THE EFFECTS OF LABORATORY ACTIVITIES ON IMPROVING SCIENCE CONTENT MASTERY

by

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STATEMENT OF PERMISSION TO USE

In presenting this professional paper in partial fulfillment of the requirements for a master's degree at Montana State University, I agree that the MSSE Program shall make it available to borrowers under rules of the program.

Michelle Dietz Slaughter

July 2013

DEDICATION

Although I have worked very hard over the course of my life to succeed in anything that I put my mind to, it has been through the guidance and support of my parents, Joanne and Larry Dietz, that I have pushed myself further in life. My husband James has also played an important part in the furthering of my education, and I am truly blessed to have so much support.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The research presented in this paper was designed to evaluate whether laboratory activities provided in a science content course improved the students' content mastery as well as their performance on formal assessments. Following the completion of the week's new science content, students were given pre-lab assessments prior to attending the supporting laboratory activity via the Smart Response Clicker System. The same assessment was given using the same data collection instrument in order to measure the class's improvement. Data showed that all three class periods increased their overall class average substantially. Students who participated in the Student Survey on Laboratory Activities provided positive feedback concerning the usefulness and value of laboratory activities on their personal learning.

INTRODUCTION AND BACKGROUND

The junior high school where I am currently teaching seventh grade life science is Riverside Meadows and is located roughly an hour from Sacramento, California. As a district we have seen an influx and efflux of different types of students and families, so to say we are a mixed bag would be an understatement. Initially we had three schools, ranging from kindergarten to eighth grade. However all that has changed in the last few years with our district changing to two elementary schools and one junior high. The students involved in the research varied in many ways, including academic performance and personal background.

According to the school records the current population was 67% Caucasian with smaller subgroups of Hispanic at 22% and African American students at 11%. However, we are not considered an educationally disadvantaged school according to my site administrator, Mr. Hofhenke (J.Hofhenke, personal communication, March 8, 2013).

As the years have gone by the school has made changes as have I in my teaching methods and goals. One goal I have always held close to my heart was the desire to make science interesting to students through hands-on labs. But how can educators determine which labs pack the most bang for their buck? That was the question I seemed to be asking myself more and more. Every time I left a lab with my students my mind was always reflecting on whether or not that was a “good lab?” Did my students make the connections I was hoping for?

Many professionals involved in the educational system would agree that the use of hands-on laboratory activities enriches student learning. However, I set out to gather the data that would support and evaluate its true importance in the science classroom.

My primary focus question was: Do students understand more science content as a result of weekly laboratory activities?

CONCEPTUAL FRAMEWORK

The effectiveness of laboratory activities has always been a topic of debate between teachers, administrators, students and parents. There is not just one way to use laboratory activities in the classroom. In fact, there are many different ways of incorporating lab activities in order to excite and involve the students, but the purpose of any lab should be diverse and encompass many goals (Basey & Francis, 2011). These goals will vary but may include dismissing misconceptions and helping the students improve their understanding of the major concepts thereby improving their overall performance.

Recently the question of whether to use inquiry-based labs versus guided labs has been debated. Inquiry science allows the instructor to be a facilitator while the students use pedagogy and a non-lecture based format. In fact, students who participated in an evidence-based approach contributed more to the process including group collaboration (Volkert, 2012). While inquiry labs do have their places in the classroom many studies have shown that guided lab exercises are preferred by students and improve learning (Basey & Francis, 2011). According to Banerjee (2010), 83% of students preferred guided inquiry labs over using inquiry only based labs. However, in the same study Banerjee found that 54% of the students felt that inquiry labs helped them feel more confident, yet 50% of students felt that a combination of inquiry and teacher driven labs was better than using one method exclusively. While students prefer guided practices they may need to be given more freedom on labs they perceive as less intimidating. Some research has shown that inquiry-based labs facilitate higher learning and a greater mastery of content (Basey & Francis, 2011). Perhaps the collaboration and involvement of the students in an inquiry-based lab is the strategy that is truly responsible for the mastery of the content and the overall success of the students and the laboratory activity (Alesandrini & Larson, 2002).

Despite the hype, not all practices such as inquiry labs fit everyone's needs including those of the students, who have different learning styles or educational needs (Longo, 2011). It is important to remember that the ultimate success of any laboratory activity is related to the design, the excitement of the students, the background support of lecture information and the students' attitude towards the lab (Basey & Francis, 2011). As skilled educators, teachers need to be able to decide for themselves and their students how to implement laboratory activities and what form of laboratory practice they believe will produce the most beneficial results.

Collecting data on the effectiveness of labs has now become easier with the development of classroom response systems, also known as clickers. Clickers are small hand held wireless devices that enable real time data collection (Kenwright, 2009). Not only can clickers be used to collaborate with colleagues and students on data analysis in the lab, but they can also be used by educators to instruct at a higher level of understanding (Buckholt, Caron, Hunter, & Rulfs, 2010). In previous years collecting data on laboratory practices may have been attempted but was neither as efficient nor as effective as the smart response clickers. With today's technological advancements instructors are provided with instant feedback, can assess students and reteach concepts quickly. Clickers have been shown to improve attendance and participation throughout the school year (Kenwright, 2009). During lectures and presentations, most instructors check for understanding by randomly asking students questions, but with the use of clicker technology, instructors can instantly evaluate areas of weakness among the majority of students responding (Kenwright, 2009).

To evaluate the effectiveness of labs with clickers, simple multiple choice pre-lab and post-lab questions can be asked. These short formal assessments allow the instructor to determine how well the labs improve student understanding and further science content understanding. In fact, students reported that they would be more likely to answer questions if they were given using the clicker response system (Kenwright, 2009).

However, clickers themselves are not enough to improve student learning and should not be the only tool used to support the content. While the clickers are entertaining for both the instructor and the students, they are more of a tool that should be used by the instructor to determine whether particular labs or the type of labs meet the learning goals set and whether the lab promoted better student understanding of the science concepts (Skinner, 2009).

METHODOLOGY

The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained. This research began in late January and ended during the middle of March after collecting data and supporting data on three separate labs. Although I had 96 students who had chosen to voluntarily participate, I decided to limit my treatment sample size to 67 students, which included periods 1, 3 and 5 and a non-treatment group of 29 students. My non-treatment students varied in ability, academic success, and many required extensive help via and aid. Had the outside support for those students been more adequate I would have included them in the research.

In my classroom I began the week by giving a brief overview of the week's content while students filled out their planners, which were used to promote student responsibility as well as to look up what lab activities we were doing and when exams were scheduled. In previous years students and parents had difficulty maintaining organization and expectations, so Riverside began a school-wide policy that implemented the use of planners in every class in order to boost student productivity. Students were responsible for filling out their weekly assignments, assessments and classwork. After filling out the planners, students started on the week's bell work questions. These questions can be from prior knowledge or may be preview questions. Bell work questions were usually designed to drive the lesson for the day or to create student discussion. Students were expected to complete their bell work in the first few minutes of every period so that we could move on to the lesson.

A typical lesson entailed reading together, asking and answering questions, and discussion with a partner. The use of visuals such as YouTube, movie clips, or smart board notes was used to enrich the lesson. We then construct Cornell Notes together, which are only completed when students can show they can use the vocabulary in complete sentences. To accomplish this task, partners read each other's vocabulary sentence and collaborate on ways to improve either the content in the sentence or the structure. I called upon students to share, or on some occasions I played a game to randomly choose a student to share out loud. When a lesson was completed, students were given homework assignments including concept maps, vocabulary practice, or comprehension questions. To reward those students who had completed the homework, a student volunteer stamped the assignment; however this did not guarantee them full credit but rather guaranteed they did not receive late points. I did not grade for completion only.

Since Riverside Meadows is a small school, all three grade levels must share the lab, making Thursdays the seventh grade lab day. Students head straight to lab, and all classroom business of bell work, homework collection, and instructions for lab are taken care of there. Labs are presented as a way to reinforce content understanding through hands-on practice and inquiry. To evaluate the students' understanding of the week's lesson a short review was given using Smart Board technology, followed by an assessment.

To determine whether the labs I have already been using are effective, I implemented a few extra steps in the week's plans. Lessons were completed by Wednesday of each week and then students were given short five to ten question Pre-laboratory Assessments. The Pre and Post-Photosynthesis Laboratory Assessment, the Pre and Post-Fermentation Laboratory Assessment and the Pre and Post-Tree Ring Laboratory Assessment were given using smart response clickers which allowed real time data on the students' understanding of the content presented during the week (Appendices A, B & C). Although students were aware of which questions they missed they were not made aware of the correct responses, leaving them to determine where they made their mistake and to reevaluate their original response. Labs were held on Thursdays as planned and then to evaluate whether the laboratory practices were beneficial, students were again given the same assessments on Fridays using the clickers. Each question was scored as one point, and the data collected were exported to Excel, displaying the class's average percent and which questions the class scored the lowest or the highest. This enabled students and me to evaluate the effectiveness of the labs. The ultimate goal of this process was to gather data to determine whether labs need to be altered, if content needed to be retaught, or to clarify any misconceptions discovered following the lab.

While students participated in their formal weekly assessment I was provided the time to make notes in my teacher observation log and to reflect on how well the laboratory activity and assessment went. To further judge how well laboratory activities improved student understanding, a Student Survey on Laboratory Activities was given (Appendix D). The survey allowed me to make connections between the benefits of labs, student performance and students' attitude towards labs. Questions ranged from how well they liked the lab, to what changes they would recommend or whether they felt the lab improved their understanding. Over the course of the research, students volunteered to provide me with their input and reflection by participating in the Student Interview Questions (Appendix E).

After the completion of each week, data were examined to decide quantitatively whether there was an improvement between the students Pre-lab and Post-lab Assessments among the entire sample size as well as the individual class periods. Student Laboratory Handouts and Examples of Student Work were evaluated for content understanding using the Laboratory Handout Rubric (Appendix F & G). Finally, students took Formative Assessments for the content covered in the lab on Friday (Appendix H, I & J). Their scores were compared with the scores of my non-treatment class, period six.

Table 1
Triangulation Matrix

Questions	Data Source 1	Data Source 2	Data Source 3
1.What content do my students know prior to labs?	Pre-lab assessment using the smart response clickers	Formal classroom assessments	Teacher observation log
2.What content do my students know post labs?	Post-lab assessment using the smart response clickers	Student Attitude/Inquiry Survey	Student Artifacts: completed lab reports
3. How effective were labs in improving student performance?	Scores from both pre and post-assessments	Formal content assessment (section quizzes and exams)	Teacher observation log
4. How did my students feel about their lab experience?	Student Attitude/Inquiry Survey	Teacher observation log	Informal student interviews

DATA ANALYSIS

The treatment Pre-lab average for photosynthesis was 70.6%, fermentation averaged 76.9% and lastly tree rings averaged 75.6%. The Post-lab average for photosynthesis was 84.5%, fermentation averaged 86.0% and the tree ring lab averaged 85.9% (n = 67) (Figure 1).

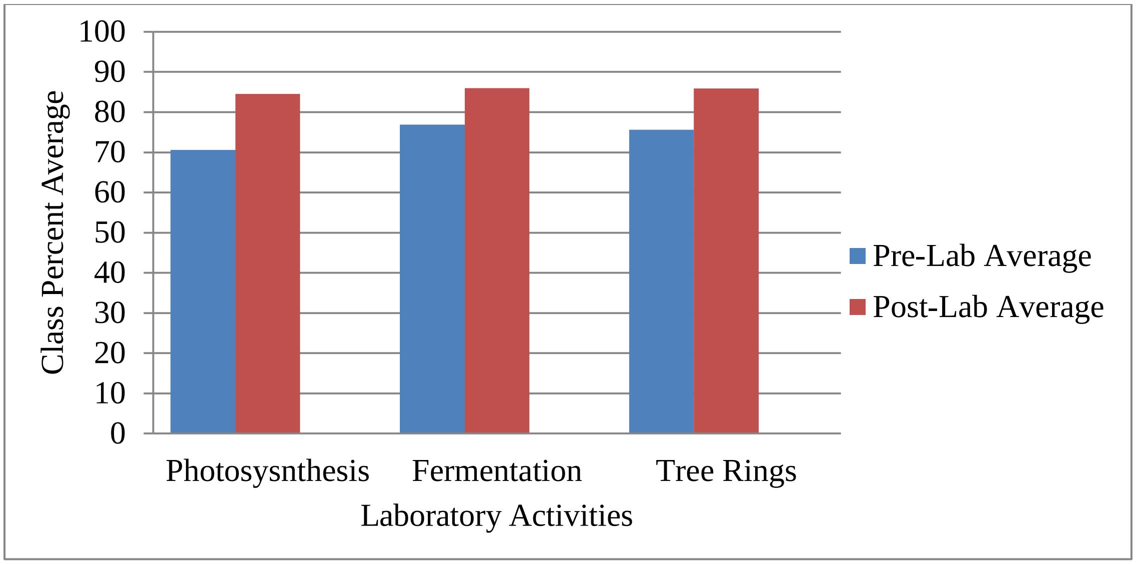


Figure 1. Pre-Lab and Post-Lab Assessment averages for Photosynthesis, Fermentation and Tree Rings Labs, (*N* = 67).

Pre- and Post-lab Assessments for individual class periods were compared using all three laboratory activities. Period one averaged 73.3%, period three 79% and period five 78.4% on the Photosynthesis Pre-Lab Assessment. Following the photosynthesis lab the class periods Post-Lab Assessment averages were 79.1% for period one, 86.7% for period three and 87.7% for period five (*n* = 67) (Figures 2 & 3).

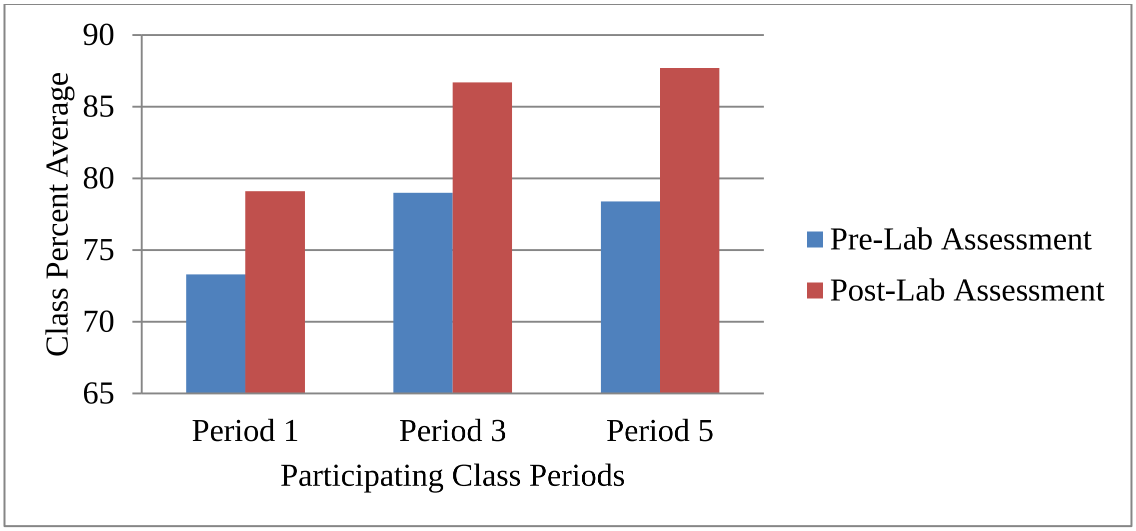


Figure 2. Photosynthesis Pre and Post-Laboratory Assessment for class averages, (*N* = 67).

Figure 3. Part of the student laboratory set-up for the Photosynthesis Laboratory.

Prior to conducting the fermentation lab, students took the Fermentation Pre-lab Assessment (Figure 4). Period one averaged 62%, period three 65.7% and period five averaged 62.3% (*N* = 67). Following the laboratory activity, the Post-lab Assessment was given. Period one averaged 87.3%, period three averaged 86.8% and period five averaged 84.1% (*N* = 67) (Figures 5).

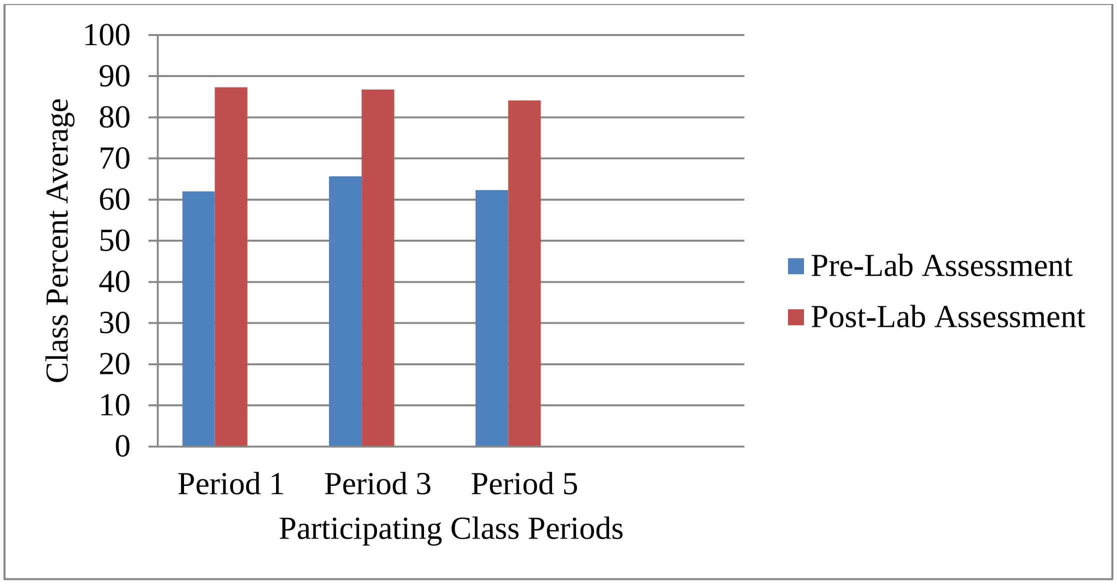


Figure 4. Fermentation Pre and Post-Laboratory Assessment for class averages, *(N* = 67*)*.

Figure 5. Part of the student laboratory set-up for the Fermentation Laboratory.

Lastly, period one averaged 70.4%, period three 80% and period five 75.6% on the Tree Ring Pre-Lab Assessment. After the completion of the lab, period one averaged 77.5%, period three 92.6% and period five averaged 87.8% on the Fermentation Post-Lab Assessment (*n* = 67) (Figure 6). I observed in my teacher log students who did well at determining which ring indicated a good growing year also did well recreating their own tree ring drawings.

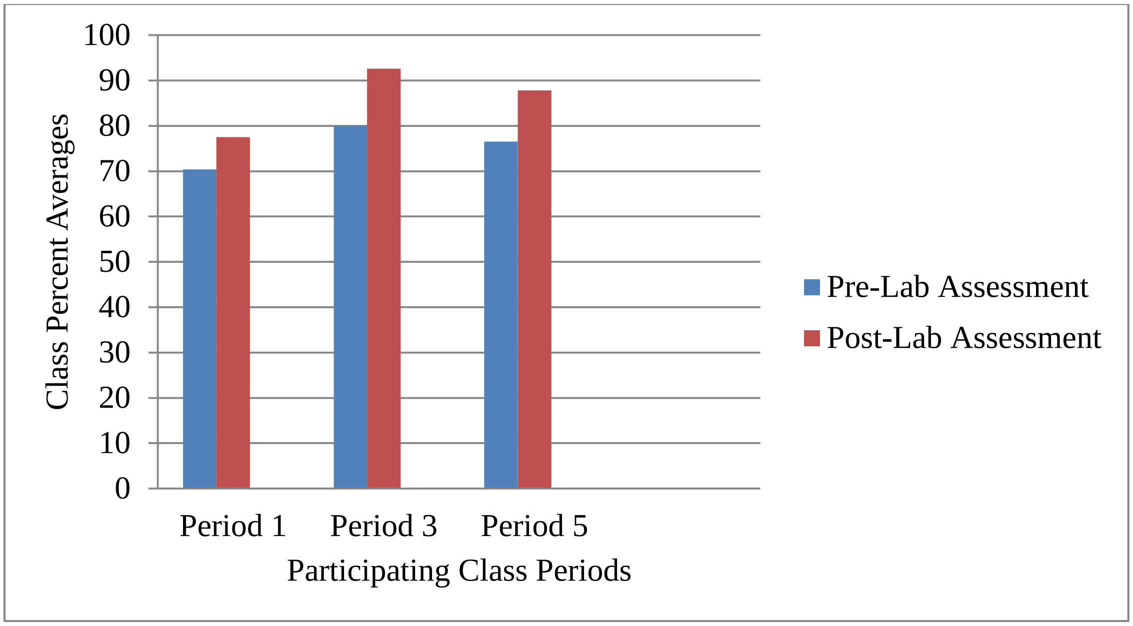


Figure 6. Tree Ring Pre and Post-Laboratory Assessment for class averages, *(N* = 67*)*.

Scores were compared to determine if students performed better on formative assessments due to participating in the laboratory activities. Period one averaged 79%, period three 83.2%, period five averaged 86.4% and the non-treatment group averaged 77.7% on the Photosynthesis Formative Assessment. I noted in my teacher log three different students used the laboratory activity to demonstrate their content knowledge of photosynthesis on a critical thinking question posed on the Photosynthesis Formative Assessment. Period one averaged 84.1%, period three 84.9%, period five 89.9%, and the non-treatment group averaged 83.2% on the Fermentation Formative Assessment. Lastly, period one averaged 87.8%, period three 85.6%, period five 87% and the non-treatment group averaged 81.3% on the Tree Rings Formative Assessment (*N* = 96) (Figure 7).

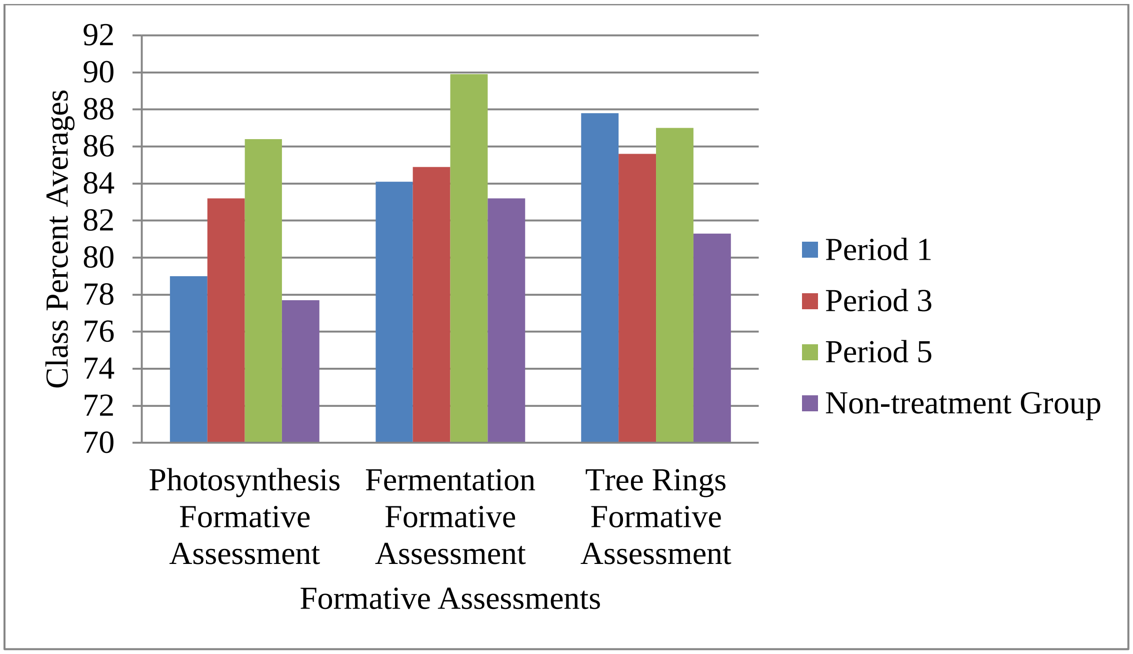


Figure 7. A comparison of the class averages for the Formative Assessments, *(N* = 96*).*

To better understand how the students felt about the laboratory activities they voluntarily participated in the Student Survey. When asked if they felt more confident after completing the lab, 43% said they strongly agreed, 42% agreed, 11% were neutral, 1% disagreed and 3% strongly disagreed. When asked if they felt they learned more by completing a lab each week, 48% strongly agreed, 30% agreed, 15% were neutral, 3% disagreed and 4% strongly disagreed (n = 67) (Figure 8). One student responded by saying, “The lab was interesting and I learned more about the process of photosynthesis.” Other students even gave suggestions on to how to improve the laboratory activities for next year. For example one student said “I think we should have gone outside to use more natural light instead of using flashlights." Another responded "Maybe we should try using different flashlights with different strengths."

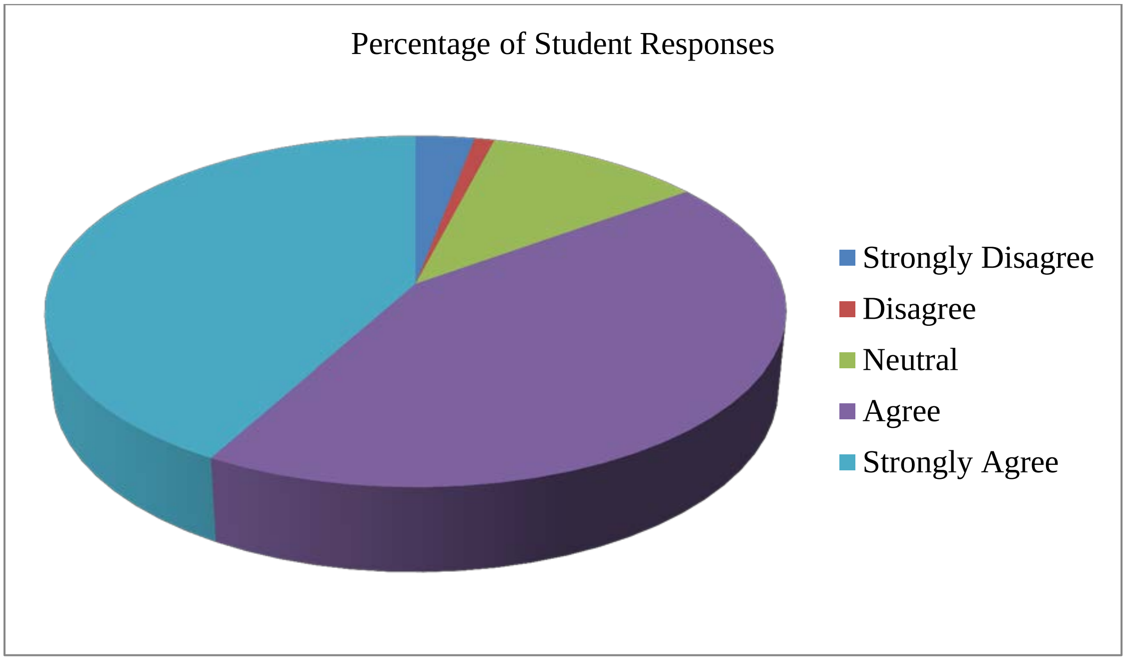


Figure 8. Average percentage of positive student responses on the Student Survey, *(N* = 67*)*.

INTERPRETATION AND CONCLUSION

The research conducted was designed to determine whether or not science content mastery improves as a result of laboratory activities. Based on the data collected from three different laboratory activities and the increased percentage of questions answered correctly on post-lab assessments, the statement that laboratory activities do improve student content mastery is supported. The evidence also showed that students enjoy labs, look forward to labs, and the labs improve their understanding of the science content. Combined with the student surveys, empirical data, and the responses of students interviewed, the research overwhelmingly supports the significance of laboratory activities in relation to achieving science content mastery. However, I should mention that the competitiveness of periods three and five may have played a role in the increased score when looking at the post-laboratory assessments. Students who participated in the treatment became excited about their scores and often strived to outperform their peers. As a result of the finding, more labs will be planned, old labs will be altered if needed, and new ways of assessing labs will be applied beginning in August.

While the main focus question was answered many more questions became apparent as the researched progressed. Two questions which presented themselves were: 1. Do English Language Learners (ELL) students perform better on formative assessments due to laboratory activities? 2. How can laboratory activities be differentiated to meet the needs of low and high performing students? In the future it would be interesting to track the progress of ELL students during units where laboratory activities were a weekly part of the science content versus units where laboratory activities were eliminated completely.

VALUE

Laboratory activities are an integral part of student understanding; they build an excitement for science and at the end of the day will improve their overall achievement in the subject. Currently my students participate in weekly science labs but after taking into consideration their responses and how much they value the labs more will be introduced in the coming school year.

One change I plan on making as a result of this study is the use of a variety of different lab styles, including inquiry-based and guided labs. Most of the labs used in my classes are semi-guided but allow the students ample opportunities to discover on their own. However, with the results of the Tree Ring Lab, which was inquiry-based, I will be altering some preexisting labs to accommodate the inquiry style. Students were open to the inquiry style and even though they were unsure of it at first they performed very well on the assessments and their Student Work (Appendix G).

To say that this experience has changed the way I view labs, how my students can achieve a better understanding of science content and how important it is to never stop searching for a better way of teaching would be an extreme understatement. When I began this journey I did not anticipate the changes or the implications of how my research might affect my teaching practices, but with the completion of my work I can stand back and say that there are some exciting changes in the future. Any time an educator, such as myself steps outside of his or her comfort zone to try a new strategy it is always awkward and nerve-racking, but the rewards are well worth it. The process of learning with my students will improve my teaching and my student's ability to succeed, which should be why every educator chooses this profession. I want my students to be the best, to get better every day they walk into my classroom and to leave knowing that the only obstacles they face are their choices. This research was designed to meet the capstone requirements for my masters, but it was more importantly designed to teach me what I can do to help my students and if what I am currently doing is fulfilling their needs.

I am a life-long learner and someone who prides herself on striving to try new strategies and to never get complacent in my teaching. This process has affirmed this belief about myself and although my research has ended for this particular endeavor, it has led me to ask more questions about my teaching and the changes that could result from further study. One aspect of this experience I had not planned on was the feeling that my students and I were working together, and they were as much as part of this research as I was. Taking the time to read their opinions and suggestions, and to see the enthusiasm in their faces as they achieved at a higher performance level really created a sense of community in my class that I have noticed is lacking in other classrooms.

While my partner teacher and I were in the hallways, colleagues would listen to our conversations.They began asking questions and wondering if what we were working on would benefit them as well. This was also a great excitement for me since my biggest frustration has been watching some of my colleagues become complacent in their practices.

Challenges are what make teaching so much fun as well as so trying, but every year that goes by gives me a new chance to teach better, support my students more, learn from my mistakes and inspire my students to become independent thinkers.

REFERENCES CITED

Alesandrini, K., Larson, L. (2002). Teachers bridge to constructivism. *The Clearing House: A Journal of Educational Strategies*, 75 (3), 118-121.

Banerjee, A. (2010). Teaching Science Using Guided Inquiry as the Central Theme: A Professional Development Model for High School Science Teachers. *Science Educator,* 19 (2), 1-9.

Basey, J., Francis, C. (2011). Design of Inquiry-oriented Science Labs: Impacts on Students' Attitudes. *Research in Science & Technology Education,* 29 (3), 241-255.

Buckholt, M., Caron, J., Hunter, A., & Rulfs, J. (2010). Using a Classroom Response System for Real-time Data Display and Analysis in Introductory Biology Labs. *Journal of College Science Teaching,* 40 (2), 19.

Kenwright, K. (2009). Clickers in the Classroom. *TechTrends*, 53 (1), 74-77.

Longo, C. (2011). Designing Inquiry-Oriented Science Lab Activities. *Middle School Journal,* 43 (1), 6-15.

Skinner, S. (2009). On Clickers, Questions, and Learning. *Journal of College Science Teaching,* 38 (4), 20.

Volkert, Delene. (2012). Inquiry Based Learning. *Nevada RNformation.*Retrieved March 22, 2013, from http://www.thefreelibrary.com/Inquiry+Based+Learning.-a0298309783

APPENDICES

APPENDIX A

PHOTOSYNTHESIS PRE AND POST LABORATORY ASSESSMENT

Pre/Post Laboratory Assessment

1. What are the correct starting materials for the process of photosynthesis?
   a. Water, carbon dioxide and sunlight
   b. Oxygen, carbon dioxide and sunlight
   c. Glucose, carbon dioxide and sunlight
   d. Water, glucose and sunlight

2. What are the products of photosynthesis?
   a. Carbon dioxide and water
   b. Glucose and energy
   c. Water and glucose
   d. None of the above

3. What plant organelle allows for the absorption of sunlight?
   a. Mitochondria
   b. Lysosome
   c. Golgi Apparatus
   d. Chloroplast

4. The difference between photosynthesis and cellular respiration is
   a. Cellular respiration releases energy whereas photosynthesis captures sunlight to produce energy.
   b. Cellular respiration occurs in the cytoplasm and photosynthesis occurs in the mitochondria.
   c. Photosynthesis produces more energy than does cellular respiration.
   d. Photosynthesis occurs in both plants and animals.

5. Photosynthesis occurs in
   a. Plant cells
   b. Animal cells
   c. Both plant and animal cells
   d. None of the above

APPENDIX B

FERMENTATION PRE AND POST LABORATORY ASSESSMENT

Pre/Post Assessment

1. Fermentation can release energy without the presence of
    a. Carbon dioxide
    b. Water
    c. Glucose
    d. Oxygen

2. Which of the following is a type of fermentation?
    a. Lactic acid
    b. Alcoholic
    c. Both a and b
    d. None

3. Is yeast alive?
    a. No
    b. Yes

4. Which of the following are produced from fermentation?
    a. Bread
    b. Sugar
    c. Water
    d. Oxygen

5. What gas is produced once yeast begins to process sugar?
    a. Oxygen
    b. Methane
    c. Ethane
    d. Carbon dioxide

APPENDIX C

TREE RING PRE AND POST LABORATORY ASSESSMENT

Pre/Post Assessment

1. How does petrified wood form?
   a. Over time the tree hardens
   b. Rain water fills in the spaces of the tree and then it becomes stone
   c. Minerals within the rain water fill in the spaces of the tree which then hardens into stone
   d. Petrified wood forms when a tree dies and is covered with ash

2. Petrified wood is
   a. A trace fossil
   b. A carbon film
   c. A mold and cast
   d. A form of mineral replacement

3. What can you tell from tree rings?
   a. The size of the tree
   b. The type of tree
   c. Good years and bad years of growth
   d. The age of the tree
   e. Both c and d

4. What rings formed when the tree was a sapling?
   a. The rings on the outside
   b. The rings closest to the bark
   c. The rings closest to the center
   d. The center

5. Can tree rings be used when observing petrified wood?
   a. No, it’s stone and not living anymore
   b. Yes, because it’s a fossil of a tree

APPENDIX D

STUDENT SURVEY ON LABORATORY ACTIVITIES

Student Survey on Laboratory Activities

Directions: Circle the number after each item. Please be as honest as possible and thank you for your help with this process. **Participation or non-participation will not affect the student's grade or class standing.**

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I understood this week's laboratory objective.	1	2	3	4	5
2. After completing the lab I feel more confident with the content with ________________________ (lab name).	1	2	3	4	5
3. I learn more by completing lab each week.	1	2	3	4	5
4. Participating in labs have changed the way I feel about science.	1	2	3	4	5
5. I understand why it is important for me to learn this material	1	2	3	4	5
6. Working with peers and completing the laboratory handouts help me to understand the content.	1	2	3	4	5

Directions: Respond to the following questions in your own words.

1. How can this lab be improved in the future? Any suggestions?

2. How would you rate this week's lab (1-poor and 10-very good)?
   1 2 3 4 5 6 7 8 9 10

   Why?

3. Is there anything else you would like to tell me concerning labs? If so, please let me know.

APPENDIX E

STUDENT INTERVIEW QUESTIONS

Individual Student Interview Questions

Participation or non-participation will not affect the student's grade or class standing.

Question:	Yes	No
1. Did the laboratory activity help you understand the content covered this week?		
2. Did the laboratory activity clear up any misconception you may have had from this week's content?		
3. Have laboratory activities changed your confidence in science?		
4. Do you think laboratory activities should be incorporated every week?		
5. Are science laboratory activities the best part of the science course?		

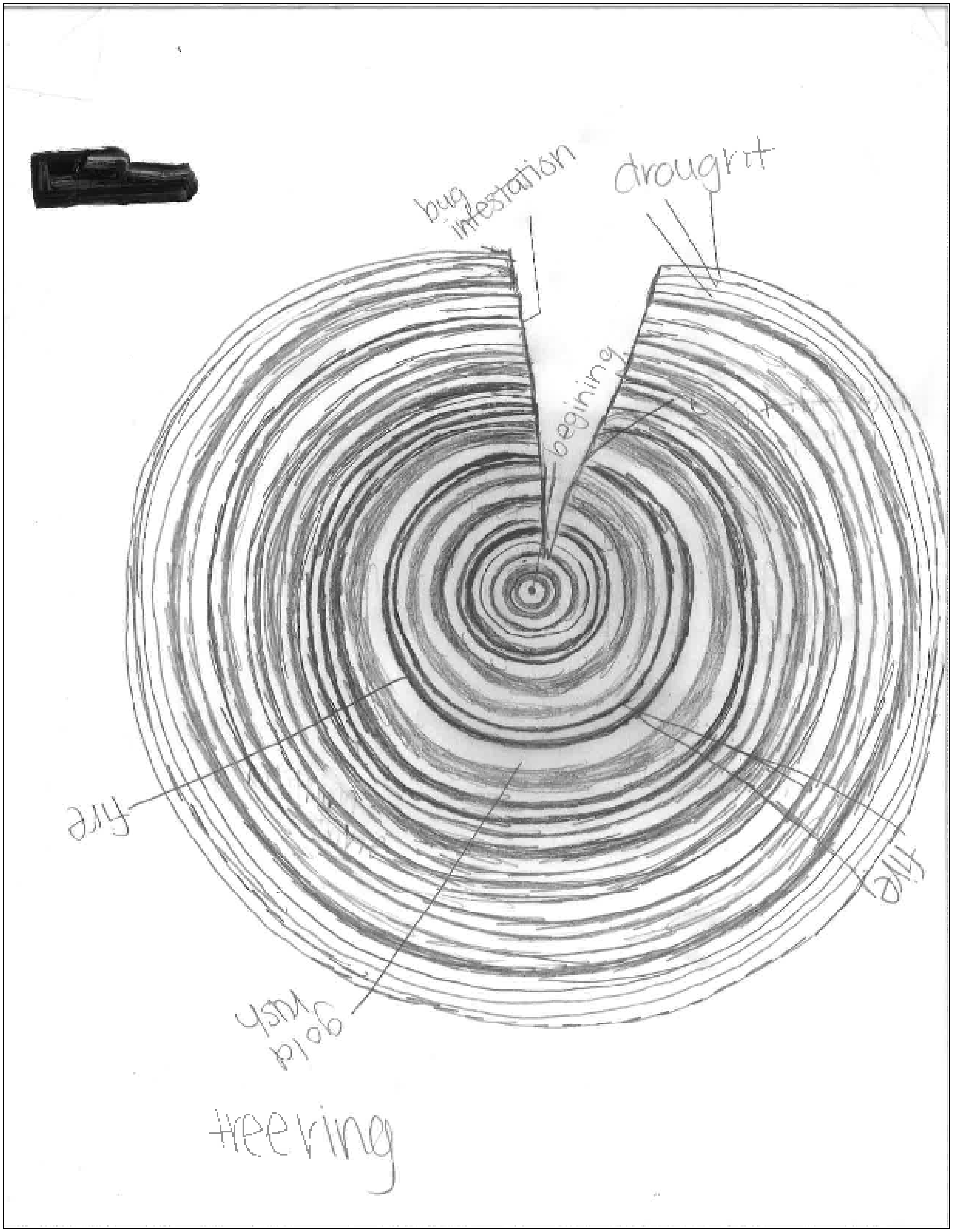
6. Please describe why laboratory activities are beneficial to your personal learning.

7. If you had to make changes to the laboratory activities what changes would you make?

8. How do laboratory activities affect your performance on the formal assessments?

APPENDIX F

EXAMPLE OF STUDENT WORK


bug infestation
drougrit
begining
fire
fire
gold rush
treering

APPENDIX G

STUDENT LABORATORY HANDOUT RUBRIC

Riverside Meadows
Lab Report Evaluation Form

A completed Lab Report should include the following sections:

Heading, Title, Problem, Hypothesis, Materials, Procedures, Data, Conclusion, and Conclusion Questions.

This Lab Report Is Completed To The Best Of My Ability.

X________________

(Student Signature)

Name: ________________________ Teacher: Mrs. Slaughter

Title of Experiment: ____

Date Submitted: ____________ Lab Partner(s): _________, _________

Teacher	Criteria	Student
0, 5, 10	Clear and Appropriate **HEADING**, **TITLE**, **PROBLEM**, and **HYPOTHESIS**.	0, 5, 10
0, 5, 10	All **MATERIALS** listed and a summary of **PROCEDURE**.	0, 5, 10
0, 10, 20	Appropriate presentation of **DATA** and observations including graph(s), chart(s), drawing(s), etc. Accuracy of data.	0, 10, 20
0, 10, 30, 50	Clear and concise **CONCLUSIONS**. Conclusion addresses problem and states knowledge gained. Answers to all **QUESTIONS**.	0, 10, 30, 50
0, 5, 10	Overall- **NEATNESS**, **GRAMMAR**, adheres to **FORMAT**, etc.	0, 5, 10
_______	←------Total points earned = Lab grade------→	_______

Teacher Comments:

APPENDIX H

PHOTOSYNTHESIS FORMATIVE ASSESSMENT

Chapter 2 Quiz: Photosynthesis

1. Which process occurs in the chloroplast?
   a. Cellular respiration
   b. Transpiration
   c. Evaporation
   d. Photosynthesis

2. Which chemical that aids in photosynthesis do you find in chloroplast?
   a. Carbon
   b. Oxygen
   c. Chloroplast
   d. Chlorophyll

3. Leaf cells use chlorophyll to absorb
   a. Oxygen
   b. Light energy
   c. Carbon dioxide
   d. Glucose

4. Both a whale and seaweed use which of the following to change glucose into energy?
   a. Water
   b. Photosynthesis
   c. Cellular respiration
   d. Bonding

5. The raw materials of photosynthesis are
   a. Water, oxygen and light
   b. Carbon dioxide, water
   c. Light, water
   d. Water, light and carbon dioxide

6. The products of photosynthesis are
   a. Carbon dioxide and water
   b. Oxygen and water
   c. Oxygen and glucose
   d. Light and water

7. In what organelle does photosynthesis take place?
   a. Chloroplast
   b. Mitochondria
   c. Lysosome
   d. Nucleus

Elodea plants in beakers of water were placed at different distances from a light source. The number of bubbles that form on the plants were counted and recorded. The data table shows the results.

Beaker	**Distance from Light**	**Bubbles per minute**
1	200cm	2
2	100cm	10
3	50cm	45
4	20cm	83

8. What gas do the bubbles consist of?
   a. Carbon dioxide
   b. Hydrogen
   c. Water vapor
   d. Oxygen

9. What is the relationship between the distance from the light source and the rate of bubble formation?
   a. The rate increases as the distance increases
   b. The rate decreases as the distance increases.
   c. The rate stays the same as the distance increases
   d. The rate changes in a way unrelated to distance

10. If another beaker with Elodea were placed 150cm from the light, about how many bubbles would form each minute?
   a. 1
   b. 7
   c. 11
   d. 24

APPENDIX I

FERMENTATION FORMATIVE ASSESSMENT

Chapter 2 Quiz 2: Fermentation

1. Which term describes the process in which cells release energy without using oxygen?
   a. Fermentation
   b. Photosynthesis
   c. Cellular respiration
   d. Transpiration

2. In lab, what gas was produced after the yeast had time to metabolize the sugar?
   a. Oxygen
   b. Methane
   c. Carbon dioxide
   d. Propane

3. The French scientist Louis Pasteur mixed yeast and grape juice in a sealed container. When he opened the container, the grape juice contained alcohol. What happened?
   a. The yeast produced carbon, which lead to the formation of alcohol.
   b. Grape juice when sealed properly from oxygen changes into alcohol via fermentation.
   c. The yeasts are living organisms which produce slight amounts of alcohol as part of their life cycle.
   d. The yeast began to consume the sugar and since there was no oxygen fermentation produced alcohol.

4. Fermentation occurs
   a. In the mitochondria
   b. In the cytoplasm
   c. In the cell wall
   d. In the nucleus

5. Foods produced either by lactic acid or alcoholic fermentation are
   a. Soda
   b. Bread
   c. Yogurt and cheese
   d. Only b and c

6. Looking at the picture above, what can you determine about the ratio of sugar to yeast?
   A. The more sugar provided the more gas produced in the bottle.
   B. The more yeast provided the more gas produced in the bottle.

7. Why will the balloons in the picture eventually stop expanding?
   A. The water will cool down and the yeast will die.
   B. The yeast will run out of sugar and will stop producing gas.

APPENDIX J

TREE RING FORMATIVE ASSESSMENT

Chapter 5 Quiz: Tree Rings and What they can tell us

1. The number of rings tells a tree's
   a. Size
   b. Shape
   c. Type
   d. Age

2. A light ring forms during what part of the growing season?
   a. Forms early
   b. Forms late

3. How can you tell when it's been a dry year for the tree?
   a. The ring for that year are dark colored
   b. The ring for that year are wide in size
   c. The ring for that year are a different color
   d. The ring for that year is thin in size

4. Can tree rings provide us with evidence of the past?
   a. No
   b. Yes

5. Which of the following is most likely to show evidence of a year with low rainfall?
   A. Tree rings
   B. Index fossil
   C. Original remains
   D. Sedimentary rock

6. How old is this tree?
   a. 1-5 years
   b. 6-12 years
   c. 13-18 years
   d. 19-24 years