PRESENTING LABORATORY FINDINGS THROUGH A CREATIVE FORMAT

by

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ABSTRACT

Research has shown traditional lab report formats create an impersonal format for students who use the format for science classes. This study examined alternative approaches to presenting lab findings through a more real world applicable approach. The purpose of this study was to test alternatives and analyze student feedback on the effectiveness of the newly designed lab report format. Forty-four freshman Biology students were divided into two groups: traditional lab reporting and alternative lab reporting. The two groups submitted different lab reports based on their grouping over from the end of January to the beginning of April 2015. Results were analyzed through student interviews, feedback surveys, lab report grades, and lab specific questions on unit exams. Although statistical analysis of the project data showed no significant difference between the traditional and alternative lab report methods, this project suggested value in challenging the way teachers approach formal lab report assignments.
INTRODUCTION

Glenview, Illinois is a predominantly affluent northwest suburb of the greater Chicagoland area. The estimated median household income for 2012 was $99,089, yet the percentage of low-income students was at a 19.9% during that very school year. This statistic alone shows the polarizing disparity we see in the 2,700+ students at Glenbrook South High School. When driving through Glenview, it is typical to see neighborhoods with sprawling estates and then drive to the outskirts of the unincorporated areas where public housing is the norm. According to the 2014 Illinois State Board of Education Report Card, Glenbrook South High School’s student demographic consisted of 73% Caucasian, followed by 16% Asian, 7% Hispanic, and 4% Other.

Academics and extracurricular activities are a huge emphasis in the culture of this school. Teachers, parents, and administration alike, all strive to produce “top tier graduates” every year. Students frequently arrive at school at 5:00am to go to an athletic practice so that they can attend a review at 7:00am for an upcoming test. Students also frequently go to school on the weekends to attend an Advanced Placement reviews or stay after school regularly for several hours to receive additional help regardless of class or academic standing. This academically rigorous culture is evident in the lessons and activities in the classroom as we have lower level freshman biology students create cell cultures and regular level biology students run gel electrophoresis tests.

Teaching & Classroom Environment

Regardless of the location of the school or the subject of the course, there is an underlying expectation for students in science to develop a certain level of competency in
how they reflect on the content. Teachers utilize many different formats to have students display their reflective understanding of their learning and experiences in the classroom. One of the most common formats is in the form of a scientific lab report. The style of writing in a scientific lab report is initially unusual to students. The objective style of consistent connection to evidence is a far cry from the colloquial mannerisms they have been so accustomed to. This creates an educational chasm. On one side, there are science teachers, who have for years, used the lab report model as a means to assess understanding. On the other side there are students who are using an unfamiliar format to display this deeper understanding of the content, which results in a true lack of personalization and real world application to the content.

Regular level Biology students at Glenbrook South High School appear to struggle in acclimating themselves to the scientific style of writing. I suspect the reasoning to be two fold. First, freshman students have been conditioned to write in a colloquial and subjective manner, where opinions are emphasized and evidence is optional. Second, assessment at the middle school level is primarily recall tests, projects, and presentations. Students go into high school without any previous exposure to the scientific lab report format and thus it becomes intimidating. The science department at Glenbrook South High School places an immense emphasis on students’ abilities to apply the content learned.

Focus Question

For my action research project, I investigated alternative formats to the traditional lab report to create alternative avenues for students to fully display their understanding of
the content learned through laboratory experiments. The alternative method encouraged students to present their findings through a format where they are given a specific role and need to present it to a specific audience. For example, after collecting data and concluding results from a pill bug preference lab, a student then presented their findings as a children’s book author to an audience of fourth graders. In another assignment, students who completed the stem cell research simulation lab presented their findings as an oncologist, specializing in treating patients with leukemia, to patients by using an infomercial addressing questions about receiving a stem cell transplant. Students were given examples and templates of role-audience formats to select from to better assist them. The purpose was to allow personalization of content and also to show examples of real world ways experimentation could be applied to their lives. The primary research questions of this project were:

1. What are my biology students’ initial understanding and proficiency of scientific writing?
2. What are my biology students’ initial attitudes towards traditional lab reports?
3. Are my students able to realize the real world application of this alternative format?
4. Did the new lab report format allow for better display of student understanding of the content and laboratory?

CONCEPTUAL FRAMEWORK

Laboratory experiments have always been synonymous with science classrooms. They have long been the summative pinnacle of applying learned content and knowledge.
It is suggested that, “if designed properly, the science laboratory has the potential to play an important role in attaining cognitive skills such as scientific thinking, inquiry skills as well as understanding the process of scientific protocols… communicating and defending scientific arguments.” (Hofstein, Shore, & Kipnis, 2004). Furthermore, the presentation of experimental findings through a laboratory report has followed the experimentation process as a means of assessment within the science curricula for as long as labs were used in the classroom.

Educators have used laboratory reports to assess summative understanding, yet often times, teachers often use reports without any clear thought out purpose (Haagen-Schuetzenhoefer, 2012). Ideally, reports should be the well-prepared culmination of not only student understanding, but also the educator’s design to help affirm importance and significance of the laboratory to the content being learned. Yet as research has found, this is often not the case. “Ritualized and restricted lab procedures leaving hardly any opportunity for students to engage individually frequently results in poor quality lab reports and moderate learning processes” (Haagen-Schuetzenhoefer, 2012, p. 430). Simply put, when asked, students do not understand the purpose and relevancy of reporting restrictive experimental findings in an irrelevant traditional format.

Considering the sheer complexity of changing restrictive lab procedures, this action research project focused more specifically towards improving the latter issue of enhancing the reporting experience. The underlying challenge with traditional laboratory reports is students find the format and style very “unnatural” and “exclusive” to a science classroom. The justification of the traditional format relies on its effectiveness to assess
students’ understanding of an experiment and also to promote the relevancy and application of science concepts. However, if students have difficulty realizing the value of learning to write in a laboratory report style beyond an assignment grade, then what can be done to enhance the laboratory reflection, while maintaining the assessment component? An alternative format for laboratory data presentation was explored to further benefit the students’ understanding of the content and to enhance perceptions of writing in science (Brydon et al., 2010).

To remedy the “unnatural” and “irrelevant” stigma traditional laboratory reports have, the target audience of the report was changed from the teacher to another group (Hofstein, et al., 2004). The students took on a specific “role” and reported their data to a target audience as means of explaining their experimental findings. Research states that there are distinct benefits of writing to audiences other than teachers (Gunel, Hand, & McDermott, 2009). Changing the dynamic in the presentation format elicits a higher level of motivation and understanding. This is because students need to take their results of their experiment and then translate the language of science into a comprehensible, everyday language. In order to complete this degree of translation, students must have a deeper understanding of the content and conclusions drawn from the laboratory. Through this translation, students must think about and present the material in a fashion most appropriate to a particular audience (Hand & Prain, 2006). As a result, connections between concepts are strengthened, objectives are elaborated upon, and the important element of personalization is utilized because “if learners are able to construct relations
both within and between different representations, they can acquire a deeper understanding” (Seufert, 2003, p. 227).

Scientific writing is essential to developing a deeper understanding of science (Dianovskyy & Wink, 2012). What the traditional form lacks is the foundational element of true ownership of the product. To enhance the overall experience, the alternative method looked to highlight that area while still maintaining the academic rigor and integrity brought forth by a traditional report. Research has also indicated when students are placed in situations where argumentative writing is encouraged, “they tend to use multiple modal representations to explain their ideas” (Chen, 2013). This further enhances their understanding as they seek different ways to present the same information.

It was also found that students who use alternative modes in their written text were more successful on unit assessments (McDermott & Hand, 2013). Thus, for this project, a format was created where application could be explicitly experienced and then used in summative writing assessments. In turn, students could potentially find a more robust level of ownership of the objective.

Studies, such as one by Midgeffe, Haria, & MacArthur (2008), have shown when scientific writing is effectively implemented, students exhibited evidence of metacognitive thinking. They are then able to “think critically and logically to make the relationship between evidence and explanation” (National Research Council, 1996). Writing incorporates another layer of dynamic learning in which the students spend more time interacting with ideas and less time interacting with the apparatus (Gunstone, 1991). The practice of blending several complex ideas including prior knowledge, collected
data, and researched rationale allows for students go deep into a level of understanding that becomes rich and personal. “By reading well-written scientific text and by endeavoring to write it, students familiarize themselves with the conceptual relations that form the basis of real scientific understanding” (Glynn & Muth, 1994). In this situation, the students can learn to cross borders between specialist and more popular readerships, which results in students who display much greater understanding and reasoning skills (Hand & Prain, 2001). “Such writing can also develop student’s strategies for self directed learning of science and provide positive affective engagement with science for all students (p. 742).”

**METHODOLOGY**

Through this action research project, students had an opportunity to display their understanding of the content learned in the laboratory in a real world applicable way. During the project, I taught two regular Biology courses. Thus, the research project was set up as a comparison between traditional and alternative methods. The traditional method class was the comparison group and the alternative method class was the treatment group respectively. The students in the comparison class continued writing traditional lab reports. The treatment group was expected to present their summative lab findings in the new alternative format. The treatment group also continued to report all summative lab findings in this manner during the full duration of the data collection period. Both groups completed three reports for specific labs during the span of the research project. The specifically targeted labs were: Genetic Pedigree Lab, Evidence For Evolution, and Bread Mold Investigation (Appendix A-C).
As we were on the block schedule, I saw two different sets of students every other day. Conveniently for this action research project, I taught Biology the third block of both days, which meant both groups had lunch before my class. This allowed for an additional layer of control between variables.

Participants

The comparative group consisted of 24 students, 10 males and 14 females. Twenty-three of the students were freshman, and one was a sophomore. When compared to the treatment group, this comparative group was more vocal and expressive in classroom interaction. However, they were also consistently scored 2-3% lower on first semester unit tests than the treatment group.

The treatment group consisted of 22 students, of which only six were males. Similar to the comparative group, all students were freshman with the exception of one sophomore. Although quieter than the comparative group, they consistently performed better on unit tests. However, when it came to first semester lab report grades, both groups were similar in average scores. The comparative group scored an average of an 83% compared the treatment groups 82%. Both groups were part of the same general Biology course offered at the high school, thus placement of the students into the respective classes was based on the same criteria.

Intervention

During the first semester, both sections had already completed four traditional laboratory reports. Those laboratory reports were scored based on a specific grading rubric shown in the Lab Write Up Format (Appendix D). At the time when this
alternative format was introduced, all students, including the treatment group, had a clear understanding of what was expected from a traditional laboratory report because of a semesters experience in writing using the traditional format. Thus, they were capable of justly reflecting their opinions on the traditional method in its effectiveness to display understanding through surveys and interviews that were conducted before the intervention and upon the completion of the data completion period. The comparative group continued to follow the traditional model.

The treatment group was given an alternative opportunity to report their data found in the laboratory experiment. Each alternative format report focused on a specific role the students had to become and thus relay their findings to a specific role audience report outline (Appendix E). For example, in the third and final report of the research project, students investigated the rate of mold growth on bread. Students were to change a single variable of a controlled model to see the effects on mold growth. While the comparison group continued to report their findings through the traditional format, the treatment group was given the option of presenting their findings as local health officials through means of a Public Service Announcement. The treatment group’s primary objective was to inform the public how different variables may enhance or reduce the amount of mold growth on their bread. The treatment completed the same experiment and collected same means of data as the comparison group. The only difference was instead of following the standard Lab Write Up Format (Appendix D), the treatment group created the suggested public service announcement to present their findings following the Role Audience Report Grading Rubric (Appendix F).
For each alternative method opportunity, students were given the freedom to follow the suggested alternative template or generate their own role-audience format as long as the format was pre-approved by me in order to ensure quality of focus. This further allowed the personalization of the assignment.

**Data Collection**

Students in the treatment group took a quiz before the first alternative report in order to assess their understanding of the structure of a traditional laboratory report. The comparison group took the same quiz. The Pre-Intervention Lab Report Quiz (Appendix G) assessed students on their basic understanding of traditional lab report formats. Students had to accurately explain the purpose and importance of various report elements such as the claim and reasoning. The quiz was administered as an indicator, along with their first semester traditional laboratory report grades, to better understand students’ perceptions and opinions of the traditional report format. Additionally, students were able to express their personal feelings and reflections of their first semester traditional reports through a Student Pre-Intervention Survey (Appendix H). The survey was issued as an opportunity for students to voice their attitudes towards the traditional format on a non-graded platform.

Both formats focused on the students’ ability to effectively present their findings with substantial evidence and reasoning. Thus, the grading rubrics of both formats placed the greatest amount of importance in the conclusion portion of the report. This was intentionally done to create parity between formats. Rubrics were consistent throughout the data collection period.
At the end of the data collection period (January-April 2015), ten students were chosen from the alternative report class to be interviewed about their experiences. Two students were selected from each letter grade tier (“A”-“F”) based on the cumulative average of all three reports. They were asked questions specific to their projects as well as the format overall using the R.A.R. Interview questionnaire (Appendix I). The purpose of the post project interviews was to identify students’ attitudes towards the new format and collect feedback to its effectiveness. They were reminded that their feedback was voluntary and had no bearing on their standing in class.

As the teacher grading both formats using the previously mentioned rubrics, I primarily focused on the students’ ability to connect the experimental findings to the content learned in class. I evaluated if students understood the bigger picture to why their results came out to what they were, and if they were not as expected, how they used research to refute or support their initial claims.

The Data Triangulation Matrix (Table 1) exhibits the different data collection methods used throughout this action research project pertaining to specific research questions, which were asked and analyzed.
Table 1

Data Triangulation Matrix

<table>
<thead>
<tr>
<th>Focus Question:</th>
<th>Data Source 1</th>
<th>Data Source 2</th>
<th>Data Source 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary Question:</strong> What format best displays students’ understanding of the connection between content and laboratory experiment?</td>
<td>First Semester Lab Report Grades</td>
<td>Alternative Method Report Grades</td>
<td>Student Reflections</td>
</tr>
<tr>
<td><strong>Subquestion 1:</strong> What are my biology students’ initial understanding and proficiency of scientific writing?</td>
<td>Pre-Intervention Survey</td>
<td>Quiz</td>
<td>First Semester Lab Reports</td>
</tr>
<tr>
<td><strong>Subquestion 2:</strong> What are my biology students’ initial feelings towards traditional lab reports?</td>
<td>Pre-Intervention Survey</td>
<td>Student Reflections in Journals</td>
<td>Student Interviews</td>
</tr>
<tr>
<td><strong>Subquestion 3:</strong> Are my students able to realize the real world application of this alternative format?</td>
<td>Student Reflections</td>
<td>Teacher Reflections</td>
<td>Student Interviews</td>
</tr>
<tr>
<td><strong>Subquestion 4:</strong> Did the new format allow for better display of student understanding of the content and laboratory?</td>
<td>Test Questions based on those specific labs</td>
<td>Report Grades</td>
<td>Reflective Survey</td>
</tr>
</tbody>
</table>

**DATA & ANALYSIS**

Over the course of three months, data was collected from both the comparison and treatment group. The collected data ranged from the qualitative to the quantitative and from the objective to the subjective, but still focused around the four main research questions. The overarching research question centered on the students’ performance between both formats: *What format best displays students’ understanding of the connection between content and laboratory experiment?*
Student’s Initial Understanding of Lab Report Format

To create a baseline for comparison, the initial understanding and proficiency in scientific writing of the biology students was determined by means of a quiz and reviewing previous report scores. Over the course of one semester, there were three lab reports, which were assigned to emphasize this skill and learning goal. However, students consistently struggled and voiced their displeasure in the “relevancy” of the report format. During the first semester, the treatment group students averaged 72% (n=22, SD=9.66) on their lab reports. The greatest area of weakness was in their conclusions. In the conclusions students are asked to make claims, provide evidence for their claims and most importantly be able to rationalize their findings. As noted in the Lab Report Rubric (Appendix D), students are asked to “connect the results to relevant biological concepts and characteristics of life” and “relate results to personal experiences by including statements like, ‘this makes sense/doesn’t make sense because….’ or ‘from my research, I found….’.” In these portions, a significant portion of these students, 37% (n=22, SD=9.66), were not able to make accurate connections between the evidence and the claim and often times made inaccurate or exaggerated connections in their reasoning portion. This was emphasized in the Pre-Intervention Survey taken by the students. Eighteen out of the twenty two students felt they were not able to better understand the content through writing a traditional lab report. Many expressed the same concerns, as one student noted, “not understanding the point of them.”

A quiz was initially administered to all the students to gauge their current understanding of science writing components (Appendix G). An average score of 76.8%
(N=46) on the quiz and an 84% (N=46) on the conclusion specific questions showed there was a foundational level of understanding the components of a conclusion across both groups. Thus the issue was not if they knew ‘what’ the elements were, but moreover ‘why’ the combined pieces was important to understand. The challenge of teaching deeper understanding through lab report writing was to help students understand the deeper relationship between data results and their daily lives.

**Student Attitudes Towards The Traditional Method**

Beyond the lackluster grades from first semester grade reports, there seemed to be student dissatisfaction in the lack of traditional lab reports’ abilities to further enhance a deeper understanding of the content. Thirty out of forty-six students mentioned in some form that there was “little to no relevance” in how they could apply what they learned from writing traditional lab reports to their daily lives. For example, one student stated, “I feel lab reports are designed to present teachers an easy way to grade things, but as a student, I really don’t understand how writing one will help me understand things better.” Another student went on to say, “Lab reports are more for a grade than to help me see science in [my daily] life.” The few positive comments centered on the idea that learning how to write lab reports were beneficial to their career goals. A student stated, “It gives me needed practice for when I go to college and take science courses.” Another student stated, “I heard you write a lot of lab reports in Chemistry and Physics so it is good practice for me now.” Although positive, those comments lacked the true heart of why science teachers in my department assign lab reports. It was clear, there was an obvious disconnect between students and the educational value in lab reporting. Additionally, the
overall Pre-Intervention Survey showed consistent frequencies in the less favorable categories. The responses for the first question from the Pre-Intervention Survey are presented in Table 2. Table 3 summarizes responses for the second question of the same survey.

Table 2
*Pre-Intervention Survey Responses for Question One*

<table>
<thead>
<tr>
<th>Scale</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Absolutley</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency (N=46)</td>
<td>9</td>
<td>26</td>
<td>8</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**Question:** Did you feel like you were able to fully display your understanding of a lab through a traditional lab report?

Table 3
*Pre-Intervention Survey Responses for Question Two*

<table>
<thead>
<tr>
<th>Scale</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>It was essential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency (N=46)</td>
<td>9</td>
<td>19</td>
<td>12</td>
<td>5</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

**Question:** Did you feel like you were able to better understand the content because of writing a lab report?

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**Realizing Relevance With Treatment**

After analyzing all the post-exit interviews, it was noted that the higher scoring students in the treatment group felt a difference in the two styles of reporting. Five out of the eight randomly interviewed students expressed a higher confidence level in the alternative method. For example, one student said, “Making a [Public Service Announcement] made it clear to how a lab in class relates to the real world.” In this lab, students ran tests to see what variables inhibited or prohibited the growth of mold on bread. As the treatment group, students then created Public Service Announcements for
the general public about preventing mold growth on food. This student was able to make the connection to how labs in class could be modeled in the real world and have meaningful application to the general public. Another student stated, “It was much easier to realize why this stuff was important and relevant at all.” The student was referring to the learning objective of connecting the content to everyday life.

The conclusion portions of the lab reports became quantifiably lengthier and more detailed in the alternative format. Although the quantity of words in the section is not a sole indicator of improvement nor quality, it is worth noting that the average number of words for the conclusion was significantly more in the treatment group (486 words) to the comparison group (232 words). The increased word count showed a greater depth in explanation and connection to the content.

In both cases the class experiment these conclusions were based on was the same. Students exhaled into a bromothymol blue solution until the carbon dioxide created an acidic solution, causing the solution to change colors. Then, they did a physical activity and tested their rate of cellular respiration through the same process. However, what set apart the conclusions was the treatment group student’s ability to personalize the lab experiment and create a format in which she had to use the same data for real world applicable purposes.

The following two quotations are excerpts from conclusions written by two different students, one from each group, that had an overall grade of a ‘B’ in the class. They were chosen as comparisons to show they were proficiently achieving in the classroom at a similar level. The first quotation shows an example of a comparison group
conclusion, which lacked a display of deeper understanding. The student had a basic framework of the content, in this specific case, cellular respiration; however, deeper connections to content were never expressed.

This makes sense because, when we exercise or run, our bodies need more oxygen. The more oxygen we inhale, the more carbon dioxide we exhale. Because we exhale more carbon dioxide when exercising, then the rate of cellular respiration is faster, because a product of cellular respiration is carbon dioxide. This data is reliable because as we ran, there was a significant rate difference from when we were resting.

In comparison, the second quotation shows a segment of a conclusion of a treatment group in which the student displayed a deeper understanding of the content. The creative format she chose was to create a public health pamphlet of the benefits of proper eating before and breathing during and physical exercise.

The data collected in the study showed BTB turned yellow the fastest in active participants. This makes sense because after any type of physical activity, people breathe a lot faster and harder while resting. This means that more carbon dioxide is being released after physical activity. This is why it is so important to exhale completely when exercising because having a good breathing pattern ensures your working muscles are getting enough oxygen. In the “real world”, athletes work so hard that their bodies need to go into fermentation (fermentation is releasing food molecules by producing ATP when oxygen isn’t present). They could probably turn the BTB yellow in under a second!
The student went on to explain the pathway of oxygen and carbon dioxide during breathing and how that connects with the steps of cellular respiration.

When asked in interviews, treatment group students mentioned how it was easier to make connections to the real world. One of the student reflections said, “It was much more straightforward for me to brainstorm connections because the whole project was based on doing so”. Another wrote:

I knew what you wanted me to mention in the first semester [comparison] reports, but it was sometimes hard to write it what I was trying to say. The new format [sic] makes it easier because the project is built on applying it to real life.

I observed many students brainstorming and debating possible formats for each report.

The Treatment And Effect on Understanding

When interpreting the scores of test questions based on lab specific questions from unit exams (Appendix J), the data revealed a four percent increase in the treatment group. The control group (N=24) scored an average of 74.55%, with a standard deviation of 7.10, while the treatment group (N=22) scored an average of 78.09% with a standard deviation of 6.07. However, according to t-test analysis results, it was not statistically significant, t(44)=1.855, p=.0702. Figure 1 shows the scores of both comparison and treatment groups on those specific test questions. It is clear that the treatment group performed better than the comparison group collectively.
Figure 1. Scores of both groups on lab-based questions on exams, \((N=46)\).

When asked in the interview some students stated they simply thought back to their projects to help them realize the connections the test questions asked of them. The overall grades for the lab reports saw smaller improvements. There was a 2.9% increase in overall lab scores from the comparison group to the treatment group. According to t-test analysis, it was considered to be not statistically significant, \(t(44)=1.6092, p=0.1147\). The control group reported an average of 78.17 (SD= 6.15) and the treatment group reported a score of 81.05% (SD=5.89). Figure 2 shows the overall grades of the lab reports between the comparison and treatment groups. The treatment group collectively performed better in this assessment than their comparison counterparts.
Figure 2. Comparative scores for lab report assignments, (N=46).

INTERPRETATION AND CONCLUSION

The initial proficiency of scientific writing of all the students in this research project was less than satisfactory based on the previous lab semester’s reports, pre-intervention surveys and quiz. Additionally, students had negative attitudes towards the traditional lab report format as they failed to see the relevance in learning and practicing the format and the effect it has on their daily lives. Thus, the framework of the alternative project provided a more explicit avenue for students to realize the application to the real world.

Students were better able to make real world connections using the alternative method than they did when they used the traditional method. This isn’t to say every treatment
group student was able to do so, but there was improvement in the quantity of students compared to the comparison group and also the quality of writing done by the treatment group. The alternative method gave a clear and distinct format for students to see how classroom work was exampled in today’s society. The students’ abilities to make those necessary connections to evidence and real world relevancy became much stronger when the alternative method was implemented.

Anecdotally, I was satisfied with my findings; however, I was rather disappointed in the lack of statistical significance to support personal interpretations. I understand the sample size was small and the window in which the data collected was short; however, I had expected a higher volume of stronger opinions on surveys and a greater gap between assessment scores. The statistical insignificance doesn’t mean there was no value in the difference between groups, just that there wasn’t enough to support my initial claim. I had originally expected the gains from lab reports to be far more significant than of the test grades due to the fact the format was more familiar and preferable to the students. However, the data shows the overall change was minimal.

A possible explanation for the less than expected margins could be because of habits and perceptions the students formed throughout the prior lab reports. For example, if a student has had a history of devoting low amounts time on traditional lab reports and receiving acceptable grades, the level of attention and preparation would be similar as the student knows what the outcome could roughly be in correlation to the amount of time devoted to the report. Because of such extraneous variables, there was not enough evidence to state there was any statistically significant improvement in the grades.
To a certain extent, I am encouraged by the results because a continuation and/or expansion of the research project may lead to more significant results. The gains, albeit small, were seen as students responded more positively with the treatment approach than the original method. Students seemed to make more genuine connections and appreciate the intent of the labs. In the exit interviews, only two students from the treatment group expressed a neutral or negative attitude towards the new method. One stated, “I can see how it was supposed to help us see it in the real world, but it was harder for us to do”. This student’s quotation highlights the underlying goal of deeper thinking where the student is asked to develop an argument. Developing an argument implies there is a baseline of knowledge and understanding of the content. It also implies an argument can be developed to persuade the specific intended audience, which is critical for the effective learning (Berland & Forte, 2010).

The purpose of this study was to find a way in which students still were able to display their understanding of the lessons learned from a lab and do so in an applicable manner. I believe implementing this particular treatment created that opportunity for the students, which in turned, as noted by the data, resulted in overall improvement. As previously mentioned research such as the works of Seufert (2003), Hand (2006), and Prain (2003) stated true realization of applicability comes when personalization of the content is fully harnessed. Even with the lack of statistical significance, I am encouraged as it may be a preliminary step to seeing desired results as continued implementation and expansion of the treatment method occurs.
VALUE

In the ever-changing landscape of science education, there has been a strong recent push to shift the focus from content laden to process-oriented curriculum that challenges students to ask “why” and “how”. The Next Generation Science Standards, which spearhead this movement, has been adopted in 26 states in the country, including my home state of Illinois. The newly framed standards emphasize the creation of environments in which students find reason to connect with the curriculum. The connections made in my treatment group paved the way for greater interest and understanding in the lessons. My students were able to answer “why we were doing the lab” and “how it applied to our lives”. This deeper and more robust understanding of lab purpose allowed for greater retention and appreciation.

After the data collection period had ended, I implemented the alternative treatment method to the comparison group, and they too were responding in a very similar fashion to how the treatment group responded originally. Students mentioned it was a “refreshing alternative” that was “long overdue”.

The nature of science relies on inquiry and unique perspectives. In order for students to each a lens to see things in such a way, they need to be given a direct reason to personalize or give importance to a topic. This study has taught me the importance of placing relevance to how I not only design labs, but my curriculum as a whole. Even if I am required to teach a specific concept or content that initially may seem to have little relevance, this study has taught me the valuable lesson of finding that unique perspective finding meaning and application for it will pay great dividends to the overall student learning experience.
REFERENCES CITED


APPENDIX A

ALTERNATIVE METHOD OPTION LAB 1: GENETICS
Genetic Pedigree Lab

Who’s The Real Son?

Cindy is happily married to Cody. They have a son together, Paul, whom they spoil, as he is their only child...or that’s what they thought. One day a man named Frank, who is similar to Paul’s age, shows up at their front door claiming to be their real son. He claims he was switched at birth with Paul at the hospital and as a result was forced to live abroad until now. Confused, shocked, and disturbed, Cindy began to investigate Frank’s claims. She had everyone in her extended family take a blood test and this is what she found out.

First the family tree:

Cindy’s grandpa, Rob, is married to Julie. Rob and Julie have four daughters: Rachel, Linda, Cassie, and Stacy. Rachel married Bill and have a son, Andy. Stacy married Brian (who has a twin brother Stephen) and had a daughter Cindy. Cindy is married Cody and have a son (Paul or Frank?)

Based on the given information:
- Build a family pedigree
- Complete the blood types chart below by testing given samples
- Decide who Linda’s real son is.

FILL CHART BELOW:

<table>
<thead>
<tr>
<th>Name</th>
<th>Blood Genotype</th>
<th>Blood Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rob</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Julie</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stacy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cassie</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linda</td>
<td></td>
<td></td>
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<tr>
<td>Rachel</td>
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<tr>
<td>Bill</td>
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</tr>
<tr>
<td>Andy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brian</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stephen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brian’s mom</td>
<td></td>
<td></td>
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<tr>
<td>Brian’s dad</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cody</td>
<td>I^B I^B</td>
<td></td>
</tr>
<tr>
<td>Cindy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paul</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Blood Test Results

<table>
<thead>
<tr>
<th>Name</th>
<th>A Allele?</th>
<th>B Allele?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rob</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Julie</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stacy</td>
<td></td>
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<tr>
<td>Cassie</td>
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<td>Linda</td>
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<tr>
<td>Rachel</td>
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<td>Bill</td>
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<td>Andy</td>
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<tr>
<td>Brian</td>
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<tr>
<td>Stephen</td>
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<tr>
<td>Brian’s mom</td>
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<td>Brian’s dad</td>
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<tr>
<td>Cody</td>
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<tr>
<td>Cindy</td>
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<tr>
<td>Frank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paul</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FAMILY PEDIGREE

Cindy & Cody’s real son: __________________________

Supporting Evidence:

Pedigree Lab Part 2

Objective:
Using the samples, materials, pedigree, and research information given at your station, you and your group need to determine the possible outcomes of the genetic cross (between A and B) and then accurately identify which of the three tested genetic diseases is autosomal recessive, sex-linked dominant, and sex-linked recessive.

RESULTS:
Genetic Disease #1 ________________________________
Genetic Disease #2 ________________________________
Genetic Disease #3 ________________________________

*You will be writing a formal lab report for this lab.*
APPENDIX B

ALTERNATIVE METHOD OPTION LAB 2: EVOLUTION
Evidence for Evolution

When Darwin laid out his hypothesis and published On the Origin of Species, we had no knowledge of genetics, molecular biology, or any modern understanding of life on earth. While evolution and Darwin's ideas about natural selection are considered to be theories, much scientific research has sought to provide support for this theory. This evidence of evolution includes, but is not limited to, studies in the areas of biochemistry, embryology, anatomy, and paleontology.

In this investigation, you will examine different pieces of evidence which provide support for Darwin's basic ideas about evolution.

Those types of evidence include: Molecular Evidence, Fossils, Comparative Embryology, Comparative Anatomy (Vestigial, Homologous, and Analogous Structures), and Current Research on Natural Selection.

Molecular Evidence

1. Do you think a mouse will be more similar to a chicken or a whale? Explain your reasoning.

Hox genes are responsible for laying out the basic body plans for many animals including humans, flies, worms, and mice. These sequences instruct the developing embryo on where to place the head, tail, legs, etc. Since many animals have Hox genes, examination of these genes can provide evidence for evolution and contribute to our understanding of how species are related to each other. Examine the small sequence of DNA for the Hox gene in the following animals: mouse, whale, and chicken.

2. What percentage of the nucleotides in the whale's DNA are different from the mouse? ___% (HINT: Divide the number of nucleotides which differ by the total number of nucleotides. Multiply by 100)%

3. What percentage of the nucleotides in the chicken are different from those of the mouse? ___% 

4. On the basis of molecular similarities, do you think the mouse is more closely related to the whale or the chicken? ___%
Cytochrome c, an enzyme found in virtually all organisms, is needed for the release of energy from food. The amino acid sequences in this protein were compared for several different animals and the number of differences found is used to infer degrees of relationship.

Find the human, rhesus monkey, kangaroo, snapping turtle, bullfrog, and tuna on the "Amino Acid Sequences in Cytochrome-C Proteins from 20 Different Species" chart provided. Compare the human amino acid sequence with each of these five animals by counting the number of times an amino acid in the cytochrome c protein is different from the amino acid in that same position of the human sequence. Record your data in the tables below.

<table>
<thead>
<tr>
<th>Animal</th>
<th>Number of amino acid differences from humans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhesus monkey</td>
<td></td>
</tr>
<tr>
<td>Kangaroo</td>
<td></td>
</tr>
<tr>
<td>Snapping Turtle</td>
<td></td>
</tr>
<tr>
<td>Bullfrog</td>
<td></td>
</tr>
<tr>
<td>Tuna</td>
<td></td>
</tr>
</tbody>
</table>

A cladogram is a diagram that shows the relationship of selected animals based on their anatomical characteristics. Examine the cladogram to the right. The squares on the diagram represent a specific characteristic and when it evolved. For example, kangaroos, rhesus monkeys, and humans all have mammary glands; however, a kangaroo does not have a placenta while the human and rhesus monkey do.

5. Practice reading a cladogram!
   a. What characteristic(s) is shared by ALL of the animals in the cladogram?

   b. What characteristic is found in bullfrogs, snapping turtles, kangaroos, rhesus monkeys, and human but is NOT found in tuna and lamprey?

   c. Based on the evidence presented in the cladogram above, which two animals are more closely related: a bullfrog and a tuna or a bullfrog and a human.
6. Use the cytochrome c data from the previous page to record the total number of amino acid differences between humans and each animal shown below. Record the number in the hexagon below the arrow.

7. Does the data from the amino acid sequence generally agree with the anatomical data that was used to make the cladogram? Explain your answer.

8. Based on the molecular data, how does the "human-monkey" relationship compare to the "duck-chicken" relationship?

**Fossils**

The term fossil comes from the Latin term for "dug up". A fossil is any evidence that an organism once lived on earth. Fossils may include bones, teeth, shells, leaf imprints, or footprints. Entire organisms may also be preserved such as the recent discovery of a wooly mammoth in ice and mosquitos which have been preserved in amber.

The study and comparison of exposed rock layers or strata in various parts of the earth led scientists in the early 19th century to propose that the rock layers could be correlated from place to place. Locally, physical characteristics of rocks can be compared and correlated. On a larger scale, even between continents, fossil evidence can help in correlating rock layers. **The Law of Superposition**, states that in an undisturbed horizontal sequence of rocks,
the oldest rock layers will be on the bottom, with successively younger rocks on top of these. This helps geologists correlate rock layers around the world. This also means that fossils found in the lowest levels in a sequence of layered rocks represent the oldest record of life there.

By correlating fossils from various parts of the world, scientists are able to give relative ages to particular strata. This is called relative dating. Relative dating tells scientists if rock layer is older or younger than another. This would also mean that fossils found in the deepest layers of rocks in any area would represent the oldest forms of life in that particular rock formation. Certain fossils are typically found only in particular rock units and are found in many places worldwide. They may be useful in guiding fossils in determining the geologic time scale. By using this information from rock formations in various parts of the world and correlating the studies, scientists have been able to establish the geologic time scale.

Refer to the strata node provided.

9. Using the law of superposition, list the index fossils from your rock strata node in terms of oldest to youngest.

10. An unknown fossil in Eastern Europe was found in rock layers containing 50 flint flakes. Approximately how old could you estimate this fossil to be? What era would you place this fossil in?

It was recently discovered that the scientist responsible for organizing fossils at the museum has been sleeping on the job. This fossil recently found boxes of fossils all mixed together. We have been charged with trying to sort out his mess! Use the resources at your station, attempt to determine where you would expect to find these fossils. Arrange them in the target list! At your station, take a picture of your poster and attach a printout of your picture to this b. %

11. What challenges did you face in trying to decide where to place the fossils?

12. Why can the fossil record only provide limited evidence for evolution?


**Comparative Embryology**

As we learned previously, fertilization occurs from the union between sperm and egg. The resultant zygote then begins to divide, forming an embryo. Even during the earliest stage of gastrulation, the embryos of animals from different groups share many characteristics. As comparisons of vertebrate embryos many similarities exist well beyond the initial differentiation. As the embryos grow and develop, they become less and less alike. Therefore, scientists can use the studying embryos to determine how closely related organisms may be.

At your station, you will find several drawings of three stages of embryo development for a fish, turtle, chicken, pig, and human.

13. Make a prediction! Which animals would you expect to have embryos most similar to each other? Give arguments for your reasoning.

Remove the drawings from the envelope and order each animal, try to arrange them in order from the earliest stage of embryo to the latest stage. When you are finished, check your answers and answer the questions below.

14. Examine the embryos in the proper order. What similarities do you observe in the embryos of all of the species? Identify at least two characteristics that can be observed in all of the species examined.

15. Examine the embryo characteristics in the second row. What characteristics would help you to determine which embryo goes with which animal?

16. Based on the evidence presented in this exercise, which animals are most closely related to each other?
Comparative Anatomy – Homologous Structures

There are many examples of anatomical structures that are formed in similar ways during embryonic development. Even though these structures often take on different forms and perform different functions, they share a similar organization of bone structure. These structures are called homologous structures. The existence of homologous structures suggests that the animals share a relatively recent common ancestor.

17. Examine the bones available at your station. What similarities and differences exist between the two bones?

18. Form a hypothesis about which bone you would expect to have greater density.

Measuring Density of Bones

Procedure

1. Use the balance provided to take the mass of each bone. Record it in the table provided.
2. Choose an appropriate graduated cylinder and fill it with an appropriate amount of water depending on the size of your bone. You will be looking to measure the amount of water displaced when the bone is submerged, so it is important that the entire bone will be able to be submerged in the water.
3. Record the initial volume in mL.
4. Place the bone in the graduated cylinder. If necessary, use a probe to ensure that the bone is fully submerged.
5. Record the final volume. See the image to the right.
6. Determine the amount of water displaced by the bone, and record it in the data table.
7. Calculate the density of each bone. Recall that density = mass/volume.

<table>
<thead>
<tr>
<th>Animal</th>
<th>Mass (g)</th>
<th>Initial Volume ((V_i)) (mL)</th>
<th>Final Volume ((V_f)) (mL)</th>
<th>Amount of water displaced ((V_f - V_i))</th>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
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</tr>
</tbody>
</table>

Due to copyright restrictions, the image has been removed.
19. How do your results compare to your hypothesis?

20. Why do you think there is a difference between the densities of these two bones? Be sure to discuss the density in relation to function, the animal’s environment, and the animal’s survival.

21. In general, how would you expect the density of a fish bone to compare to a human bone? Explain your reasoning.

Comparative Anatomy — Analogous Structures

There are also many examples of body structures in animals that are very similar in function and superficially similar in form, however, they develop very differently. These structures are called analogous structures. The evolution of analogous structures and patterns is evolutionarily known as convergent evolution.

22. Consider the three animal figurines at your station: shark (cartilaginous), whale (mammal), and an extinct reptile. Identify physical characteristics shared by the three organisms.

23. Using your understanding of natural selection, explain how these three species evolved to have such a strong resemblance for each other despite the fact that they are not closely related.
24. Provide three different examples of pairs of animals not mentioned above which exhibit analogous structures:

<table>
<thead>
<tr>
<th>Example</th>
<th>Animals</th>
<th>Which structures are analogous?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 1</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Example 2</td>
<td>%</td>
<td>%</td>
</tr>
</tbody>
</table>

**Comparative Anatomy of Vestigial Structures**

Vestigial structures refer to parts of an organism which have lost most or all of their original function in the course of evolution. The existence of vestigial structures provides clues to the evolutionary origins of species because vestigial structures are remnants of the species' ancestors.

25. Examine the diagram of a whale skeleton. Although a whale does not have legs, you might notice the presence of a small pelvis and femur. These bones are considered to be vestigial. What does the presence of these bones suggest about the whale's evolutionary history?

26. What structures might be considered vestigial in humans? Complete the following table:

<table>
<thead>
<tr>
<th>Name of Structure</th>
<th>What do you think our ancestors used this structure for?</th>
<th>Why don't we use this structure anymore?</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>%</td>
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</tr>
</tbody>
</table>
Recent Research as Evidence for Evolution

Evolution is very difficult to prove because much of the evidence requires piecing together bits and pieces of a puzzle which is missing many pieces. Further, the evidence of evolution is slow and very long periods of time. However, research done in the 1970’s by Rosemary and Peter Grant at the Galapagos Islands, known as Daphne Major. Every year, they collected data on the Galapagos finch population. In medium ground finches (Geospiza fortis) and small finches (Geospiza scandens), they fed 100% of 1977 and 1978, they recorded a period of 50 days in which there was no rainfall. During this extreme drought, many of the plants failed to produce the small seeds that the medium ground finches were accustomed to. Birds with larger beaks were able to find alternate food sources because they could crack open larger seeds. In addition to feeding strategies, finches tend to choose mates with similar beak sizes.

Examine the data presented at this station and answer the following questions.

27. What is the independent variable in this experiment from Figure 1? __________________________

28. What is the dependent variable in this experiment from Figure 1? __________________________

29. For the statements, indicate WHICH figure(s) support the postulate. Explain why it is supported.
   a. Individuals within population vary in their traits.________________________

   b. Individuals with advantageous traits will survive and reproduce.____________________

   c. Beak size is heritable and passed on to offspring.______________________________

   d. Due to limited resources, there is struggle for survival.________________________

30. Summarize the change in beak size following the drought. Why do you think this occurred?____________________

31. If the early 1980’s saw several years of above-average rainfall, what would you expect to happen to the distribution of beak size? Explain your answer.______________________________
APPENDIX C

ALTERNATIVE METHOD OPTION LAB 3: BIODIVERSITY
Bread Mold Investigation

Background

Centuries ago people treated infections in a rather curious way. They often placed decaying breads, cheeses, and fruits such as oranges on the infection. Although the people did not have a scientific reason to do this, every once in a while the infection was cured. What these people did not know was that the cure was due to a type of fungus, called mold, which grows on some foods.

In 1928, the Scottish scientist, Sir Alexander Fleming found out why this treatment worked. Fleming discovered that a substance produced by the blue-green mold Penicillium could kill certain bacteria that caused infections. Fleming named the substance Penicillin. Since that time Penicillin, an antibiotic, has saved millions of lives.

Have you ever seen mold growing on bread? Bread mold looks like tiny fluffs of cotton. The fluffs are groups of long hyphae that grow over the surface of bread. Shorter hyphae grow down into the bread and resemble tiny roots. The shorter hyphae release enzymes that break down chemicals in the bread. The broken-down chemicals are foods for the mold and are absorbed by the hyphae.

The tiny black spheres on bread mold are spore cases, which produce spores. The spores are carried from one place to another through the air. When the spores land on food, they begin to develop into a new mold.

Due to copyright restrictions, the image has been removed.
Hypothesis
Predict what will happen as a result of your changing one variable in the procedure below. Will bread mold growth (when compared to the class control) be inhibited, promoted, or not affected?

Materials
1 Ziploc Bag
1 Slice of White Bread
Tape
Spray Bottle of Water
Other materials as used (record what & how much you used)

Procedure
Control (demo as a class)
1. Place one slice of white bread in a plastic container
2. Moisten bread with 10 sprays of water
3. Seal container with tape and place in a dark cabinet (at room temperature).

Experimental
4. Follow the same procedure as for the control except change one variable so that you can see how it affects the growth of mold. (Write what you did as this part of step 4.)
5. Observe both the control and experimental bread every day.
6. Record your observations. Be specific and descriptive!

Observations
1. Record your observations every day.
2. Include drawings and/or photographs of your experiment.
*Remember, drawings and photographs are only useful if they are detailed and labeled well enough to be understood by someone who has not actually done the lab.

Conclusion
Was your hypothesis supported or not supported by your data? Why?

Type a formal lab report with your group to discuss your findings.
APPENDIX D

LAB WRITE-UP REPORT FORMAT
Lab Write Up Format
(out of 28 points)

Title: Describes the lab content concisely, adequately and appropriately. Ideally, the title should address both the independent and dependent variables. Titles like “Termite Lab” or “Osmosis Lab Report” are inadequate. (1 point)

Date: The date(s) the experiment was conducted. (1 point)

Purpose: May be a statement or a question. (1 point)

Introduction: A few sentences to provide the reader with the necessary background information needed to design/conduct the experiment and analyze data. Include information about the organism you are working with and/or any concepts or principles that are relevant to your reader. Adequate background information will be a short paragraph and likely require to do some research (3 points)

Hypothesis: Must be stated as an IF…..(independent variable), THEN…..dependent variable. (1 point)

Materials: bullet list format, detailed, quantitates should be listed. (1 point)

Procedure: Numbered, step-by-step format. Describes the procedure used to gather data. Gives enough detail to allow for a repeated experiment by other scientists. Include pictures/ diagrams if necessary. (2 points)

Variables: Identify the independent, dependent, and controlled variables, and control group (if present). (2 points)

Safety: Note and describe all reasonable safety concerns or hazards. Indicate if none are present. (1 point)

Results and Analysis: (4 points)
   Data: Data must be arranged in charts, tables, etc. Graphs should follow if appropriate. Graphs alone are not acceptable. Include labels and titles for graphs and tables.
   Data Analysis: Summarize data in narrative format. Number and answer all analysis questions from the lab (if present) in complete sentences.

Conclusion:
   Paragraph 1- CLAIM (2 points)
   Answer the question posed by your purpose. In other words, now that you have completed the experiment what do you CLAIM to be an answer to your question? Restate your hypothesis and indicate if the hypothesis is supported or rejected based on the data.
   
   Paragraph 2- EVIDENCE (3 points)
   Summarize and interpret the data you collected and how you collected it. Include averages of numerical data. Do not restate the entire procedure, just summarize it.
   
   Paragraph 3- REASONING & EXPERIMENTAL ERROR (6 points)
   Explain how your data supports your claim. Discuss the importance of the experiment and what was learned. Do some research to try to explain your results and if relevant, relate the results to your personal experiences. Include statements like, “this makes sense/doesn’t make sense to me because…” and “from my research…”. Connect the results to relevant biological concepts and characteristics of life. Discuss sources (or possible sources) of experimental error and their effect on data. Address the reliability of the data and what could be done differently to improve it. It is not acceptable to say that everything went perfect. Indicate additional questions brought about by the results or further questions that could be explored.
APPENDIX E

ALTERNATIVE METHOD OUTLINE
Mendelian Genetics Unit  
Name ____________________________________________  
Role Audience Reports

For the next three units we will replace our usual lab reports with Role Audience Reports (R.A.R.’s). For R.A.R.’s, you need to become a specific role and present your lab findings to a distinctive audience. For example, if this was assigned during Unit 1, a possible R.A.R. could have been:

*After collecting data and concluding results from the Pillbug Preference Lab, you will present your findings as a children’s book author presenting the information to an audience of 4th graders.*

For this current Pedigree Lab in our Mendelian Genetics Unit, you will take the role of a geneticist telling the Hoffman Family of the level of risk their unborn child may have to the three genetic diseases the lab investigated. Since the Hoffman’s are not familiar with the scientific terminology, but very interested to know the complete details, you are to clearly explain the data you collected and how you came to your conclusions. If you would like to do a different R.A.R., please have it pre-approve by me before starting your report.

Evolution Unit  
Name ____________________________________________  
Role Audience Reports

For this unit’s R.A.R., create a short story to another episode of Sherlock Holmes. Sherlock and Watson are investigating the claim that “there is no evidence whales were the evolutionary ancestor of land dwelling mammals”. You are to create a short story or comic strip that details Sherlock and Watson’s explanation to the data found from the Speciation Lab to prove your claim. If you would like to do a different R.A.R., please have it pre-approve by me before starting your report.

Biodiversity Unit  
Name ____________________________________________  
Role Audience Reports

For this unit’s R.A.R, you will present your findings from the Bread Mold Lab as local health officials through means of a Public Service Announcement to inform the general public of the best environment to reduce mold growth on food such as bread. If you would like to do a different R.A.R., please have it pre-approve by me before starting your report.
APPENDIX F

ALTERNATIVE METHOD GRADING RUBRIC
Grading Rubric

<table>
<thead>
<tr>
<th>Your Lab: ______________________________</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
<td></td>
</tr>
<tr>
<td>- Background information is sufficiently provided.</td>
<td>_____ / 4</td>
</tr>
<tr>
<td>- Rationale to why specific independent variable was selected was well incorporated into the project.</td>
<td></td>
</tr>
<tr>
<td><strong>Data &amp; Analysis</strong></td>
<td></td>
</tr>
<tr>
<td>- Correct type of data was collected in your experimented</td>
<td></td>
</tr>
<tr>
<td>- The data was properly analysed.</td>
<td></td>
</tr>
<tr>
<td>- The evidence (from analysis) was incorporated and appropriately presented in your project.</td>
<td>_____ / 6</td>
</tr>
<tr>
<td><strong>Conclusion</strong></td>
<td></td>
</tr>
<tr>
<td>- Claim was distinctly stated</td>
<td>_____ / 10</td>
</tr>
<tr>
<td>- Reasoning was sufficient</td>
<td></td>
</tr>
<tr>
<td>- Proper explanation of overall purpose</td>
<td></td>
</tr>
<tr>
<td>- Why the results make sense</td>
<td></td>
</tr>
<tr>
<td>- Additional research to support evidence</td>
<td></td>
</tr>
<tr>
<td><strong>RAFT – Role, Audience, Format, Topic</strong></td>
<td></td>
</tr>
<tr>
<td>- RAFT is well established</td>
<td>_____ / 4</td>
</tr>
<tr>
<td>- Format is consistent with RAFT selected</td>
<td></td>
</tr>
<tr>
<td><strong>Presentation</strong></td>
<td></td>
</tr>
<tr>
<td>- Quality of work</td>
<td></td>
</tr>
<tr>
<td>- Interesting and engaging… don’t be BORING!</td>
<td></td>
</tr>
<tr>
<td>- Professionalism</td>
<td>_____ / 4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>_____ / 28</td>
</tr>
</tbody>
</table>

Comments:
APPENDIX G

PRE-INTERVENTION LAB REPORT QUIZ
Lab Report Quiz
Name_________________________________

1a. What is mentioned in the claim of your lab report?

1b. Why is the claim portion essential to your lab report?

2a. What is mentioned in the evidence of your lab report?

2b. Why is the evidence portion essential to your lab report?

3a. What is mentioned in the reasoning of your lab report?

3b. Why is the reasoning portion considered the most important part of your report?

4. What is the purpose of a lab report?
APPENDIX H

STUDENT PRE-INTERVENTION SURVEY
Lab Report Survey

What was a positive from learning to write lab reports?

What was a negative from learning to write lab reports?

Did you feel like you were able to fully display your understanding of a lab through a lab report?

1 2 3 4 5

No, not at all O O O O Yes, absolutely

Did you feel like you were able to better understand the content because of writing a lab report?

1 2 3 4 5

No, not at all O O O O Yes, it was essential.
APPENDIX I

POST INTERVENTION INTERVIEW QUESTIONS
R.A.R. Student Interview
Student’s Grade In Class: ___________________

Student’s Grade on R.A.R.: ________________

1. Tell me about your experience with the R.A.R. format. What do you like about it? Dislike?

2. How was it different to our traditional report format?

3. Which did you prefer? Why?

4. How do you think the traditional format can be improved to better help you present what you understand about the lab and content?

5. How do you think the R.A.R. format can be improved to better help you present what you understand about the lab and content?
APPENDIX J

LAB SPECIFIC QUESTIONS FROM UNIT EXAMS
GENETICS

45. Mr. Jones, the wealthiest man in the state of Illinois, recently died. Since his death, 3 women have come forward claiming to have a child by Mr. Jones. They are demanding a share of his estate. Can any of the three children be Jones’s?

a. Yes, X’s child could be Jones’s
b. Yes, Y’s child could be Jones’s
c. Yes, Z’s child could be Jones’s
d. No, none of these children could be Mr. Jones’s

Free Response #1

How can genetic screening be beneficial to a couple planning to have a baby?

Free Response #3

How can karyotypes be used to help determine future traits of offspring?

EVOLUTION

Imagine you are a biotechnologist. You have injected chimpanzee blood into a rabbit. The immune system of the rabbit recognized the chimpanzee blood protein as foreign and produced antibodies. The rabbit’s antibodies were then extracted and developed as a serum. When the serum is added to blood samples in different test tubes removed from of a variety of different animals, a precipitate forms. The more precipitate forms, the more closely related the animal is to the chimpanzee. The table below that shows the percentage precipitate formed in this investigation.

<table>
<thead>
<tr>
<th>Animal Species</th>
<th>Percentage Precipitate Formed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gorilla</td>
<td>Very High</td>
</tr>
<tr>
<td>Baboon</td>
<td>High</td>
</tr>
</tbody>
</table>
35. According to the data table, what is the chimpanzee most closely related to?

Free Response #2

You have a friend who says she doesn’t believe in the theory of evolution because there “isn’t enough evidence to support it”. Based on the labs and lessons from the unit, give at least four examples of evidence that support evolution.

**Biodiversity**

Free Response #1

Identify three factors that may inhibit growth amongst molds.

Free Response #2

Make one connection between the importance of researching the diversity of species to the impact it makes to humans.