IMPLEMENTING INTERACTIVE SCIENCE NOTEBOOKS WITH ENGLISH LANGUAGE LEARNERS

by

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DEDICATION

This paper is dedicated to my family, whose continued encouragement and support through the MSSE program kept me motivated to complete what was started. A special thank you to my daughters Ava and Vivienne, for being patient with me while I completed assignments and my wife Amy, for always being there for me.

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ABSTRACT

The primary focus of this study was to answer the question, what are the effects of using interactive science notebooks with English Language Learners? There were 52 students from two sections of biology involved in this study, enrolled at San Ysidro High School, San Diego, California. Students used scientific notebooks throughout the treatment unit and participated in formative assessments that gauged content knowledge. Pre- and Post-tests were given for both non-treatment and treatment units and scores from the treatment tests were compared to notebook rubric scores. There was a positive correlation between notebook rubric scores and test scores. In most cases, students who did well on formative assessments within the notebook performed better on unit tests.

INTRODUCTION AND BACKGROUND

Over the past 11 years, I have taught science at San Ysidro High school, located in San Diego, California. The school opened in 2002 and I had the privilege of working with students in the first graduating class. I have taught a variety of classes, including Biology, Earth Science, Integrated Science, and Advanced Placement (AP) Environmental Science. What makes San Ysidro unique to some of the other schools in San Diego is its proximity to the U.S./Mexico border. Out of the 2,460 students enrolled in the 2014-2015 school year, 94% were Hispanic or Latino. Many of the families in the area were at or below the poverty level, with 67.9% of the students qualifying for free or reduced lunch. Nearly 40% of the students enrolled at San Ysidro were classified as English Language Learners (ELLs), which almost guarantees that every teacher on campus has worked with students who are learning English as a second language (Education Data Partnership, 2016).

The school administration attempted to prepare teachers for instructing ELLs by providing professional development that focused on reading and writing strategies. We were encouraged to incorporate some form of reading and writing daily. In most core classes, this was usually done with short articles, paraphrased text, and various forms of cooperative learning, such as Think-Pair-Share (Lyman, 1987). With all of the training and professional development time spent on these strategies, there was very little to no mention of interactive notebooks to improve reading and writing. I used notebooks with my science students for several years, mainly as an organization tool. As I began to learn more about inquiry-based science, it became clear that the notebook could be used in many ways besides just a place for keeping items organized. A well designed, interactive science notebook can be used to promote observations, encourage creativity, perform data analysis, and develop student reflections. At the same time, for students who are developing their reading and writing skills in English, a content specific notebook can provide further literacy practice.

Since most classes that I taught were in biological sciences, the students were exposed to a large amount of vocabulary and content specific language. Making sense of the terminology can be challenging for many students, especially English Language Learners. The days of rote memorization are a thing of the past and students are required to complete performance tasks that include data analysis, critical thinking and short answer responses. An excellent place to practice these skills is within a science classroom that promotes inquiry. One tool that can help facilitate inquiry-based learning is an interactive science notebook. Students are given opportunities to collect observations, make predictions, test out ideas, collect and analyze data, and draw conclusions. As this information is processed into the notebook, reading, writing, and even oral discussion occur. This idea has led to my focus question, *what are the effects of using interactive science notebooks with English Language Learners?* In addition, the following sub questions will also be addressed:

1. Can the use of science notebooks help close the achievement gap between English Language Learners and students who are classified as Fluent English Proficient?
2. Will various writing assignments in science improve student engagement and performance?

CONCEPTUAL FRAMEWORK

In the recent past, science education has taken a back seat to other core subjects like mathematics, reading, and writing, due to the requirements placed on schools by high-stakes standardized testing. Instructional time dedicated to teaching science in primary schools was reported as low as eight percent in some cases (Hargrove, 2003). As students were promoted onto high school, they arrived with minimal critical thinking and problem solving skills. Many students face additional challenges because they have learned to speak English as a second language. The United States remains an immigrant nation which can be reflected through public education (Gandara, 2003). A high number of English Language Learners (ELLs) can be found in California, where many students' native language is Spanish. Nearly 40% of the nation's ELLs are in California and 31% of these students are enrolled in grades 7-12 (Gandara, 2003; Callahan, 2005). Although most ELLs are found in the primary grades, the secondary population is increasing. This has put an even higher demand on educators to focus on fluency in English across all curricula. In 1998, California replaced an extensive bilingual education program for Limited English Proficient students with Structured English Immersion (Baker, 1998).

When ELLs are mainstreamed into a specific content area classroom, the transition can be overwhelming. These students are required to perform two tasks simultaneously: learning English and the content subject at hand (Callahan, 2003). There are several strategies that a science teacher must implement when working with ELLs to scaffold information. It is well documented that the use of science notebooks and inquiry-based science education are paramount in engaging students and working toward higher academic achievement. In El Centro, California, the Valle Imperial Project in Science was conducted over a four-year span collecting data on ELLs participating in kit-based science classes and using science notebooks. This reform model was based on the five elements of high quality curriculum, sustained professional development and support for teachers and school administrators, materials support, community and top level administrative support, and program assessment and evaluation. The data collected from assessments given to students concluded that the longer the students participated in the program, the higher the achievement scores were in science, writing, and mathematics. This held true for both ELLs and English Only students (Amaral, 2002).

The benefit of combining inquiry science and language acquisition is that learning is enhanced in both domains (Stoddart, 2002). Students who are participating in science inquiry are not only being exposed to science concepts, but are also being engaged in active thinking and discourse around activities. These conversations among classmates can help promote scientific literacy and potentially improve understanding and engagement in science (Capps, 2012). Thinking like a scientist involves asking questions, coming up with some type of investigation, and developing an explanation based on observations. It is possible that the language in science could alienate some students and prevent them from participating in scientific conversations. This is where educators need to identify the language demands of their students by providing feedback and asking probing questions. It is important to avoid a quick evaluation of a student’s response, which could discourage the student from further participation (Lyon, 2011).

One common strategy used by educators who practice inquiry-based science instruction is the implementation of science notebooks. The science notebook can be used as a thinking tool, a guide for teacher instruction, a method of enhancing literacy skills, and a support for differentiated learning (Gilbert, 2005). It is a place where students can organize their questions, predictions, conclusions, and reflections based on specific investigations. The use of language, collection of data, and overall experience help form meaning for students, which ultimately leads to scientific understanding (Klentchy, 2005). Science notebooks also allow ELLs a place to practice English and science terminology without taking risks, since they are not being formally assessed (Nelson, 2010). For students, whose first language is something other than English, observations can be done with diagrams and illustrations along with a brief written explanation. The science notebook should be a tool that provides structure and support for all students to achieve. Teacher feedback, both verbal and written is critical to the effectiveness of the science notebook (Gilbert, 2005).

A valuable feature of the science notebook that might sometimes be overlooked is its use as a tool for formative assessment. Formative assessments occur within instruction as opposed to summative assessments, which are at the end of instruction (Hargrove, 2003). To gauge where students stand at any point in a specific unit, teachers can gain insights about student understanding by doing frequent notebook checks. Having access to student thinking can guide the next steps of instruction for the teacher. In addition, constant feedback from the teacher can help close the achievement gap and allow students to be actively involved in their own learning (Gilbert, 2005; Hargrove, 2003).

Science notebooks can also be used as assessment tools outside of the classroom. For example, district personnel can use them to assess the quality of teacher feedback given to the students. This form of assessment could be used to determine if scoring systems are accurate and consistent to be considered as achievement indicators, as well as if teachers require further professional development in the methods of using science notebooks (Ruiz-Primo, 2004).

As school districts move forward with the implementation of Common Core State Standards (Common Core Standards Initiative, 2012) and Next Generation Science Standards (NGSS Lead States, 2013), there needs to be a concentrated effort of coordination between all core subjects. The movement toward a new standards system provides opportunity to improve curriculum, teacher development, assessment, accountability, and ultimately student achievement (Bybee, 2014). In the past, schools were held accountable for assessments based on student learning. Now through NGSS, assessments are designed for learning, which should equate to a better understanding of science content (Herman, 2013). Included with NGSS are Science and Engineering Practices that include both knowledge outcomes and cognitive abilities of students. It’s not just about asking questions and forming explanations with supporting evidence. Students will also need to be able to participate in argumentation, apply mathematics, and communicate results of investigations (Bybee, 2014).

With these new expectations placed on teachers, as well as students, there will need to be an adjustment period and time for practice. Science teachers will need more professional development geared toward the NGSS and students will need to practice inquiry-based science. ELL students have traditionally been expected to focus on English and math and many ELLs are not receiving rigorous science education at the high school level. The time has come for English Learners to continue their language development in all core classes, including science. The science and engineering practices imbedded in NGSS will lead to opportunities for ELLs to practice not only English, but the language of the science classroom. Teachers who implement these practices need to be equipped with strategies that will include all students, regardless of English proficiency (Lee, 2013). The use of inquiry-based science investigations, organized science notebooks, and opportunities to reflect and engage in discourse should benefit all students, especially ELLs.

METHODOLOGY

Treatment for this study involved the implementation of interactive notebooks scored with a rubric and inquiry-based science instruction. Notebooks were used to help enhance inquiry-based science instruction, promote better writing skills, and model science practices. Students who were classified as English Language Learners as well as students who were considered proficient in English participated in the study. All students were enrolled in two sections of biology (N=52).

Prior to the treatment unit, students were exposed to content lectures and teacher led activities, followed by a summative unit assessment. During the treatment unit, students used their notebooks for recording observations and inferences, taking notes from lectures, recording data and analysis, and designing special assignments that used art to reinforce content. Each notebook was spiral bound, single subject, college-ruled, and large enough to glue handouts directly into the notebook. A blank table of contents was provided and all pages were titled and numbered. Activities during this unit were inquiry based and lessons followed the 5E Instructional Model (BSCS, 2006). 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 (Appendix A).

To determine what impact science notebooks had on the academic development of English Language Learners, various forms of data were explored through qualitative surveys, interviews and quantitative analysis of test and rubric scores. At the beginning of the treatment unit, students completed the Student Literacy Confidence Survey (Appendix B). The survey consisted of Likert-type questions related to student perceptions of science, writing in science, and the use of notebooks in science. Each question contained possible responses ranging from *strongly disagree* to *strongly agree*. This instrument was also administered post-treatment and answers were analyzed using modes, medians, and frequencies. Comparisons between pre- and post-treatment surveys were made and bar charts were used to present the data collected.

Content knowledge was also assessed before and after treatment. The Cell Division Unit Test (Appendix C) was used in the non-treatment unit and the Genetics Unit Test (Appendix D) was used in the treatment unit. The pacing calendar for the course did not allow for the same test to be used for both treatment and non-treatment. Normalized gains were used to analyze test score changes from both pre- and post-unit assessments. Scores below 0.3 were considered low, 0.3 to 0.7 medium, and greater than

0.7 high (Hake, 1998). Scores for each assessment were presented in box and whisker plots.

To encourage completion and organization of science notebooks, students were provided a copy of the Science Notebook Scoring Rubric (Appendix E) at the beginning of the treatment unit. The rubric was a ten-point scale based on the level of organization, completeness, effort on assignments, and scientific thought present in summaries and reflections. Grades assigned to individual notebooks were compared to test scores to determine correlation between the two instruments and analyzed with the Pearson Correlation Coefficient. A scatterplot graph was used to show the relationship between the two variables. A random sample of students was selected to participate in answering the Pre-Treatment Interview Questions and Post-Treatment Interview Questions (Appendix F). Answers were analyzed for common themes among students and connections were made to the data collected from the other instruments.

Formative assessments were also used to collect writing samples from students during the treatment unit. The One Sentence Summary Classroom Assessment Technique (Angelo & Cross, 1993) was used to summarize an article based on science content (Appendix G). After annotating the article for key terms, a central claim and supporting evidence, students created a summary with answers for the following questions: *Who or what? Does what? To what? When? Where? Why? How?* The answers to these questions were woven together by students into one sentence, to summarize the article. Summaries were then analyzed for common themes and level of comprehension. Students were also assigned a creative vocabulary assignment using vocabulary from the unit. The Genetics

Haiku Vocabulary Assignment (Appendix H) gave students the opportunity to display subject matter knowledge, writing ability and creativity in one short assignment. This assignment was assessed using the Notebook 10-Point Scoring Rubric (Appendix I). A summary of the data collection instruments and focus questions is presented as a triangulation matrix in Table 1.

Table 1
Data Triangulation Matrix

Focus Questions	Data Source 1	Data Source 2	Data Source 3
Primary Question:			
1. What are the effects of using interactive notebooks with English Learners?	Student Science Literacy Confidence Survey	Pre- and post-content assessments scores.	Rubric scores for notebooks during the treatment unit.
Sub Questions:			
2. Can the use of science notebooks help close the achievement gap between ELL's and students who are classified as Fluent English Proficient?	Pre- and post-content assessments scores.	Student Science Literacy Confidence Survey	Interview questions based on value of performing well in science.
3. Will various writing assignments in science improve student engagement and performance?	Rubric scores for notebook and vocabulary assignments.	One Sentence Summary completion for article.	Interview questions based on writing in science.

DATA AND ANALYSIS

The results of the Student Science Literacy Confidence Survey given before treatment, which included 20 Likert-type questions, indicated that 77% of the students either *agreed* or *strongly agreed* that writing in science would help them understand the English language better (*N*=52). When this was compared to the post treatment survey, the frequency increased to 82%. (Figure 1). One student said, “I feel like writing helps me understand more about the topic.”

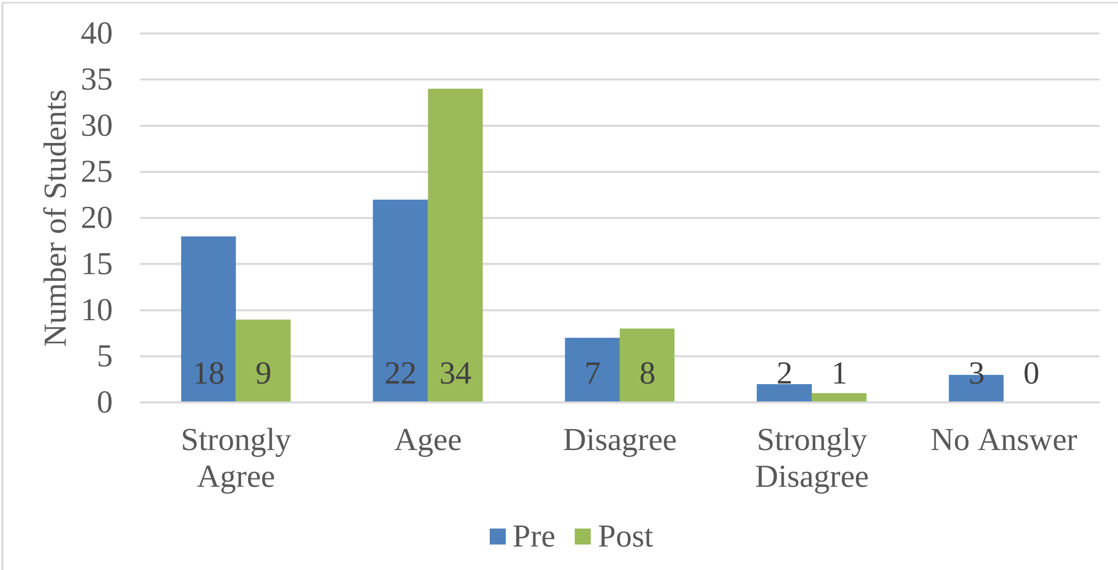

Figure 1. Student responses to the statement “Writing in science will help me understand the English language better”, (*N*=52).

Students were also asked if it was easy for them to write a summary of what they have learned in science. Sixty-five percent of students either *agreed* or *strongly agreed* with the statement before the treatment, while 81% responded the same way after treatment (Figure 2). One student interviewed mentioned that “Writing summaries helps me remember the details of what we have learned.”

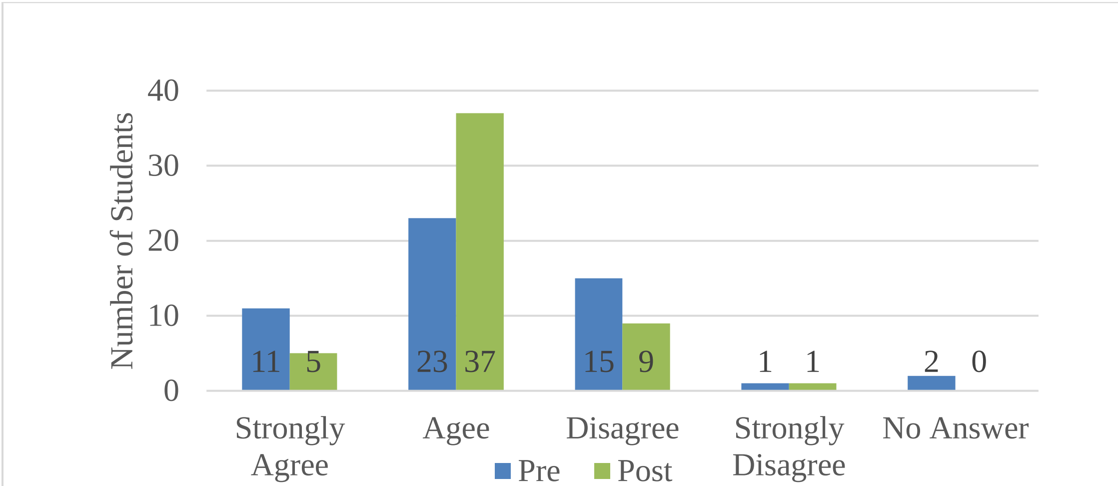

Figure 2. Student responses to the statement, "It is easy to write a summary of what I have learned in science", (*N*=52).

The comparison of the non-treatment pre- and post- Cell Division Unit Test showed an average normalized gain of 0.58, which is considered medium growth. Students averaged 14% on the pre-test and 60% on the post test. The lower quartile increased from four percent to 44% and the upper quartile grew from 20% to 80%. Thirty percent of students showed normalized gains > 0.7, which indicated a high level of growth (*N*=52). Fifty-five percent of the students passed the test with a score of 60 or higher out of 100 points. A box-and-whisker plot was used to show the increase in test scores between the pre- and post- tests (Figure 3).

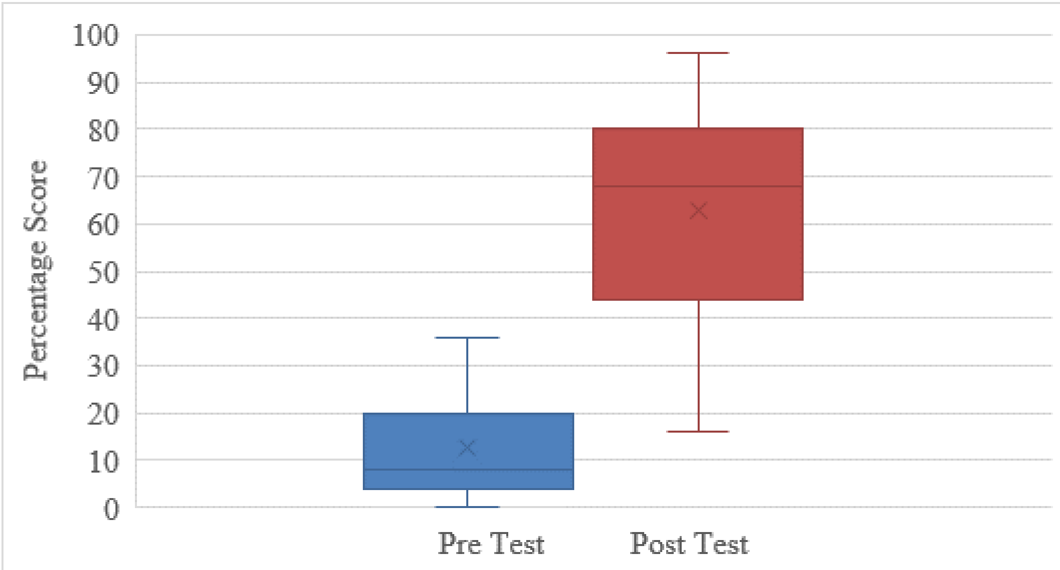

Figure 3. Box-and-whisker plot for Cell Division pre- and post- tests, (*N*=52).

The comparison of the treatment pre- and post- Genetics Unit Test showed an average normalized gain of 0.51, which is considered medium growth. This was 0.07 lower than the gains observed in the non-treatment unit. Students averaged 8% on the pre-test and 55% on the post-test. The lower quartile increased from four percent to 40% and the upper quartile increased from 12% to 72%. Twenty-one percent of students showed normalized gains >0.7, which is considered a high level of growth (*N*=52). Forty-seven percent of students passed with a score of 60 or higher out of 100 points. A box-and-whisker plot was used to show the increase in test scores between the pre- and post-tests (Figure 4).

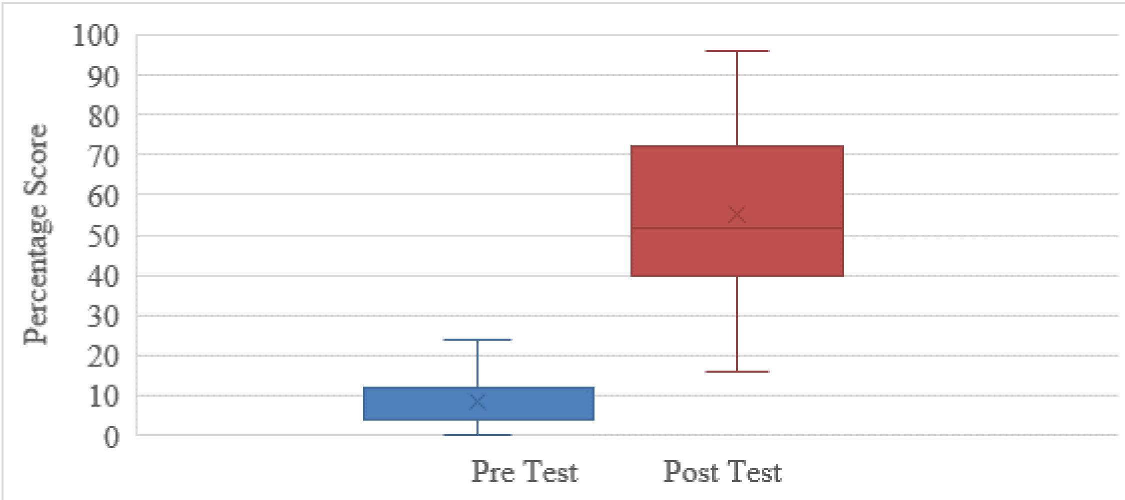

Figure 4. Box-and-whisker plot for Genetics Unit pre- and post- tests, (*N*=52).

When student notebook rubric scores were compared to treatment unit test scores, there appeared to be a positive correlation between the two variables. One student said, “Using the notebook has helped me a lot. I used to just throw everything in my bag and it was a mess!” The Pearson’s Correlation Coefficient for all ELL students was r = 0.28 (*N*=20). However, at a five percent confidence level, the P-Value was 0.23, which is not significant. The scatter plot shows that as student notebook rubric scores increase, so do unit test scores (Figure 5).

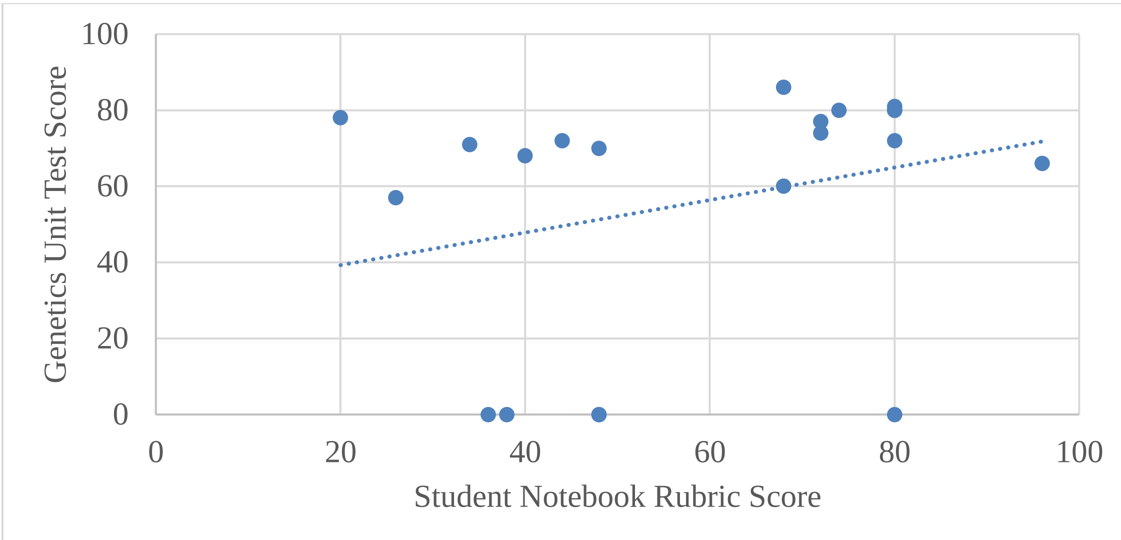

Figure 5. Scatterplot showing correlation between unit test scores and student notebook rubric scores among ELL students, (*N*=20).

During the non-treatment unit, a random sample of students were interviewed about their opinions on science, writing in science, and the use of notebooks in a science class. When one student was asked if science was a difficult subject, the response was "It is difficult for me because of all the strange words, and there can be a lot of information in a word." Another student responded to the same questions by saying, "Yes, because I have trouble remembering names and steps." Issues with vocabulary and memorization were a common theme among many students, especially students who are classified as ELL.

Student data for the non-treatment unit test revealed that ELL students averaged a normalized gain score of 0.56. For the same unit, English Only students had an average normalized gain score of 0.60. Both are recognized as medium growth. The lower quartile for ELLs was 0.33 and 0.45 for English Only. The upper quartile scores were 0.73 for ELLs and 0.79 for English Only. The distribution of scores can be seen in a box and whisker plot (Figure 6). There was one student who was an outlier, since their post-test score was lower than the pre-test. The highest normalized gain for an ELL student was 0.95 and 0.85 for English Only. Thirty percent of ELL students showed normalized gains >0.7, which is a high growth (*N*=52).

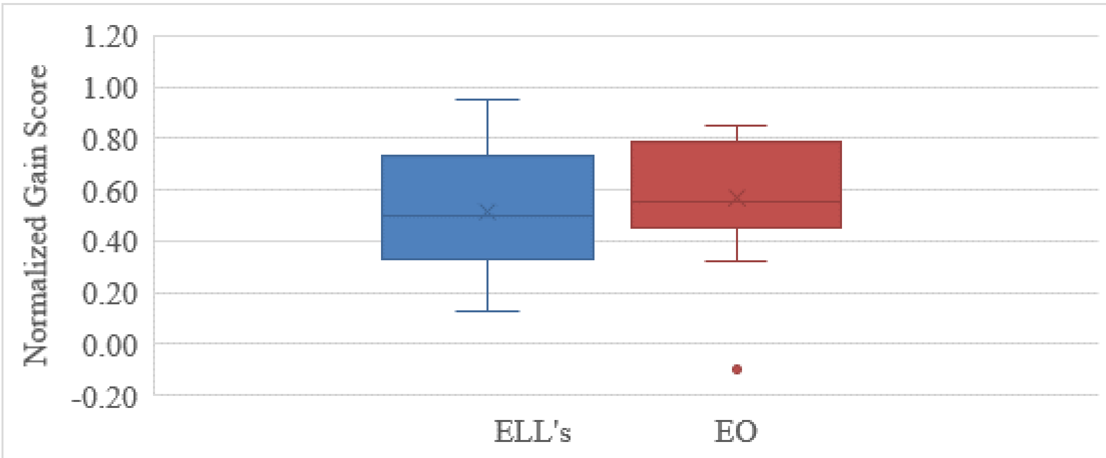

Figure 6. Box and whisker plot showing normalized gains for both ELL and English Only Students after the non-treatment unit test, (*N*=52).

Normalized gains were also compared after the treatment unit. Both ELL and English Only students averaged normalized gains of 0.51, which is recognized as medium growth (*N*=52). The highest normalized gain for an ELL student was 0.96 and 0.88 for English Only. The lower quartile was 0.31 for both, but the upper quartile for ELL students was 0.71 and 0.69 for English Only students. Thirty percent of both groups showed normalized gains >0.7, which is high growth. Although the average scores were lower for the treatment unit test compared to the non-treatment unit test, the scores between ELLs and English Only students were on the same level (Figure 7).

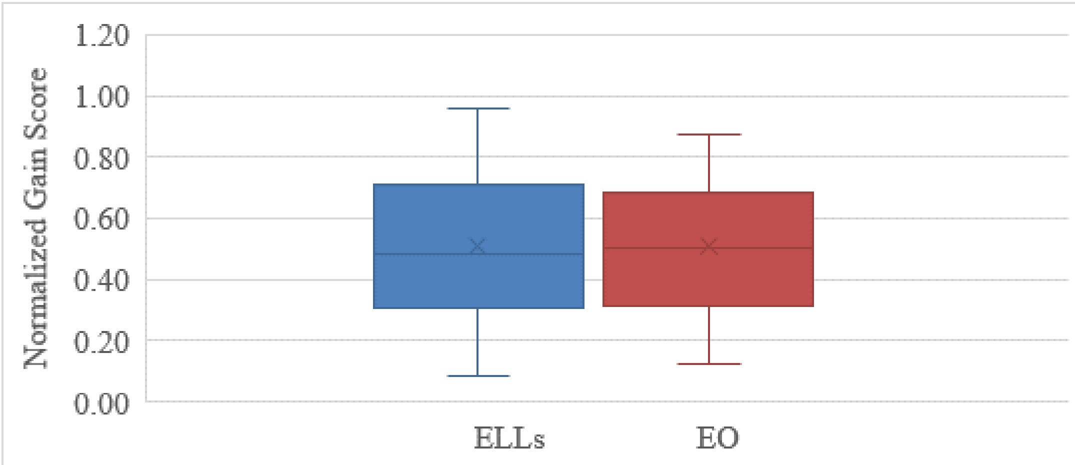

Figure 7. Box and whisker plot showing normalized gains for both ELL and English Only students after treatment unit test, (*N*=52).

In both pre-treatment and post-treatment Student Science Literacy Confidence Surveys, students were asked if using a notebook in science class helps them stay organized. Eighty-seven percent of students either *strongly agreed* or *agreed* pre-treatment. That number rose to 90% post-treatment. One student who was interviewed post-treatment about notebooks and organization stated, “My organization skills have improved since the beginning of the year because I use the notebook for biology and it helps me know where I have papers that are important.” On the other hand, another student responded, “I think they got worse because I would prefer to turn in papers at the end of class, rather than keep them.” Out of the 15 students interviewed, only 13% felt that their organization had not improved since the beginning of the school year. Students were also surveyed on how they value science. When asked if it is important to do well in science, 95% of all students either *strongly agreed* or *agreed* in both pre- and post-treatment surveys. It was observed that within the five percent who did not find value in science, only two percent were English Language Learners.

Sixty percent of students classified as English Language Learners completed the Genetics Haiku Vocabulary Assignment. When Notebook 10-Point Scoring Rubrics were compared to treatment unit test scores, there was a positive correlation between the two variables. A student who was interviewed about creative writing in science said, “It makes learning the words more fun.” The Pearson’s Correlation Coefficient for all ELL students was r = 0.68 (*N*=20). At a five percent confidence level, the P-Value was 0.0009. This result is considered significant. The scatter plot shows that as student rubric scores increase, so do unit test scores (Figure 8).

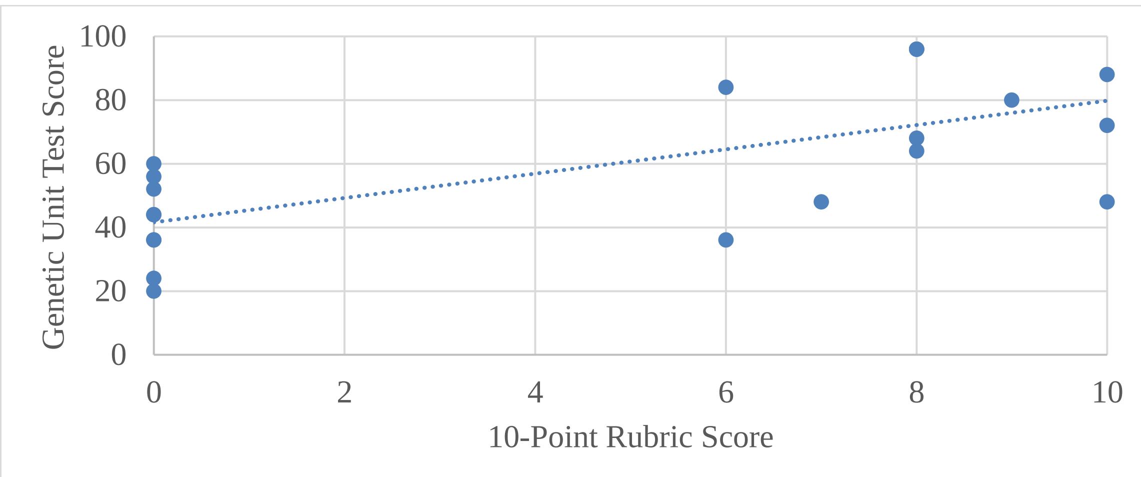

Figure 8. A scatter plot showing the relationship between the Genetics Haiku Vocabulary Assignment and Unit Test Scores for ELL students, (*N*=20).

Another formative assessment used to check for understanding of content was the One Sentence Summary. The article, *New York Fertility Doctor Says He Created Baby with 3 Genetic Parents* (Stein, 2016), was used for this assignment. A list of the most common answers can be seen in Table 2.

Table 2
One Sentence Summary: Most Common Answers

Who?	John Zhang
Does what?	Traveled to Mexico
To what?	To perform a procedure
When?	In May, 2016
Where?	In Mexico City
Why?	To help a couple have a baby
How?	By using DNA from three adults

One hundred percent of all students identified the *who, does what, to what,* and *why* portions of the summary. Ninety percent of students identified the *when,* and 95% of students mentioned the *where* and *how.*

When students were asked what they found valuable about writing One Sentence Summaries, one student responded by saying, “It helped my focus on the main parts of the reading and it helps me see my progress.” Another student stated that “With those summaries, you actually learn something about what you read.” Although many students found value in the formative assessment, it was not the same for everyone. “I don’t really find anything valuable in writing them, they’re just another writing assignment to me.” Whether students enjoy writing or not, the data tends to show that implementing an interactive notebook in a science class can improve test scores, especially for ELL students.

INTERPRETATION AND CONCLUSION

After analyzing the data collected, there are positive correlations between the use of interactive science notebooks and student achievement. In cases where students scored 80% or higher on the unit test, 84% also scored high on notebook rubrics and formative assessments. Fifty percent of those students were classified as ELL. Although average test scores were slightly higher on the non-treatment test compared to the treatment test, ELL normalized gains were comparable to English Only students after treatment. This is a good indication that on average, ELL students can perform at the same level as their English Only classmates when science notebooks are utilized.

It was also observed that many students agreed the use of notebooks and writing in science would help their overall achievement in class. Through compiling the data collected from surveys and interviews, over 80% of students felt that if they kept up with the notebook and completed the writing assignments they would perform better in biology. Although the correlation between notebook, vocabulary assignments and test scores supports this belief, there were still students who did not complete the assignments. Thirty five percent of ELL students did not submit the Genetics Haiku Vocabulary Assignment and 15% of all students did not turn in a completed notebook during the treatment unit. It was somewhat frustrating to know that these students see the value in writing in science, but still chose not to apply the strategies designed to help them perform better.

Since the students involved in this study did slightly better on the non-treatment unit test compared to the treatment unit test, there was still a question that remained. Did students come into biology with more background knowledge in cells than genetics? This could be possible, since the pre-test scores for the genetics unit were six percent lower than the pre-test scores for the cells unit. The biggest difference was in the median scores on the post-tests, 68% for the cells unit test and 52% for the genetics unit test. Looking at these numbers, it could be stated that students did better without the treatment. However, with the use of normalized gains and statistical analysis finding positive correlations with notebooks and test scores, I feel the treatment was successful.

Through the literature review process, I came into this investigation with the idea that the use of interactive science notebooks would facilitate higher achievement for all students, especially those classified as ELL. The resources outlined in the Conceptual Framework of this study share this idea as a common theme. If students are given opportunities to produce language in specific content areas, they will develop language proficiency faster and enhance their critical thinking skills. Overall, the findings from my project aligned with what the research tells us. The use of notebooks and writing in science can lead to higher achievement for English Language Learners.

VALUE

Being able to conduct this action research investigation with my students has been a positive experience. Thirty eight percent of the students who participated in the study were classified as ELL. I focused on this group of students specifically because of the high percentage of ELL students school wide. Although data was only collected for two of my classes, all four biology sections received the same treatment. I had been using science notebooks with my students for several years, but they were usually just filled with notes and lab investigations. Using it as a formative assessment tool with a clear scoring rubric, specific writing tasks, and creative vocabulary assignments has given the notebook a greater purpose. Student progress can now be evaluated in various ways and much needed feedback can be given to students more efficiently.

In the past, I had rarely taken the time to survey or interview my students directly about specific issues within the classroom. It was extremely eye opening to listen to their thoughts one-on-one through interviews and to find common themes within the survey responses. In a way, this gave students the opportunity to be involved in their own education. I found that after surveys and interviews were conducted, more students were willing to ask questions in class and start conversations without being prompted. Students perceived that their opinions mattered and that was a huge boost to their confidence and being able to share their ideas. This is a skill that students can continue to build on as they develop their language proficiency.

One thing that did not become clear within this study was a change in student engagement. I followed inquiry-based science instruction throughout the school year to keep students motivated. It is probably not realistic to think that a teacher can reach every student and get them to feel passionately about the subject they are learning, but that is always my goal. I do feel somewhat responsible for student success, but I know much of the burden lies on the shoulders of the individual student. They must want to be successful. About 25% of students who participated in the study had a failing class grade at the time the study ended. This was somewhat discouraging, but it seems to be the current trend across all curricula.

Moving forward, it will be my responsibility to continue to give students opportunities for success. This can be done through frequent checks for understanding, well-structured lesson plans that consider differentiated instruction, designing various formative assessments, and implementing interactive science notebooks that follow a clear scoring rubric. I plan on utilizing surveys more often and continue to listen to what my students think about their education. The whole process of this investigation has been a tremendous learning experience and I reflected on my teaching practices multiple times. The cycle of reflection, action, and evaluation continues even after this study is complete. Although I have been teaching for over a decade, I am still learning how to become a more effective educator. Working with English Language Learners can be challenging at times, but I have discovered that they can compete with English Only students academically if given the tools to do so. I listened to student perspectives on content and adjusted assignments based on student needs. It was very time consuming, but well worth it. Having critical friends and the process of peer review has also helped me recognize my own weaknesses and strengths in teaching. I have always found value in reflection, but this project has enhanced that value. As the study has come to an end, so will the school year. In the fall, a whole new group of students will arrive with their own strengths and weaknesses. I look forward to the next adventure.

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APPENDICES

APPENDIX A

IRB EXEMPTION

MONTANA STATE UNIVERSITY

INSTITUTIONAL REVIEW BOARD

For the Protection of Human Subjects
FWA 00000165

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c/o Microbiology & Immunology
Montana State University
Bozeman, MT 59718
Telephone: 406-994-6783
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Chair: Mark Quinn
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Administrator:
Cheryl Johnson
406-994-4706
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MEMORANDUM

TO: Ryan Soto and John Graves

FROM: Mark Quinn *Mark Quinn cy*

DATE: November 7, 2016

SUBJECT: *"The Effects of Implementing Interactive Notebooks and Inquiry Based Science on the Academic Achievement of High School English Language Learners"* [RS110716-EX]

The above research, described in your submission of November 7, 2016, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

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

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

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

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

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

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

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

Exemption Regarding Informed Consent

I, Hector Espinoza, Principal of San Ysidro High School, verify that the classroom research conducted by Ryan Soto is in accordance with established or commonly accepted educational settings involving normal educational practices. To maintain the established culture of our school and not cause disruption to our school climate, I have granted an exemption to Ryan Soto regarding informed consent.

(Signed Name)

HECTOR ESPINOZA

(Printed Name)

Oct 7, 2016

(Date)

APPENDIX B

STUDENT LITERACY CONFIDENCE SURVEY

Directions: Please complete the following survey to the best of your ability by circling the most appropriate answer or filling in a short response.
Participation in this research is voluntary. Participation or non-participation will not affect a student's grades or class standing in any way.

1) I have Mr. Soto for Biology during period
1 2 4 6
2) I am a successful student.
4 Strongly agree 3 Agree 2 Disagree 1 Strongly disagree
3) I think that I am a capable student.
4 Strongly agree 3 Agree 2 Disagree 1 Strongly disagree
4) When it comes to school I think that I am organized.
4 Strongly agree 3 Agree 2 Disagree 1 Strongly disagree
5) I can find my assignments quickly.
4 Strongly agree 3 Agree 2 Disagree 1 Strongly disagree
6) I am a good problem solver.
4 Strongly agree 3 Agree 2 Disagree 1 Strongly disagree
7) When I learn something in science I can see how it applies to my life.
4 Strongly agree 3 Agree 2 Disagree 1 Strongly disagree
8) When we do work in science class I can see that I am building background knowledge that I will use later in life.
4 Strongly agree 3 Agree 2 Disagree 1 Strongly disagree
9) It is easy for me to ask for help in science.
4 Strongly agree 3 Agree 2 Disagree 1 Strongly disagree
10) In science, I am a strong independent learner.
4 Strongly agree 3 Agree 2 Disagree 1 Strongly disagree

11) It is important to me that I do well in science.
4 Strongly agree 3 Agree 2 Disagree 1 Strongly disagree
12) I can read something in my science text and understand it.
4 Strongly agree 3 Agree 2 Disagree 1 Strongly disagree
13) I can read the tables and graphs in my science text and understand them.
4 Strongly agree 3 Agree 2 Disagree 1 Strongly disagree
14) It is easy for me to write a summary of what I have learned in science.
4 Strongly agree 3 Agree 2 Disagree 1 Strongly disagree
15) It is easy for me to understand the information in my textbook.
4 Strongly agree 3 Agree 2 Disagree 1 Strongly disagree
16) When I take notes in class it helps me to understand the topic.
4 Strongly agree 3 Agree 2 Disagree 1 Strongly disagree
17) It is easy for me to understand scientific concepts.
4 Strongly agree 3 Agree 2 Disagree 1 Strongly disagree
18) I understand how to follow procedures during lab activities.
4 Strongly agree 3 Agree 2 Disagree 1 Strongly disagree
19) Using a notebook in science helps me stay organized.
4 Strongly agree 3 Agree 2 Disagree 1 Strongly disagree
20) Writing in science class will help me understand the English language better.
4 Strongly agree 3 Agree 2 Disagree 1 Strongly disagree

APPENDIX C

CELL DIVISION UNIT TEST

Name ______________________________ Score _____/ 25 x 4 = _____ @ __________%

1. In humans, there are ________________________ in each skin cell.
   a. 23 chromatids
   b. 23 chromosomes
   c. 46 chromatids
   d. 46 chromosomes

2. Right after a bone breaks, the cells at the edge of the injury
   a. begin to build blood.
   b. begin to divide rapidly.
   c. stop dividing.
   d. stop transporting blood.

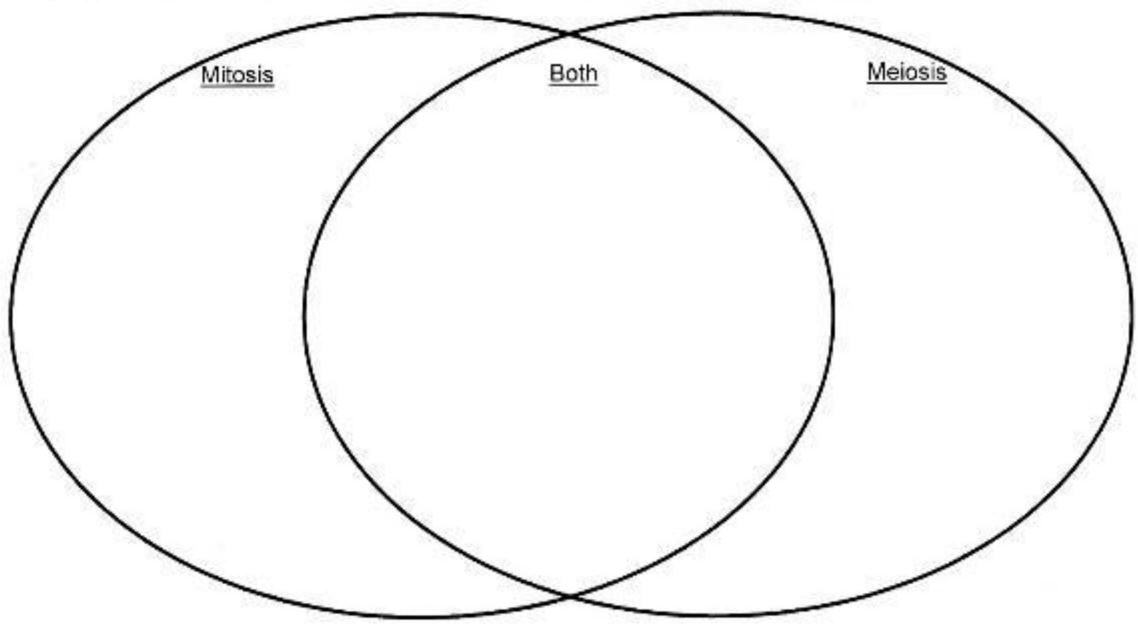
3. After cell division, each daughter cell has
   a. an identical number of chromosomes as the parent cell.
   b. less DNA in its nucleus than the parent cell.
   c. more chromosomes than the parent cell.
   d. more DNA in its nucleus than the parent cell.

4. Cancer is a disorder in which some cells have lost the ability to
   a. control their growth rate
   b. control protein production.
   c. form a thin layer of tissue.
   d. form clots in the blood.

---

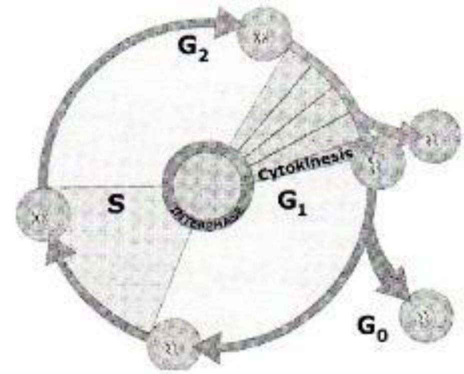
5. 6 pts: Complete the following Venn Diagram by placing the following information into the diagram:

anaphase	metaphase	prophase	telophase
produces 2 cells	produces 4 cells	produces body cells	produces gametes
$2n \rightarrow n$	$2n \rightarrow 2n$	undergoes 1 cell division	undergoes 2 cell divisions



6. In what part of Interphase does DNA replication occur?
   a. G1 c. G2
   b. S d. M

7. Approximately how long does the cycle take to complete in humans?
   a. 2 seconds
   b. 2 minutes
   c. 8 hours
   d. 3 days



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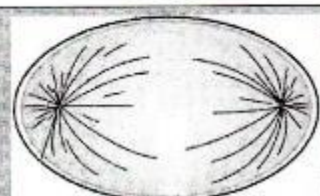
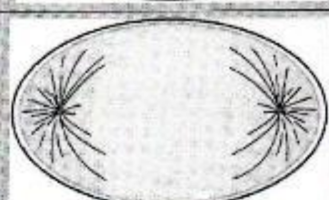
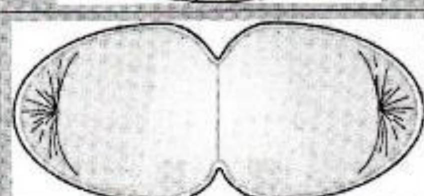
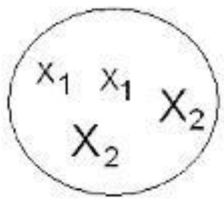
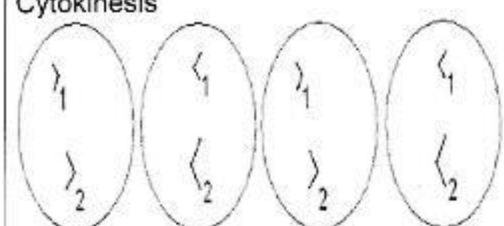
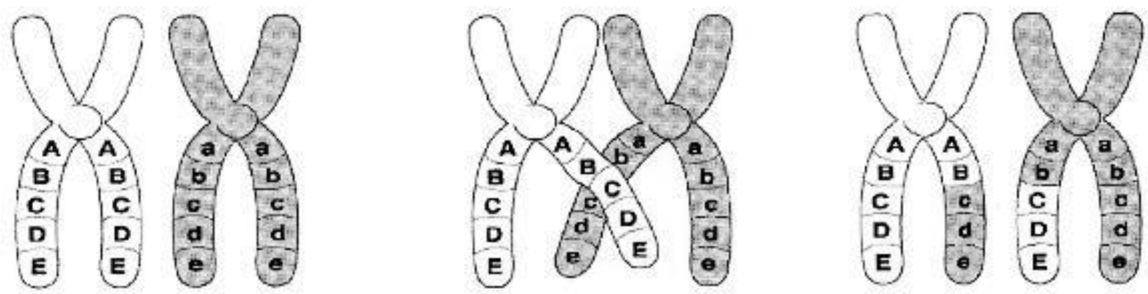
8. 7 pts: Complete the shaded areas of the chart below by
   i. by labeling the stage names (1 pt)
   ii. drawing the chromosomes or chromatids in the stages (3 pts)
   iii. describing what is happening in each phase (3 pts)

Phase Name	Phase Drawing	Phase Description
		The chromosomes are being prepared for cell division, while the nucleus is broken down.
		
		
Telophase & Cytokinesis		Two ______________ are formed, then the cell's cytoplasm ______________ ______________ ______________.

9. 4 pts : Complete the Meiosis chart. Be sure to differentiate between chromosomes and chromatids.

Meiosis I	**Meiosis II**
Prophase I 	Prophase II
Metaphase I	Metaphase II
Anaphase I	Anaphase II
Telophase I	Telophase II
Cytokinesis	Cytokinesis 

10. Mitosis undergoes ONE cell division and Meiosis undergoes TWO cell divisions. What is the purpose of the second cell division?



11. How does the process of "crossing-over" increase genetic diversity in gametes?

APPENDIX D

GENETICS UNIT TEST

Name ______________________________

Score __________ / 25 x 4 = __________ @ __________ %

1. Gregor Mendel used pea plants to study
   a. flowering.
   b. gamete formation.
   c. the inheritance of traits.
   d. cross-pollination.

2. The principles of probability can be used to
   a. predict the traits of the offspring produced by genetic crosses.
   b. determine the actual outcomes of genetic crosses.
   c. predict the traits of the parents used in genetic crosses.
   d. decide which organisms are best to use in genetic crosses.

3. In the Punnett square shown in Figure 1, which of the following is true about the offspring resulting from the cross?
   a. About half are expected to be short.
   b. All are expected to be short.
   c. About half are expected to be tall.
   d. All are expected to be tall.

T = tall, t = short

	T	*t*
T	*T T*	*T t*
T	*T T*	*T t*

Figure 1

4. (2 pts) In Mendelian genetics, round seed pea plants are dominant to wrinkled seed pea plants. **Construct** a Punnett Square for a true-breeding homozygous dominant round (R) plant crossed with a true-breeding homozygous recessive wrinkled (r) plant.

5. In question 4, what are the percentages for each phenotype?

   Round: _____% Wrinkled: _____%

6. (2 pts) A man and a woman, who are both heterozygous for normal skin pigmentation (*Aa*), produce an albino offspring (*aa*). Complete a Punnett Square for these parents. **What is the probability that their next child will have normal skin pigmentation?**

7. What are the **different** allele combinations would be found in the gametes produced by a pea plant whose genotype was *RrYY*?

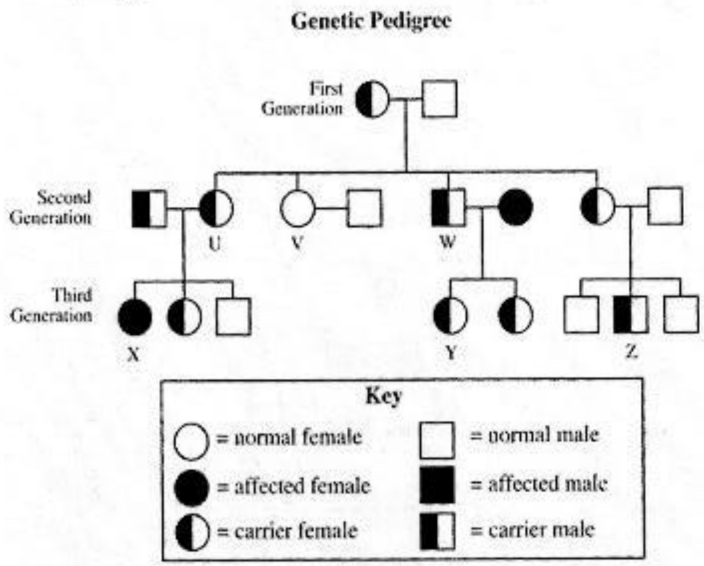
8. (2 pts) What is the approximate probability that a human offspring will be female? **Provide evidence.**

9. Use the property of incomplete dominance. If a red flower is crossed with a white flower, **specify** the color of the offspring.

10. Use the property of codominance. If a black rooster is crossed with a white hen, **specify** the color of the offspring.

11. (2 pts) Colorblindness is more common in males than females. **Why** are males more likely to become colorblind?

Use the pedigree chart below to answer the following questions:



12. (2 pts) Using the letter (A) for the dominant allele and (a) for the recessive allele, show the possible genotypes for the First generation couple.

13. **Draw** a circle around **all** the individuals in the pedigree that are affected by the disorder.

14. (2 pts) Is the disorder dominant or recessive? **Explain** how you know.

15. (2 pts) Mendel performed a dihybrid cross of ***two*** heterozygous parents to observe whether the genes were linked genes. Complete the Punnett sqaure above to determine the following:

R r T t

R r T t				

Seed shape
R - round
r - wrinkled

Plant Height
T - *tall*
t - *short*

16. (2 pts) List the possible genotypes and respective phenotypes of the offspring in the chart below.

Genotypes	Phenotypes

17. What is the phenotypic ratio of the offspring in the Punnett square above?

APPENDIX E

SCIENCE NOTEBOOK SCORING RUBRIC

Science Notebook Scoring Rubric

Your notebook will be collected at the end of each biology unit and graded using the following scale:

10	Notebook contents are neatly completed, all pages are numbered, titled and dated. Right-side/left-side topics are correct and organized per Table of Contents. Table of Contents reflects ALL entries to date. Summaries and reflections show scientific thought and effort beyond what is required. Exceptional work on all entries
9	Notebook contents are neatly completed, all pages are numbered, titled and dated. Right-side/left-side topics are correct and organized per Table of Contents. Table of Contents reflects ALL entries to date. Summaries and reflections show scientific thought and effort based on what is required.
8	Notebook contents are MOSTLY NEAT and complete (at least 90%), pages numbered, titled and dated. Right-side/left-side topics are correct and organized with no more than 2 assignments incorrectly placed. Table of Contents reflects 90% of all entries up to date. Right side notes meet requirements. Summaries and reflections show a basic understanding of content topics, shows some thought and effort.
7	Notebook contents are legible, complete (at least 80%), pages numbered, titled and dated. Right-side/left-side topics are correct and organized with no more than 4 assignments incorrectly placed. Table of contents reflects at least 80% of all entries to date. Summaries and reflections show a limited understanding of content topics, limited thought and effort.
6	Notebook contents are sloppy or incomplete (50%), many pages are not numbered, titled or dated. Right-side/left-side is inconsistent and contents are unorganized with more than 5 assignments incorrectly placed. Table of contents shows limited attempts at keeping entries up to date. Summaries and reflections show only a superficial understanding and/or some inaccuracies, little thought or effort.
5	Notebook turned in but too incomplete to score well. Majority of pages are missing or incomplete. Dating and labeling of pages is inconsistent. Summaries and reflections show minimal understanding, not neatly written, minimal effort.
0	Notebook not turned in. No evidence of work done.

APPENDIX F

PRE-AND POST-INTERVIEW QUESTIONS

PRE-TREATMENT INTERVIEW QUESTIONS

1. How do you normally keep your school work organized?
2. What do you find useful about taking notes in class?
3. Is science a difficult subject for you? Why or why not?
4. What do you like the most about biology?
5. What do you like best about using a notebook in science?
6. How do you feel about writing assignments in biology?
7. Do you think creative assignments using the biology vocabulary would help you understand the content better? Why or why not?
8. Is there anything else you would like me to know?

POST TREATMENT INTERVIEW QUESTIONS

1. Do you think that your organization skills have improved since the beginning of the school year? Please give an example.
2. What do you find useful about taking notes in class?
3. Is science a difficult subject for you? Why or why not?
4. What do you like most about biology?
5. How has the Notebook Scoring Guide helped you improve your notebook organization?
6. How do you feel about writing assignments in biology?
7. What did you find valuable about writing *One Sentence Summaries* for biology topics?
8. Is there anything else you would like me to know?

APPENDIX G

ONE SENTENCE SUMMARY SAMPLE ARTICLE

New York Fertility Doctor Says He Created Baby with 3 Genetic Parents

A doctor who treats infertility in New York City says he has helped a couple have the first baby purposefully created with DNA from three different adults.

John Zhang of the New Hope Fertility Center in Manhattan traveled to Mexico earlier this year to perform a procedure for a couple from Jordan that enabled them to have the baby in May, according to a clinic spokesman.

Zhang performed the procedure in the hopes of helping the couple, who the clinic declined to identify, have a healthy baby. The couple had lost their first two children to Leigh syndrome, an inherited neurological disorder.

The idea of creating babies this way to help prospective parents who come from families plagued by genetic disorders has long been controversial. In February, a 12-member panel assembled by the National Academies of Sciences, Engineering and Medicine outlined a plan for how scientists could ethically pursue the research.

The Food and Drug Administration had requested the report after two other groups of U.S. scientists asked for permission to try. Despite the report, the FDA said Congress had prohibited the agency from allowing the procedure. In response to the latest development, the FDA reiterated that position in an email to NPR.

That prohibition had prompted Zhang to travel to Mexico, according to the clinic.

The baby's birth prompted both praise and criticism. Some infertility experts welcomed the development as a potentially important step for women carrying genetic disorders.

"This work represents an important advancement in reproductive medicine," said

Owen K. Davis, president of the American Society for Reproductive Medicine, in a written statement.

Zhang plans to present the details of the case at the society's meeting next month in Salt Lake City.

Some scientists said the move was irresponsible because not enough research had been done to know whether it was safe.

"This is a troubling development on a number of levels," wrote Paul Knoepfler, a cell biologist at the University of California, Davis, in an email to NPR. "It could have gone wrong in any number of ways and still could."

Others fear the move could open the door to the creation of so-called designer babies, in which parents try to pick and choose the traits of their children.

"This is entrepreneurial reproductive technology at its most unethical and irresponsible," wrote David King, who heads the genetic watchdog group Human Genetics Alert in London, in an email. "When are the world's governments going to stop rogue scientists crossing crucial ethical lines?"

One scientist hoping to perform this procedure in the United States is worried about details he has seen in Zhang's presentation.

"While exciting, there appears to be problems with the study," wrote Dieter Egli of Columbia University Medical Center in an email. Egli said he sees possible abnormalities in the embryos Zhang created, which he says reinforces why the FDA should be overseeing such experiments.

"For a technique pioneered and developed in the U.S., it be fitting to see the benefits to patients here as well," he says. "Because of funding restrictions to the FDA, promising medical advances are forced to move elsewhere."

The birth of the child was first reported Tuesday by the British magazine New Scientist. A clinic spokesman who asked not to be named told NPR that most of the details in the article were accurate except statements that the baby was born in Mexico and there was no oversight of the procedure there.

Leigh syndrome is known as a mitochondrial disorder because it is caused by defects in a type of DNA known as mitochondrial DNA. Mitochondria are structures in cells that provide the cells with energy.

To help women who carry defects in mitochondrial DNA, scientists have developed techniques to replace the defective mitochondrial DNA with healthy DNA.

The technique Zhang used involved removing all the DNA from the nucleus of eggs donated by women with healthy mitochondrial DNA. The DNA in the nucleus of eggs carries most of the genetic information needed to create a person, including the information most people consider important, such as determining an individual's physical appearance.

Zhang then removed all the nuclear DNA from the eggs of the woman trying to have a healthy baby and placed that DNA into the donor egg, leaving the defective mitochondrial DNA behind. Those eggs, which then presumably had only healthy DNA, were then fertilized with sperm from the husband of the woman trying to have a baby.

Zhang created five embryos this way. Only one developed normally, according to his report. It was transferred into the woman's womb and resulted in the birth of a boy, who appears healthy, according to the clinic.

Because mitochondrial DNA is only passed from women to their offspring, the boy is incapable of transferring the mitochondrial DNA to any future children, sidestepping many of the ethical concerns.

Rob Stein, September 27, 2016, NPR

APPENDIX H

GENETICS HAIKU VOCABULARY ASSIGNMENT

Haiku

A haiku is a minimalist, contemplative poetry from Japan that emphasizes nature, color, season, contrasts and surprises. Usually is has three lines and 17 syllables distributed in a five, seven and five syllable pattern. It should show a sensation, impression or drama of a specific fact or concept.

- 17 syllables
- Five syllables in the first line
- Seven syllables in the second line
- Five syllables in the third line
- The haiku must follow the pattern and deal with any aspect of topic covered in class.
- The section must have artwork reflecting the topic – you pick the aspect you wish to emphasize in the haiku and artwork.
- There must be a three- to five-sentence explanation telling how the haiku shows an understanding of the assigned topic
- Example:

Gregor Mendel was
A monk and farmer of peas
Learned how traits are passed

Adapted from: *AVID Science Summer Institute*

APPENDIX I

NOTEBOOK 10-POINT SCORING RUBRIC

NOTEBOOK 10-POINT SCORING RUBRIC

10 Points (A WOW Product)

- All of the requirements are evident and EXCEEDED
- The product is VERY neatly done and EXTREMELY well-organized
- The product shows A LOT of creativity and is colorfully illustrated
- Completed on time

8 Points (What Is EXPECTED)

- All of the requirements are evident
- The product is neatly done and well organized
- The product shows creativity and is colorfully illustrated
- Completed on time

6 Points (Almost What Is EXPECTED)

- The requirements are evident (maybe a few missing)
- The product is neatly done and organized
- The product shows some creativity and is illustrated
- Completed on time

4 Points (Sort of What Is EXPECTED)

- The requirements are evident (many are missing)
- The product is done and sort of organized
- The product shows little creativity and is illustrated
- Complete on time

2 Points (Not What Is EXPECTED)

- MANY of the requirements are NOT PRESENTED
- The product shows LITTLE TO NO creativity and illustrations are POORLY done
- Completed on time

0 Points (Does Not Meet Standards)

- Unscorable or no product)