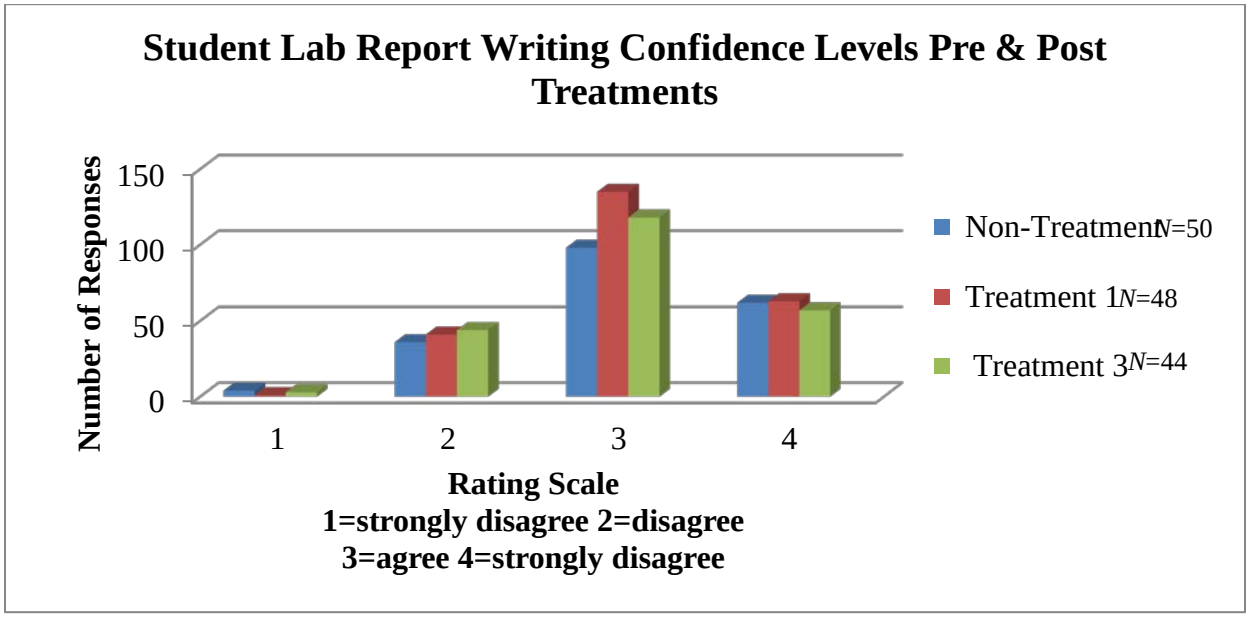

Figure 2. Student Lab Report Writing Confidence Levels Pre & Post Treatments, (*N*=50, *N*=48, *N*=44).

As seen in Figure 2, there are a couple outliers related to confidence levels. Only one student answered with a 1 after treatment three. This student also scored low circling a 2 on confidence in writing a lab report and writing a solid conclusion on the individual questions. When asked about his past experiences on the survey he stated “not very good at all.” Obviously this particular student had not had good experiences and lacked confidence, when it came to writing lab reports. His current grade hovered between a low C or D. This student was generally not very motivated and a low achiever overall. The rest of the results from the survey all fell in the same areas with the majority of the responses being 3’s or 4’s for all questions asked. This meant that the students agreed or strongly agreed with the questions, and had good feelings about science labs and confidence as lab report writers.

The next method used for data collection was a lab report scoring rubric that was used to score student lab reports. The first lab report, the Catalase Lab, was scored as a baseline for data collection. The students had not received any treatments at this point, so this was the non-treatment cycle of the research. The next two labs were scored after treatment one, where the students had access to the rubric to use as a reference when writing the lab reports. Treatment two involved the students scoring student lab report samples using the rubric. This was done on two separate occasions, scoring an exemplary and non-exemplary sample each time. In treatment three the students wrote a rough draft of their lab reports, and the reports were peer edited by at least two or three classmates, corrections made and the final draft was turned in for grading. Below are the average results for 6 of the lab reports after the three treatments. Throughout the process several students had failed to turn in their labs so *N* varied. I have no explanation for the lack of labs to score, other than some students choose not to turn in their lab reports and one of the labs was due right before finals for the first quarter. For these and other reasons, I do not have all 52 students' lab report scores.

Table 4
Lab Report Scores Non-treatment and Post Treatment One, Two and Three, (N=39, N=46, N=29, N=30)

	Non-treatment Lab Report (*N*=39)	Treatment One Lab Report (*N*=46)	Treatment Two Lab Report (*N*=30)	Treatment Three Lab Report (*N*=41)
Average Percentage Score	53%	55%	73%	78%
Lab Report Score out of 40	21/40	22/40	29/40	31/40

As seen in Table 4 the lab scores for the non-treatment lab and the average scores for the labs after treatment one are close. Non-treatment average scores were a 53% (21/40) and the average scores after treatment one, rubric alone, were a 55% (22/40). From this data it could be concluded that having the lab report scoring rubric as a reference had a slight impact on student performance. After treatment two, lab critiques, when sample lab reports were scored, there was an increase in the average scores. The average score after treatment two was a 73% (29/40). This is an eighteen percentage point increase from the non-treatment lab report and the treatment one lab report. After treatment three, peer editing, the average score was a 78% (31/40) showing an increase of five percentage points from the treatment two averages and a twenty-five percentage point increase from the non-treatment average. These results indicated that treatment two, critiquing lab report samples, and treatment three, peer editing had the greatest impact on student performance.

After the three treatments, the standard deviation was found for lab report scores after the three treatments. Treatment one resulted in scores ranging from 28% to 90% (M = 56, SD = 6.73). Treatment two had scores ranging from 53% to a 95% (M = 73, SD = 4.45). And treatment three scores ranged from 33% to 100% (M = 78, SD 1.21). Since the standard deviations continued to get closer after each treatment, it suggested that student performance was increasing on their lab reports, as reflected in Table 4. A t-value was then calculated using a dependent sample t-test, to show confidence levels in the treatments. The results of the t-test were a little disheartening with regards to confidence levels. Comparing treatment one and treatment two showed no confidence, t (74) = 5.8, p <.001, 0.1% *CI.* Treatment one compared to treatment three also showed no confidence,

t (70) = 8.84, $p < .001$, 0.1% *CI* . When comparing treatment two and treatment three, the results were more conclusive: t (80) = 1.8, $p < .10$, 95% *CI*. After statistically analyzing the data collected, I determined that treatment two and three resulted in increases in the lab report scores, but I cannot conclude that the differences in scores between treatment one and two, or treatment one and three are due to the treatments alone. Further data needs to be generated to determine why the scores improved from treatment one to treatment two and one to treatment three. However, after reviewing the data collected, there were improvements in the lab report scores as the three treatments were implemented. This showed that rubric use increased student performance on lab reports.

After treatment two, lab critiques, the students were given a semantic differential survey to gauge how effective the grading of student samples was for the students (Appendix D). The semantic differential survey posed questions that received a quantitative rating going from a negative three (-3) to a positive three (+3) on the rating scale. The students were asked several questions and two of these pertained to how helpful and beneficial they thought the treatment was, and another asked if they felt grading student samples would improve their own scores on lab reports. The students choose scores ranging from a -3 to a +3. A +3 represents very beneficial or helpful and a -3 would be not at all beneficial or helpful. Table 5 contains the results from these questions.

Table 5
Semantic Differential Results Related to Usefulness of Treatment Two, Lab Critiques, (N=46)

	Helpful	Beneficial	Increase Scores
Score 2 or 3	38 (83%)	37 (80%)	28 (61%)
Score 1 or less	8 (17%)	9 (20%)	8 (17%)

The results from the semantic differential showed that the students felt that grading sample lab reports using the rubric was helpful to them since 83% (38/46) responded with a 2 or 3 as their rating. The majority felt that using the rubric to critique labs had been a helpful activity that could be transferred to their own lab report writing. As far as being beneficial to their own lab report writing, 80% (37/46) responded with a 2 or 3 rating. This showed they felt grading a student sample with the rubric would benefit them when they wrote their own lab reports. The third question analyzed asked the students if they thought critiquing sample lab reports with the rubric would help increase their lab report scores. Over half of the students 61% (28/46) responded with a 2 or 3 rating agreeing that critiquing sample lab reports using the rubric had been both helpful and beneficial. The results of the semantic differential survey showed most students thought that treatment two was helpful, beneficial and would result in increases in individual performances on lab reports. I found this interesting, since this was the third choice for the most helpful treatment when students were asked this question after treatment three.

During the student surveys, the students were asked which of the three treatments were the most beneficial: the rubric as a reference, grading student samples using the rubric or peer editing using the rubric. The students responded with various answers with 32% (14/44) saying they thought the rubric itself was the most helpful. Several students responded with “it told us what to do” or “I knew what was expected.” Other responses included, “The rubric was the most beneficial, as I could use it as a basis for my report.” And “The rubric because it made you grade yourself.” Another response stated that

"…we knew exactly what you were grading us on" And probably the best one was "The rubric helped a lot, I've never wrote a lab write up before…"

Peer editing was the next choice for being the most beneficial treatment. Out of the 44 students surveyed 27% (12/44) stated that peer editing was helpful. Some comments were, "Having a peer edit because they see things that I don't." and "Peer editing helped as I greatly appreciate others feedback." There were several similar responses which stated that it was helpful to have someone else look over their work. The third choice was the grading of student samples using the rubric only, 14% (6/44) chose this as being helpful. Some responses that supported this treatment were, "Grading labs helped by showing what you're supposed to have in yours." And "Grading reports because shows examples." There were a few outliers with respect to this question; one student said "All of them." Another student talked about the Teddy Graham lab as most helpful, so they obviously didn't understand the question and two students did not answer. Figure 3 displays the results from the student survey.

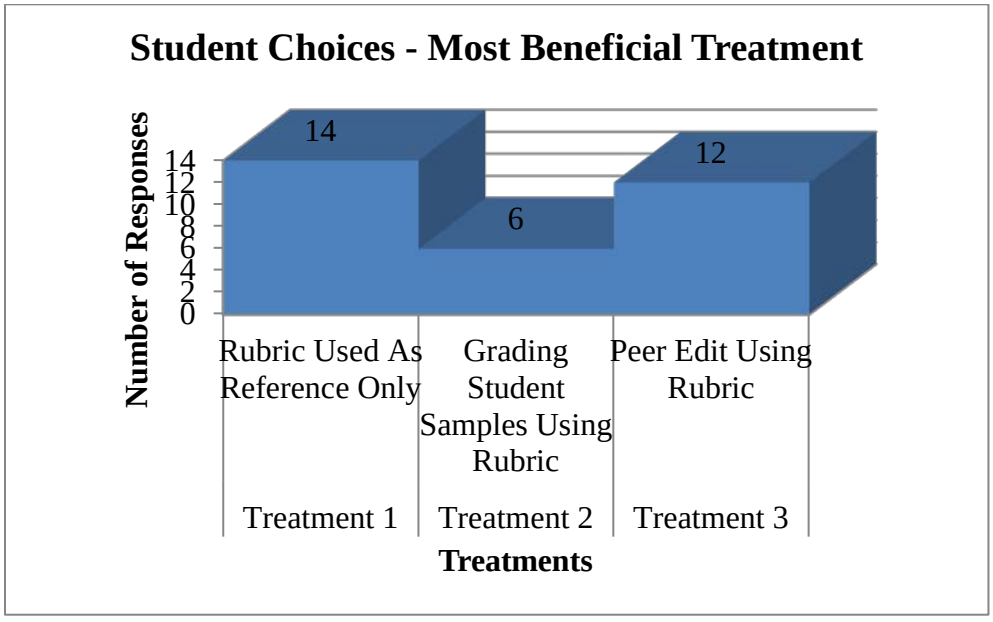

Figure 3. Student Choices – Most Beneficial Treatment, (*N*=44).

The data collected from the student survey and the lab report scores showed what the students think is sometimes in line with how they perform. The vast majority of the students liked doing science experiments. When surveyed on how confident they were in writing lab reports, over 80% felt confident in their lab report writing skills. After scoring lab reports, it appeared that their confidence levels and performance scores do not match up. The average score before treatments was a 53%. After treatments there was a significant increase, up to a 78% average after treatment three. It appeared that the treatments did have an impact on student performance.

By asking students about beneficial treatments, it can be determined that the rubric itself was the favorite, although this produced the smallest increase in lab report scores. There was only a 1% increase between non-treatment and treatment one. Obviously, the students did not make this connection. The next choice was treatment three. This treatment was a peer editing session where students had rough drafts of their lab reports edited by two peers. Treatment three resulted in the greatest impact on student performance with a 25% increase from the non-treatment scores and a 24% increase from scores after treatment one. Treatment two, lab critiques, was the third choice for the students, but resulted in a 20% increase in performance from the non-treatment lab report. This could mean that the students did not directly transfer the information gained by lab critiques, but synthesized the information without realizing it. When lab reports were written after this treatment, students applied techniques they had viewed when critiquing and applied these to their own lab reports unknowingly. This could explain the increase in performance after treatment two, even though it was the students' third choice as a preferred treatment.

At the end of the semester and completion of all three treatments, personal interviews were conducted (Appendix F). Nine students were interviewed on the same day. Each interview was conducted outside my classroom in a quiet hallway to reduce distractions. I personally asked the students questions, and wrote down their responses as direct quotes and summaries. The most apparent themes from the interviews were related to the benefits of the conclusion section, the rubric making them better report writers, agreement that treatment three, peer editing, was the most beneficial, and a rise in confidence levels as lab report writers.

When students were asked about the parts of the rubrics they found to be the most beneficial; three stated that all parts were helpful, three thought the conclusion section was helpful, two liked the data/results section and one student said the hypothesis was helpful. Some students comments were; definitely the "most beneficial was conclusion… had what was necessary compared to past years," another comment was probably the "conclusion part, cuz tells what you are supposed to talk about." Another student thought the graphs and tables section was most beneficial because, "I never put on titles, so that helped me out." With regards to the hypothesis section being helpful one student said the "scientific thought helped the most," since this was the focus for the hypothesis section.

Another question asked the students to evaluate if the lab reports reflected their strengths or weaknesses as a student. Five students responded that it reflected both their strengths and weaknesses. One student commented that lab reports reflected his strengths because it allowed him to go in depth. "I think I write stuff people don't usually think of." Another student thought it helped her get her ideas across. And another student commented it showed his strengths because he is good at "putting parts together," so

following the rubric to write the lab reports was easy for him. The five students who responded with a “yes” reflection of their weaknesses stated that it showed the areas that were “not strong” and “showed where needed improvement.” One of the IEP students said that he reads really slowly and he “sucks at writing,” so the lab reports emphasized these weaknesses. When he reread his report he had a hard time telling “what I need to correct to make it sound better.” Six of the students were not sure if the lab reports reflected their strengths or weaknesses. One comment was, “Don’t think the report reflects this just the grade” and just a simple “I don’t think so” were responses to this question. It appears from the student responses that most felt the lab reports reflected both their strengths and weaknesses as students. One student commented that they like doing labs and understand better by doing the lab report. And another student said “lab reports helped me follow instructions.” For the most part it appeared there are benefits to lab reports, whether students are able to showcase their strengths or identify their weaknesses for improvement.

Interview question 4 asked the students if the rubric helped them be better lab report writers and, if so which parts were the most helpful or most confusing. There was an obvious theme related to this question, seven responded with a yes and two said no. One student who responded yes stated “definitely” opposed to previous years when the rubric was broad and vague, this rubric is “so specific.” The conclusion section was the most helpful with five out of the nine choosing this section. Comments were “conclusion part with the why and support” of hypothesis with data collected. Another student said he learned that gathering data is not useful if you don’t “try to make sense of inferences” and the rubric helped to guide this process. Only two of the nine students felt the rubric was

confusing and said “most of it” and “how it was worded”, “just confusing.” The parts of the rubric that were the most confusing were spread out with the conclusion, purpose, data, trends and wording, each receiving one response. Four students did not choose a confusing part. Those confused had comments like “the results never got graphed right, probably need more practice with graphs,” purpose was “hard to know the independent and dependent variable”, and one was confused by trends “didn’t know what that meant.” In general the rubric was helpful improving the students’ confidence, even though some were still confused, most felt they had become better lab report writers by using the rubric. This statement sums it up; “Yes” I am a better lab report writer….“improved my scores”….. had the rubric next to me when writing.”

Another theme from the interviews indicated that the students felt peer editing was the most beneficial treatment. Four students interviewed were asked which treatment they thought was the most beneficial; treatment one, rubric as a reference; treatment two, critiquing examples of lab reports; or treatment three peer, editing their lab reports using the rubric. Three of the four agreed that treatment three, peer editing, was the most beneficial and one of the four said treatment two, critiquing other lab reports. This student stated that grading other lab reports “gives real life examples”….something to compare to when writing my own. Of the three who choose peer editing one stated, “got to read, got good ideas and saw other student’s mistakes….. helped me not do the same.” It is no surprise that peer editing would be the most beneficial, since the students had the opportunity to have someone else look over their work. However, some were a little reluctant to share either their work or their criticisms.

The last question asked students to discuss confidence levels regarding writing lab reports, and the overall theme indicated that confidence levels did rise. A survey was given earlier in the research process, and students responded to several questions regarding confidence levels in writing lab reports. Before treatments 80% responded with a 3 or 4 rating; 4 being very confident. After treatment one, rubric as a reference, the confidence levels went up to 83% responding with a 3 or 4 rating. When the survey was given after treatment three, peer editing, the confidence levels dropped to 79% responding with a 3 or 4 rating. By asking this as an interview question, I received personal insights into why there were changes in student confidence. The students rated themselves on a scale of 1-4 to determine confidence levels related to lab report writing skills after treatment three. One (1) being less confident and four (4) being very confident. Of the nine students interviewed no one felt less confident: two students rated themselves with a 2, six students rated themselves with a 3, and one student rated himself a 4, very confident. One of the IEP students said his confidence was “pretty low” before the treatments, but now ranked himself a little bit higher (2), “cuz not the best at it, but not super bad anymore.” This student improved overall in the class raising his grade from a D at midterms to C for the semester. I felt his increased confidence radiated to his overall confidence as a student. Those students who rated themselves at a 3 said things like; “Ok at it in beginning, by end “pretty good.” And “Feel better now than before….confidence was really low before now a 3.” One student said, “feel better now than before.” “Yea got a lot better …..got an F on the first and a B on the last.” Another student who is a solid A student but struggled with writing conclusions gave herself a 3.4, she said “I feel better…. Definitely grown, conclusion was a weak part …now I know

how to get the perfect medium." The one student who ranked himself a 4 said now I feel "pretty confident" before just somewhat. I found this intriguing because he never had very good scores on his lab reports. However, this is a gifted and talented student who struggled with the structure of assignments at times. I was encouraged to see the students became more confident as lab report writers, after being exposed to the treatments with the rubric. This was also reflected in the overall scores on lab reports from the non-treatment scores averaging 53% to the post-treatment scores averaging 78%.

The following is a summary of my thoughts recorded in my teacher journal immediately after the interviews that day. I found that the students were forthcoming with information. The data showed that most liked having the rubric and they felt it helped. One student didn't think it helped but his scores went up. The peer editing was chosen by most and treatment two, lab critiques. It seemed that just having the rubric was not enough there needed to be an explanation of the rubric as well. With reference to the rubric a few students didn't like the 0-4 scale for rating. They thought it should allow for more A's. I found this interesting. However, it was the Honors students who suggested this. All in all, I thought it was a successful endeavor, and I found that using rubrics needs to be a guided process with practice to see any real impacts.

There were four main treatments that were analyzed in a teacher journal: the non-treatment, treatment one, treatment two and treatment three. In the journal student behaviors were noted during the labs and the implementation of the treatments. Several themes arose which related to an increase in lab report scores, understanding of how to use the rubric and ways to cut corners, if possible.

The first journal entry was on September 15th. The Catalase lab was the baseline

or non-treatment lab. I observed the students and noticed that they were all on task and engaged in the experiment. Many groups were discussing the quality of bubbles that were being produced using good observation skills. I did have one group having trouble with following directions. The average lab report scores for the non-treatment reports were 53% (21/40). Normally, the first lab report assignment receives low scores, so I was not surprised by the results and a common theme that has been apparent in past classes.

Treatment one was implemented in October. For treatment one the students were given the Lab Report Scoring Rubric to use as a reference (Appendix A). We discussed the rubric and the students were told to use the rubric as a guide for writing their lab report for the Investigating Osmosis Lab. After discussing the various sections of the rubric and expectations, the class broke into groups to discuss the procedures they were to design for the upcoming lab. In this lab students were to design their procedures, which is one of the skills assessed on the rubric. I noted in my journal that the students didn't like having to come up with their own procedures, but were engaged when they began discussing what they were going to do. One group of girls had a disagreement. One girl felt left out and I am not sure if they ever really resolved the issue. A couple others discussed what to test in relation to their hypothesis; "Do we test a raisin and celery since we already saw the potato?" They couldn't seem to decide on their hypothesis at this point in time. The next day the lab experiment Investigating Osmosis was conducted in class. After the students finished the lab they were to begin working on their lab reports. Some students chose to hand write the report instead of typing, which was fine but they were told it needs to be legible. They didn't seem to understand that they needed to use graphs, and I reminded them several times to use the rubric as a reference. One student

asked me to look at her conclusion. I told her it was weak she needed to accept her hypothesis, not say it was correct. I also told her she needed to look at the rubric. As a whole the classes seemed to have trouble using the rubric as a guide. The average scores for this lab were a 56%. A week later the next osmosis lab was conducted and again the students were to use the rubric as a guide to write their reports. The students had class time to begin writing their reports. At this point I observed that all but four or five got out their rubric. One class had no questions as they began their reports. However, the other class had some questions. Some asked about the last lab report, but nothing specific. I was asked to look at one student's report and she asked, "Is this acceptable." I asked this student if she had followed the rubric. She said she had "kind of." It appeared that the students were looking at the rubric, and a few are paying attention to the actual details on the rubric. The average scores for this particular lab, Osmosis: Effects of Temperature and Sugar were 58% percent, and the students did not seem to pay attention to the rubric. This was a slight improvement from the first attempt when the rubric was used as a reference. The average scores for both osmosis labs after implementing treatment one, rubric alone were 55% (22/40). After observing the students during both labs one common theme appeared, having the rubric as a reference did not impact scores significantly. Another theme I noted was anywhere students could find a shortcut they would take it. This was evident in the quality of procedures they wrote and the time taken to write the lab reports. This is a shortcoming I have observed throughout the years at all levels I have taught.

Toward the middle of October treatment two was implemented. This time the students used the rubric to score examples of past lab reports. These are some of the

observations I noted in my teacher journal. The students worked as partners to assess a non-exemplary example of a lab report. The students quietly discussed the reports and were using the rubric as a guide to score the report. I heard comments like, that's "zero points for no graph," and have to accept the hypothesis not say it's "correct." Some noticed there was no graph and asked "if they had to have one." They also asked about the control and variable. After about ten minutes we discussed the scored lab reports as a class, going over each scored. The scores given were similar in both classes. Most students gave the report 3's and 2's on all sections of the rubric. There was a few that were tough scorers giving some 1's for sections, if just one part of the criteria was missing. A couple days later the students were given an exemplary example to score using the rubric with a partner. Again there was good discussion between partners. One group asked is "the question the same as the purpose?" So they obviously paid attention to detail, since the rubric says purpose, but on the sample report it had question. The variables are to be included in the purpose according to the rubric, so one student assumed that the variables should just be there, "don't have to be identified, if they are in the purpose." We discussed this as a class. Again after about ten minutes, we discussed the scores given for this lab. The evident theme for scoring this sample report was primarily 3's and 4's, no 2's or less was given. This was the exemplary report example. Some comments from the students were "easier to grade", ….. followed the rubric, so it was easier to follow." Another comment was it "helped because now we know how you grade." After listening to the student comments I could tell that they were beginning to understand the function of the rubric and how to apply it to their own lab report writing. I

felt after this treatment they all had a better understanding of how to interpret and use the rubric.

The next week following implementation of treatment two, lab critiques, the students conducted a lab on fermentation. Notes from my teacher journal follow. During this lab there was trouble with the respirometers they built, and confusion on how to measure the bubble produced by the carbon dioxide. Most groups appeared to be gathering good data. We used class averages as part of our data collection related to temperature and percent sugar. The students were assigned lab reports. At this point they had used the rubric as a guide, and had graded sample reports using the rubric. The average score for the Fermentation Lab report was a 73% (29/40). There appeared to be a marked improvement after critiquing sample reports with the rubric. The theme that arose showed the students were able to transfer information to their own lab reports, thereby increasing performance as reflected in the scores after treatment two. There was still a common theme in students wanting to take short cuts, and not take adequate time when writing their reports.

The first week of November the students conducted a DNA extraction lab. A demo lab was done the day before to introduce DNA extraction methods to the class. The next day they designed their own experiment for DNA extraction. Again the students are being assessed on the lab report and the procedure skill was being emphasized in the lab. “They did a better job of designing procedures than the first time. Not near as many complaints. I think they are beginning to understand the importance of the scientific method and how to apply it to their own work.” I also observed and wrote in my journal that the groups worked well together, but noted I need an activity or something for the ten

minutes of wait time. We discussed what could be brought in for testing and what variables they could manipulate. I was not sure if they got the idea that they could change amounts of detergent and enzymes, not just materials. The next day the “real” DNA extraction lab was conducted. The groups all remembered their samples to test and the groups worked well, some were a little confused about why their extractions didn’t work so well. Most groups were able to extract at least small amounts of DNA from their samples. Some groups needed help in following procedures. I also noticed they were not writing down observations. At this point I wasn’t sure if understood the purpose of the lab report. However, one group took pictures for their data/results section, so that was encouraging. I noted this since the data/result section of the rubric was worth 15 of the 40 possible points, so if they ignore this section while collecting data, it will impact the overall report grade. I realized I should have given more guidance on items used for DNA extraction, and closed the loop with regards to why they were or were not able to extract DNA from their samples.

Before the students completed their lab reports we discussed the DNA Extraction lab and the reports. I noted a few general comments in my journal; one student stated, “I wrote three paragraphs last time and still got a low score.” We discussed that it is not always about quantity but quality and to address the elements in the rubric. I also reminded them the data section on this particular lab report should have included qualitative data not quantitative. Since there were no tables or graphs they needed to title their pictures or sketches. We also discussed trends in the data and possibly looking at which samples had the most DNA and why? I noted, “Not sure if they are getting it still. I am concerned that this will not be a good report to score.” As it turned out the average

score for the DNA Extraction lab was a 73% or 29/40. The scores for both lab reports after treatment two were identical at 73%. So treatment two, lab critiques, resulted in improvements in lab report scores when compared to scores after treatment one. There still was a theme related to treatments and performance. After each treatment the scores slowly increased, which illustrated that the treatments were generating positive results. However, I noticed a theme relating to the students' understanding of how to use the rubric. More attention was paid to the various aspects of the rubric, and making sure all parts were addressed in their reports, again this was reflected in the average scores after treatment two. There were still those who were looking for shortcuts, which was a common theme every time, as well.

On November 16th the students were assigned another lab called Teddy Grahams and Natural Selection. Treatment three was implemented at the conclusion of this lab, and the students would peer edit lab report rough drafts. This lab was challenging since the students needed to pay close attention to the directions. Partners worked together to simulate what happens when a predator is introduced into a population of Teddy Grahams. After the partners got results, we posted the results in a class data table. This was important because the results and data section were a significant part of the lab report grade, worth 15 of the total 40 points possible. I noted in my journal that there were some discrepancies in some of the numbers. We discussed this and what might have been the causes. Some groups threw out data because they didn't think it fit. This was a great opportunity to discuss integrity in data collection, and the importance of using the data collected, no matter what. You can't make the data fit to answer your hypothesis. This really bothered some of the students, because the data didn't show what they thought it

should. The class really seemed to be over thinking this one. They seemed to be distracted by their own "smartness." Some thoughts I wrote were; "They wanted to spend more time arguing about the data than what the lab was really about, so not sure they got the point of the lab, that natural selection caused a change in the population. It will be interesting to read conclusions and see if they could stick to the rubric's guidelines." At this point the students had conducted the lab, collected and shared data, and answered conclusion questions. They now had to synthesize this information into their lab reports. The students were expected to have a rough draft of their lab report by November 18th.

Treatment three was implemented when the students shared rough drafts with their peers. The students used the rubric to critique the reports. The students had approximately 15 minutes to edit someone's report, switch and be edited by one more peer. I noted these questions in my journal; "Do we use questions from the lab handout." And "no control variable" what do we do? The partners seemed to be questioning each other about the reports, but some didn't have much to edit. Some also seemed reluctant to share and needed a little help to get started. After corrections were made the reports were turned in for grading. The average lab report scores for the Teddy Graham and Natural Selection lab were 73% (29/40). After treatment three, peer editing, there was no change in the average scores compared to the averages after treatment two, lab critiques. One theme I noted was students had a hard time being critical of each other, and some did not have rough drafts to share. Those that were critical of each other's work benefited, but as a class the common theme was that peer editing was not that helpful in improving performance. I think another reason I saw little or no change in the average score was

related to the lack of reports turned in for grading. In both classes there were inconsistencies with turn-in rates, which impacted the averages for the class.

At this point in time (mid November) I noted in my journal that the Honors biology class is giving me much more reliable data than the 7th block general biology class. “The difference in students is remarkable,” I stated after completing the next to last lab report with both classes. The 7th block class “just doesn’t seem to get it”, although three or four of the students seem to be putting forth an effort. But overall “they just seem to need their hands held more.”

The last lab report evaluated after treatment three was a lab on infectious diseases, and was done the week before finals. I noted that the students were excited to share a “disease” with each other and see who caught it. Two days after the lab students shared rough drafts for peer editing, as before. There were better comments or critiques this time. I heard comments like you need to put a title on your graph, to make sure you “discuss the trends” when they were going over the conclusions. After corrections and final draft grading the average scores for the Infectious Disease lab were 83% (33/40). An overall theme after treatments was an increase in scores, and a better understanding of how to use the rubric. Students still liked to complain and cut corners when they could though.

The data showed there was a slight increase in average scores between treatment two, lab critiques at 73% and treatment three, peer editing, at 78%, however some of this could be related to the lack of reports turned in for scoring. For this reason, I did not get a true picture of all students and improvements or lack of improvements. Overall, from personal observations noted in my journal, the common theme was; treatments impacted

the students and their performance on lab reports, which coincides with the average score data, as well as the survey results. This data also suggested that the students gained an understanding of how to use the rubric, as seen in the average score increases. As far as cutting corners, the students began to take more time from lab to lab report, which again is reflected in the average scores. The surveys suggested that the students felt the treatments were helpful and beneficial, and there were positive changes in confidence levels too.

After completion of the research, I realized from the journal entries and data gathered from report scores and surveys, that students showed growth not only quantitatively, but qualitatively. By the end of the semester, they had a grasp of what a good, solid lab report should look like. They began to understand the importance of a conclusion, and how to express their findings in a scientific way. I also saw students become more self-assured in their writing and presentation of work; a new sense of pride showed in the quality of the last two lab reports. Overall, the students showed growth, not only with increased scores, but in confidence as report writers. Hopefully, this skill will carry over into other areas, as they continue their educations.

Unit assessments were another data source used to determine if using the rubric would impact students' science content knowledge. Three unit assessments were given during the research time: Unit 3 which included content on photosynthesis, fermentation and osmosis; Unit 4 a genetics unit; and Unit 5 the evolutionary biology unit. Unit 3 and Unit 4 assessments were given after treatment one, rubric alone, and treatment two, lab critiques, and Unit 5 assessment was administered after treatment three, peer editing. Scores were evaluated only for those questions pertaining to information directly related

to labs and reports with similar content. Unit 3 questions included scores after treatment one and two were implemented. These questions were related to the content from the photosynthesis and osmosis labs. The Unit 4 question included scores after treatment one and two. The assessment question used for analysis related to the concepts presented in the DNA Extraction Lab. Unit 5 assessment occurred after all three treatments had been implemented, and the assessment question was related to the concepts of natural selection. This question related to concepts from the Teddy Graham and Natural Selection Lab. There were no pre-test scores used for comparison. I only looked at percentage scores on those assessment questions related to the labs' content.

Table 6 illustrates the percentage scores for all three units. The data showed that 67% (264/392) of the responses to assessment questions earned 100%. Question responses earning a 99%-80% were 16% (66/392); 6% (22/392) of the responses earned a 70%-79%, and only 10% (40/392) earned less than a 70% on responses to the assessment questions. I did not have a means for comparison, but if 90% of the class scored a C or better on test questions there must be adequate comprehension of the science content. There were only 15, or 2%, of the students who scored a 20% or lower on the test questions evaluated. Some of this could be attributed to a lack of effort on the students' parts. Those that received a zero didn't even attempt to answer the questions. Overall, the assessment data indicated that student assessment scores which pertained to content post treatments, had scored similar or higher than on the individual lab reports. From this data, I have concluded that using the rubric on lab reports had an impact on student comprehension when assessed over similar content. However, I cannot feel confident in

stating this without first having a standard for comparison, and more research to determine if this truly is the case.

Table 6
Unit Assessment Percentage Score - Number and Percent of Correct Answers, (N = 392)

Percent Score Earned for Assessment Questions	100%	99%-80%	79%-70%	<70%
Number of Correct Answers	264/392	66/392	22/392	40/392
Percent of Correct Answers	67%	17%	6%	10%

After completion of the research, the data showed that student performance did improve on lab reports, which helps to answer the research question: how will using rubrics impact or improve student performance on lab reports and increase understanding of biological concepts? The data analyzed showed that student scores on lab reports increased after each treatment was implemented. The non-treatment average score was a 53% after treatment one, rubric only, the average scores improved to 55%; 73% after treatment two, lab critiques, and 78% after treatment three, peer editing. Although the increase statistically cannot be attributed to the treatments alone, there was a noticeable improvement from the non-treatment lab reports to the final lab reports after treatment three. Student confidence levels also increased after implementing the treatments. Before treatments they were 80% confident in their lab report writing skills, after treatment one, rubric only, students responded with being 83% confident, however after treatment three, peer editing, the question was more specific and the response was 79% percent feeling

confident with their lab report writing skills. After treatment two, lab critiques, students were surveyed to see if they felt the treatments were helpful, beneficial and if their scores improved. The majority of students responded positively to all three aspects of this survey. When responses to interview questions were taken into account, it was apparent that students were more aware of the lab report requirements, therefore making their inadequacies more obvious to them. This would tend to lower the confidence levels for some students. In general the survey results; lab reports, unit assessments, and interview responses have shown that performance on student lab reports was impacted rubric use. To what extent the rubrics truly impacted student performance and content knowledge is hard to determine from the data collected. As for how using the rubric has impacted my teaching, I can say without a doubt it has made me realize that explaining and placing emphasis on rubric use is vital to obtaining results. Dr. Arter mentioned seven strategies to be used when implementing rubrics in the classroom. The strategies were: teach students the vocabulary needed to think and talk like a problem solver, practice scoring anonymous samples of student work, practice focused revisions, share professional examples for assessment, model it yourself as the teacher, give students many opportunities to show what they know and focus lessons on traits and qualities that are being assessed (Arter, 2000). Students need to be guided in the use of rubrics; just handing out a rubric is not enough. From now on I will make sure to discuss how to use the rubric, model its use, grade examples, and use peer editing; all as tools to help improve student performance on lab reports. In the end I hope this will transfer to their understanding of the science concepts as well.

INTERPRETATION AND CONCLUSION

The purpose of this research project was to determine if the use of rubrics and how these rubrics were used would impact student performance on lab reports. The main research question was; **how will using rubrics impact or improve student performance on lab reports and increase understanding of biological concepts at the high school level?** From the data collected and analyzed, I concluded that the use of rubrics had a positive impact on student performance. The students' lab reports scores increased throughout the research. In the beginning of the research, a baseline or non-treatment lab report received an average score of 53%. After treatment one, using the rubric as a reference when writing the lab report, there was a minimal increase in scores to a 55%. The scores increased considerably after the students had used the rubric to critique sample lab reports, such as treatment two. After this treatment the average lab report score was a 73%. This was a 20% increase in scores. The scores continued to rise after students used the rubric and peer edited each other's lab reports, such as treatment three. The average lab report scores after treatment three increased another 5% to a 78%. This was a significant increase from the baseline of 53%, and showed the use of rubrics did have a positive impact on student performance with regards to writing lab reports. However, several students 7 of the 52, actually showed a decline in scores from treatment one to treatment three. One student dropped from a 93% to an 83%, another went from an 85% to a 53% and one from a 73% to a 50%. There could be several reasons for the drop in scores, for instance poor time management or just lack of effort. On the other hand, 5 of the 52 involved in the research showed significant increases in scores throughout the treatments. The most significant was an IEP student improving from a 33% to a 74%.

Another student improved from a 58% to a 75%. And one student went from a 58% to a 70%. As well as improvements, 5 of the 52 students performed at a consistent level throughout the research. Three of the 5 had a C average on all reports assessed and one student consistently earned an A, receiving a 100% on the final lab report. Even with these outliers, the overall data indicated that the use of rubrics and how they were used had a positive impact on student performance and content knowledge.

One sub-questions was, **when is the rubric most beneficial to students, before or after the lab experiment and how does this impact their performance on the lab report?** This question was answered after treatment one, two and three. In all three cases the students had the rubric before the lab experiment and lab report. In each case the scores improved, as stated going from a 53% to an average score of 78%. Once again this indicated having the rubric prior to the lab experiment and lab report was beneficial to the students' performance.

Another sub-question was; **how will peer group discussions and peer evaluations using the rubric impact performance on the lab report?** This question was addressed during treatment three when students had the opportunity to have peers edit their lab reports using the rubric. The students had a chance to make corrections and turn in a final lab report for grading. This treatment resulted in the most dramatic increase in scores from the baseline 53% to an average lab score of 78%. It was evident that the peer editing had a substantial impact on student performance on lab reports. Peer editing will be a technique I plan to implement from now on.

The next sub-question addressed was; **how does the use of rubrics affect student attitudes about science experiments and lab reports?** This question was

answered using several student surveys; asking students questions about science experiments and confidence levels in writing lab reports. The average results of these surveys showed that 93% of the students enjoy doing science experiments, however it should be noted that after the last treatment only 86% of the students enjoyed doing experiments. I cannot help but think this had something to do with all the lab reports that were assigned due to my research. In the future I will assign fewer lab reports, because of the time involved and lack of lab experiments that lend themselves to good lab reports. However, I plan to continue using the rubric as I did in my research.

Another sub-question asks; **how will student's knowledge of science content be influenced by the use of lab report rubrics?** The data collected from unit assessments indicated that at least 50% of the students received a 70% or higher score when assessed on material that pertained to the labs and lab reports. Since there was no standard for comparison and no pre-test to gather a baseline, I cannot conclusively say that the use of the lab report rubric was the reason for the assessment scores. However, I can judge from past experiences, and say with confidence that I saw more scientific thought and scientific concepts applied than I had from past classes, answering similar questions.

The last research question addresses **how the use of rubrics for scoring student lab reports impacts my teaching?** After analyzing my journal entries, I can say that I now realize the importance of rubrics to student performance. The most important lesson I learned was you cannot just give the rubric as a reference and expect it to be used correctly or at all. Since the rubric alone resulted in the lowest percent increase in lab report scores, going from an average 53% to an average score of 55%. In the past I had handed out a lab report guideline sheet and explained my expectations. I always thought

this should be enough. I now realize that the rubric needs to be explained to the students, as well as used as a student tool for grading. The students were actively involved in the grading process when we scored student samples using the rubric. We were able to generate good questions about what made one example better than another. They were able to see how you discuss trends in your data, and how to support your hypothesis with results. Most importantly, they had models to use as examples when writing their own lab reports. For the most part, they transferred what they observed to their lab reports, as seen by the increase in average scores to a 73%. As for peer editing, it was anticipated this would have the most dramatic impact on student performance, not only from what the research says, but from my own past experiences. Most of the students seemed to enjoy the chance to share their work and edit others. They appreciated the comments and made corrections per suggestions from their peers. By implementing peer editing using the rubric, the students were able to catch items they had left out; like independent and dependent variables, for example. As a result of peer editing, the scores jumped up again to an average of 78%, with at least two students receiving a perfect score. Hooray! All in all, I learned that I need to do more modeling with the rubric, let the students critique student samples, and allow time for peer editing; if I want to get the most out of my students on lab reports. I am pleased with the results of my research, and plan to continue using rubrics in this way to help my students perform at a higher level. This not only benefits me as the teacher, but the students who are now more proficient in their skills of communicating via a lab report.

VALUE

For me the value of this research has been the fact that I know better ways in which to implement rubrics in the classroom. Having exposure to the rubric isn't enough. The rubric needs to be used by the students, and peer editing is essential to improving student performance. As for the value to the students, I feel they now have a better understanding of how to use a rubric as a guide. This knowledge should transfer to other areas, whenever a rubric is used for assignments. This can be invaluable knowledge for students, since they will be given rubrics throughout their educations. By being involved in this research, they have gained extensive experience in rubric use, which will benefit them in many ways. Anytime students have more involvement or ownership in their learning there are benefits, so as teachers we need to continue to find strategies that build on these types of skills.

The results of my research could be generalized for any assignment, in any classroom where a rubric would be used. I think the most important aspect for teachers to learn is; you can't just hand out the rubric and expect it to be understood and used correctly. The rubric needs to be explained and used by the students themselves. In this way they gain a true understanding of the expectations of the rubric, which will transfer to their work and therefore improve performance. There are many types of rubrics to be used depending on the task and the subject. Throughout this process, I have found various rubrics, probably the most accessible one is Rubistar (Rubistar, 2000-2008), which can be accessed online and used to create many types of rubrics. As stated in the article "Beyond Grading;" a rubric needs to be designed to address various components that will increase learning, explain learning goals, and help to build understanding while encouraging

students to take risks intellectually (Siegel, Halverson, Freyermuth, & Clark, 2011). I found that choosing or designing a rubric can be challenging, but once the right tool has been developed it can improve your performance as a teacher, as well as the students.

Where this study leads I am not sure. I think it would be interesting to see which types of rubrics work the best. I would also like to do research with student generated rubrics, where they make their own rubric for specific assignments. Another question that arose during the research had to do with motivation or lack thereof. I had a hard time getting students to complete the lab report assignments. I would like to know why this is. Are they truly that unmotivated, since lab reports were a part of their grade you would think they would at least try to complete the assignment. Did they think it was too hard, were they afraid of the work involved, were they confused or just lazy? We did have a class discussion about this and the majority of the class stated, “they just didn’t want to work that hard.” Interesting, since many of these students were in the Honors class. Anyway, it would be interesting to see what the problem is and then find a way to solve it. These are the main questions I have asked myself since the completion of my research. There is definitely a value to using rubrics to improve student performance, and I will continue to use rubrics as an assessment tool in my classroom.

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APPENDICES

APPENDIX A

LAB REPORT SCORING RUBRIC

APPENDIX A

LAB REPORT SCORING RUBRIC

Rating Scale: 4 = Excellent 3 = Very Good 2 = Acceptable 1 = Unacceptable 0= Missing

Report Section	Score	Comments
Purpose/Problem: Question clearly stated Includes independent and dependent variables	4 3 2 1 0	
Hypothesis: Clearly stated in "if/then" format. Testable, supported by scientific thought	4 3 2 1 0	
Methods and Materials: Procedural steps provided in concise manner that can be repeated. The control and variables are clearly indicated. Students use chemicals appropriately.	4 3 2 1 0	
Results: Data tables and graphs are used appropriately. *Data Table Scoring Guide* Title; column headings indicate what is being measured with units of measure; data correctly and completely entered. *Graph Scoring Guide* Title; independent variable is on the horizontal axis labeled with units; vertical axis is labeled with units for dependent variable. Intervals are even and points plotted accurately; legend indicates which data is indicated by each line if there is more than one.	4 3 2 1 0 4 3 2 1 0 4 3 2 1 0	
Discussion/Conclusion: There are details about what happened and why it happened. There is a clear statement of whether or not the hypothesis was supported. There is a summarization of trends or patterns in the data. There is an explanation of how the trends or patterns support or refute the hypothesis.	4 3 2 1 0 4 3 2 1 0 4 3 2 1 0	

*Adapted from Scoring Guide for Laboratory Report, pg. 135, Science Educators Guide to Laboratory Assessment, Doran, Chan, Tamir & Lenhardt, NSTA Press, 2002.

APPENDIX B

QUESTIONNAIRE

APPENDIX B

QUESTIONNAIRE

Questionnaire

Name_____ ID#_____ Date_____

1. What is your high school GPA?
   □ 4.0-3.5 □ 3.4-3.0 □ 2.9-2.5 □ 2.4-2.0 □ Less than 2.0
2. You are:
   □ male □ female
3. Check your grade in school.
   □ Freshman □ Sophomore □ Junior □ Senior
4. How many science classes have you taken at PHS?
   □ 1 □ 2 □ 3 □ 4 □ None
5. In your last science class, how many lab reports did you write?
   □ 0-3 □ 4-6 □ 7 or more
6. On the last formal lab report how much time did you spend writing the lab report?
   □ 30 minutes or less □ 30-60 minutes □ Over 60 minutes
7. What do you estimate your grade to be on the Catalase lab report?
   □ A □ B □ C □ D □ F

APPENDIX C

STUDENT SURVEY: ATTITUDES TOWARDS LAB REPORTS

APPENDIX C

STUDENT SURVEY: ATTITUDES TOWARDS LAB REPORTS

Name: _____ Student ID # _____ Date: _____

I like to do science experiments/labs. 1 2 3 4

Why did you answer this question this way?

_____

_____

I feel confident about writing a lab report. 1 2 3 4

I feel confident in constructing tables & graphs. 1 2 3 4

I feel confident in writing a hypothesis. 1 2 3 4

I can identify the variables and controls in an experiment. 1 2 3 4

I feel confident in writing a good, solid conclusion 1 2 3 4

Please tell me your past experiences with these science skills from previous classes.

_____

_____

I have used a rubric in other classes. 1 2 3 4

Please give examples of these classes and the assignment.

_____

_____

1 = strongly disagree 2= disagree1 3 = agree 4 = strongly agree

APPENDIX D

SEMANTIC DIFFERENTIAL: SCORING LAB REPORTS USING RUBRIC

APPENDIX D

SEMANTIC DIFFERENTIAL: SCORING LAB REPORTS USING RUBRIC

Name: _____ ID # _____ Date: _____

Grading the lab report using the rubric was a helpful activity.

Not Helpful -3 -2 -1 0 1 2 3 Helpful

I feel using the rubric this way will benefit me when writing my next lab report.

Not Beneficial -3 -2 -1 0 1 2 3 Beneficial

I feel my lab report scores will increase by critiquing lab reports using the rubric.

No Increase -3 -2 -1 0 1 2 3 Increase

The rubric's language/descriptions are easy to understand.

Confusing -3 -2 -1 0 1 2 3 Not Confusing

The rubric is easy to use when scoring a lab report.

Difficult -3 -2 -1 0 1 2 3 Not Difficult

APPENDIX E

STUDENT SURVEY: ATTITUDES TOWARDS LAB REPORTS AFTER TREATMENTS

APPENDIX E

STUDENT SURVEY: ATTITUDES TOWARDS LAB REPORTS AFTER TREATMENTS

Name: _____Student ID # _____Date:_____

I have enjoyed doing science experiments/labs this semester.	1	2	3	4

Why did you answer this question this way?

_____

I now feel more confident about writing a lab report.	1	2	3	4
I now feel confident in writing a hypothesis.	1	2	3	4
I now feel more confident in constructing tables & graphs.	1	2	3	4
I can now identify the variables and controls in an experiment.	1	2	3	4
I now feel more confident in writing a good, solid conclusion.	1	2	3	4
Having a rubric as a guide was beneficial.	1	2	3	4
Grading sample lab reports was helpful in improving my skills.	1	2	3	4
Having a peer edit my lab report was helpful.	1	2	3	4

Of the three which was the most beneficial or helpful and why?

_____

1 = strongly disagree 2= disagree1 3 = agree 4 = strongly agree

APPENDIX F

STUDENT INTERVIEW QUESTIONS

APPENDIX F

STUDENT INTERVIEW QUESTIONS

1. What part of the assessment/rubric used is the most beneficial to you as a student and why?

2. Do you feel the assessment reflects your strengths as a student and how? What about your weaknesses, how?

3. The last assessment used a check system with points awarded; this assessment uses a scale of 0-4. Which assessment did you like better? Why?

4. Will this type of assessment/rubric help make you a better lab report writer? Why?

5. What did you learn from this particular assessment/rubric? Give specific examples if possible.

APPENDIX G

INSTITUTIONAL REVIEW BOARD

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For the Protection of Human Subjects
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M EMORANDUM

TO: Tori Hellmann
FROM: Mark Quinn, Ph.D. Chair
Institutional Review Board for the Protection of Human Subjects
DATE: November 7, 2011
SUBJECT: *The Impact of Lab Report Rubrics on Student Performance [TH110711-EX]*

The above research, described in your submission of November 7, 2011, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal Regulations, Part 46, section 101. The specific paragraph which applies to your research is:

X (b)(1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

X (b)(2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

(b)(3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

(b)(4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

(b)(5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

(b)(6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.