THE EFFECTS OF TEACHING SCIENCE FICTION IN CONJUNCTION WITH SCIENCE CONTENT

by

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DEDICATION

This paper is dedicated to Sophie and Rhett. Thank you so much for your patience with your mother always doing homework and working on the computer. I appreciate all of the questions, giving me an extra eye, and just the support for me to earn this degree.

I also want to thank my seventh grade students for being part of this process and putting in the work in both English and science class to make this project work. Although at times your energy would drive me crazy, it was that energy and enthusiasm that kept this project going.

ACKNOWLEDGEMENTS

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ABSTRACT

The purpose of this action research was to determine if teaching a science fiction novel in conjunction with science content leads to better retention. This was tested by having seventh grade students read the novel Maximum Ride by James Patterson in their English Language Arts class at the same time that they were studying genetics and evolution in their life science class. Data was collected both quantitatively through pre and posttests as well as a final exam. Qualitative data was collected by student surveys. After the research had concluded, the quantitative data was inconclusive as to if there was an advantage in reading the novel while learning the content. However, both students and teachers saw an increase in attitude and learning during the treatment units.

INTRODUCTION AND BACKGROUND

Context of the Study

I teach at Saratoga Middle High School as one of two science teachers. Saratoga, Wyoming is a small, mountain town located off Interstate 80 between Rawlins and Laramie. It has a population of 1,830 people. It is mainly a ranching community with ranches surrounding the town in all directions. The North Platte River runs right through the town which allows for lots of water activities throughout the year. There are two schools within the town itself: a) Saratoga Elementary School which houses kindergarten to sixth grade, and b) Saratoga Middle High School, which has grades seven through twelve. These schools are part of the Carbon County 2 School District along with schools in Encampment, Hanna, Elk Mountain, and Medicine Bow, Wyoming.

I teach seventh grade life science, ninth grade physical science, and tenth grade biology. Within grades 7-12, there are roughly 127 students, the average class size being around 20 students. The school is structured in such a way that each class is offered in two different hours. Therefore, I usually teach ten students per hour. Although we are a small school, our students often score higher on the science portion of the Wyoming Test of Proficiency and Progress (WYTOPP) test than the state average. The science department in our school has worked hard to build skills in data analysis, claims, evidence, and reasoning, and many lab procedures to help boost students' test scores.

Teaching seventh grade science has its challenges. Due to requirements for teaching reading, mathematics, and writing, science is rarely taught in the elementary classes. Students come into my class with a basic understanding of science, the main

emphasis being in ecology and little experience understanding scientific methods. As such, it has been necessary to come up with many different instructional practices to help students learn the skills needed before eighth grade, including providing accommodations for students through differentiated instruction and practical applications of the content. Through my instruction, I have noticed having a practical application of the content helps students better retain the content. This is why I have added a practical or hands-on activity to each major concept that we are learning.

I have relied greatly on the National Science Teachers Association (NSTA) for training and ideas on how to better teach my students in all my classes. With membership to the NSTA, I receive the publication *The Science Teacher*. Within the January/February 2021 edition, they published an interesting article on teaching the Hunger Games along with an ecology unit. It showed how students were able to learn and apply the concepts in a real-world situation, as well as think critically through this process (Rodriguez et al., 2018). This made me wonder if it would be possible to achieve similar results using a science fiction book with science content, such as adaptations and evolution.

Due to Saratoga Middle High School being a small school, as a staff, we rely on each other to help our students achieve, regardless of subject matter. That is what has interested me in this study as well. In the past, our students have scored decent on English Language Arts (ELA) standardized tests. However, there is room for improvement in these scores as well as the constant need for better reading comprehension. Research has shown that having many different types of knowledge can lead to positive impacts in comprehension (Alexander et al., 1994). With that in mind, it made sense to combine both science and ELA in a collaborative project that would help both classes grow

academically. Resultantly, the interdisciplinary project I implemented had students reading a science fiction novel in ELA while learning the content in science to explore whether the interdisciplinary approach would lead to better understanding as well as retention of the concepts being taught in both subjects.

Focus Question

My focus question was, What are the effects of collaboratively teaching science fiction in conjunction with science content?

My sub-questions include the following:

1. Does the collaboration between English and science improve students' science content knowledge?
2. Does the teaching of science fiction in conjunction with science content lead to better retention of science concepts?

CONCEPTUAL FRAMEWORK

Overview and Background of Cross-Curricular Activities

The use of cross curricular activities is one way to build student's interest in multiple subject areas with a singular goal to be accomplished. Cross curricular activities, like science fiction novels and project-based learning (PBL), planned between science and English classes can have many benefits. For example, using science fiction novels and PBL can increase students' content knowledge and retention of the content being taught (Geier et al., 2008). Plus, incorporating reading and writing into the science classroom helps learners develop their scientific knowledge as well as increased engagement (Norris & Phillips, 2003). These two instructional methods can lead to more student engagement due to using a different type of reading, such as science fiction, than is usually found in a science classroom, which usually consists of just informational text along with hands-on learning.

There are many differences between English and science teaching. When collaborations were studied by Alexander (2012), it was noted that science teachers were more likely to focus on factual content or scientific method, while the responses of English teachers focused on language and literary devices. While communication and literacy in English content seems more important than that within the science classroom, it has been noted that communication in science is just as important (Alexander et al., 2008). Science communication is extremely difficult. This is due not just to content and format but also due to perceptions both socially and politically (Martinez & Macknik, 2017). Although the differences between science and English literacy seem vast, there are

ways to bring the two disciplines together. Alexander et al. (2008), stated “there is an interest in critical literacy and scientific literacy, again on the grounds that these are essential in an information-saturated society” (p. 23). With all this in mind, there are many ways that these collaborations can take place. This collaboration is beneficial because it is common to have books used within the science, technology, engineering, and math (STEM) classes to help build interest in the topics, assist in learning content, and inspire design challenges (Jackson & Forsythe, 2020).

Interdisciplinary Teaching

Cross-curricular activities are not the only way that teachers can work together for student success. Another way is through interdisciplinary teaching. Interdisciplinary teaching refers to using different methods to connect different disciplines for a common goal. Interdisciplinary teaching can be beneficial not only for students, but also for teachers. It has been found that having interdisciplinary collaboration can lead to teacher development that shows improvement over time (Grossman et al., 2001). Interdisciplinary teaching can be successful if all teachers are confident, enthusiastic, and positive about the collaboration (Alexander et al., 2008). As stated by Alexander et al. (2008),

> it is considered worthwhile for pupils to observe teaching colleagues working together by making complementary contributions. This method of teaching helps to break down the barriers between subjects and demonstrates the connections between different areas of knowledge (p. 32).

As visible to students with other English and science collaborations, they can be successful if these factors, such as enthusiasm for the collaboration and subject mastery for all teachers, are considered. Lesson content should be authentic, grounded in each

contributing subject, and have genuine learning outcomes. When these conditions are satisfied, a synergy is created which results in real benefits for pupils in terms of their reading practice, interests, and understandings (Alexander et al., 2008).

These collaborations can also lead to improved student retention of content. According to Rinne et al. (2011), some of the ways that teachers can build more retention with their students is through various methods more incorporated in language arts than science such as (a) rehearsal, (b) elaboration, and (c) emotional arousal. With rehearsal, a teacher can have students rehearse repeated information over time within the classroom (Rinne et al., 2011). This repetition can be seen in the creation of nonverbal/artistic representations and helps with recall of the information (Rundus, 1971). Elaboration is another technique that helps increase retention. Elaboration, as long as it adds meaning, through more engaging activities lead to better long term retention of the information (Rinne, 2011). This elaboration is beneficial when students can relate the information to themselves in some way (Klein & Kihlstrom, 1986). Another way that students can relate information to themselves and retain more content is through emotional arousal. Information can impact memory more when there are high levels of emotional arousal because that arousal can lead to changes in attention during instruction as well as greater long term memory (Rinne, 2011). All three of these tasks not only lead to better retention of information, but also are easily incorporated through the reading of a science fiction novel in contrast to reading the content through informational text.

Science Fiction Narratives

One way to interest students in both science and English is the use of science fiction literature narratives in a collaborative, project-based unit. Finding a way to incorporate science content in a fictional manner, can be quite beneficial to both students and their comprehension (Vrasidas et al., 2015). There are several diverse ways in which these benefits can occur. When applied in a fictional and theoretical world, students can understand the concepts and apply them to real-world situations in future class and life settings (Rodriguez et al., 2020). There are many benefits, including increased memory and understanding when narratives are used in science classes (Avaraamidou et al., 2009). Also, it has been shown that the use of narratives, helps students develop better research skills and improve their critical and creative thinking. These are skills that help students be successful in the 21st century (Vrasidas et al., 2015). Vrasidas et al. (2015) stated

> that the use of Sci-Fi narrative in the learning process encourages students to view literature as playing with imagination. This in turn can help develop a positive stance towards literature and reading (p. 204).

From previous studies in this area, it was found that cross-curricular Sci-Fi units helped with student engagement (Vrasidas et al., 2015). With all of these in mind, the collaboration between a science and English class incorporating science fiction to help retain science content can be successful and beneficial to the students involved.

Project-Based Learning

Project-Based Learning (PBL) is another method commonly used in conjunction with cross-curricular projects and can be used to link science fiction to science content. The use of project-based instruction gives students ownership of their learning, affords more voice and choice, and provides more opportunity for active learning (Larmer et al., 2017, as cited in Rodriguez et al., 2020). Based on research, Kingston (2018) states "that PBL can promote student learning and may be more effective than traditional instruction in social studies, science, mathematics, and literacy." (p. 2). One of the benefits of PBL is the use of multiple modalities to share information. Multiple modalities give students opportunities to work with information in a variety of methods (Lannin et al., 2020). Multiple modalities refer to an instructional practice used to engage students by employing a variety of teaching methods. By using a variety of instructional practices, students can learn to communicate on a deeper level (Hill, 2014). Plus, if there are multiple modes of communication within a lesson, this gives students many opportunities to make sense of the learning (Boerman-Cornell, 2016). With all these ideas, there is the potential to have a successful collaboration of both English literacy and science content using science fiction literature and PBL.

METHODOLOGY

Demographics

This project focused on a collaboration between a seventh grade English language arts class and a life science class. The collaboration was based around the teaching of a science fiction novel, Maximum Ride by James Patterson. The students read the novel and did activities in both classes while they were in their genetics and evolution units in science. This mixed methods action research project aimed to answer the following two research questions:

1. Does the collaboration between English and science improve students' science content knowledge?
2. Does the teaching of science fiction in conjunction with science content lead to better retention of science content?

For this project, I used my seventh grade life science class. I taught this class in two separate sections with a total of 20 students. As with most classes, this class had a wide variety of academic skills and abilities but were similarly on the same level for the purpose of this study. This class also contained an English Language Learner (ELL) student. The student attended the class in English, but a copy of the novel in Spanish was provided. Although these students had a variety of skills, for the majority, their science skills and foundation were low. As is the reality for most elementary schools, there is little time allotted for science. Luckily, this class worked hard and has progressed at learning the process of science in both skills and content.

I chose the seventh grade life science to work with because I knew that I could work well collaboratively with their English teacher. The English teacher is a second year teacher who has great energy and ideas, and I knew would be up to trying out this treatment. After a brainstorming session on different novels to use with students, we chose Maximum Ride by James Patterson, which is a middle school level novel that fits in nicely with the curriculum of seventh grade life science, specifically with the units of genetics and evolution. Last, this grade was chosen because due to a lack of science education at the elementary level, I knew that this class would be a good blank slate to work with on the units with both the treatment and without. These students were working on building up their foundation, skills, and knowledge in science, so I knew that they would not have many misconceptions and preconceived knowledge so data could be gathered with less bias.

The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for work with human subjects was maintained (Appendix A).

Treatment

The treatment for this capstone project is studying the effects of teaching science content in conjunction with a science fiction novel to see if it improves both English literacy as well as retention of science content. The treatment was used on my seventh-grade life science class (N=20) and required working closely with their English Language Arts (ELA) teacher. I used the novel Maximum Ride by James Patterson and had the students do a book study while they were in their genetics and evolution units in my

class. By using units that fall in the middle of the school year, I could compare the data to the other units that they were learning this year while not reading a related novel in their ELA class. This treatment was designed as a mixed method approach by collecting both quantitative and qualitative data. It was important to collect qualitative data. Qualitative data is data that is collected from interviews, surveys, and firsthand observations. Often this data helps researchers to determine the frequency of certain characteristics (Given, 2012). Qualitative data deals more with the emotions and perceptions of the people involved in the study. The qualitative data that was collected was in the form of formal observations. Quantitative data is the collection and analysis of numerical data (Mertler, 2020). Quantitative research attempts to find cause and effect relationships within the study. This is essential for action research projects because the independent variable affects the dependent variable (Wilson, 2018). The quantitative data that was collected were the pre and posttests, cumulative final exam, and student surveys (Table 1).

This collaborative project between English and science classes looked at four units within the seventh grade life science curriculum: (a) cells, (b) genetics, (c) evolution, and (d) classification. All four units were taught similarly through lecture, lab work, and hands-on activities. With the genetics and evolution unit, the students read a science fiction novel in their English class which helped to reinforce the science content that they were learning in science class. They also performed special projects and assessments that required them to combine skills from both English and science class. As shared previously, data was collected similarly for all four units in the forms of pre and posttests, surveys, and a final exam and helped answer both research questions.

Table 1. Data Triangulation Matrix.

Data Collection Instruments	Does the collaboration between English and science improve students' learning of science content knowledge?	Does the teaching of science fiction in conjunction with science content lead to better retention of science content?
Pre/post Cell Unit Test	X	
Pre/post Genetics Unit Test	X	
Pre/post Evolution Test	X	
Pre/post Classification Test	X	
Student Surveys	X	X
Cumulative Final Exam	X	X

Data Collection and Analysis Strategies

To gather the data needed for this project, there were many quantitative and qualitative data that were collected to support the evidence that the treatment was or was not effective in this project. The instruments include pre and posttests, surveys, observations, and a final exam.

Pre and Post Tests

Within the study, pre and post-test instruments were used to collect quantitative data across four content units. The units included (a) cells, (b) genetics, (c) evolution, and (d) classification. Two units of data were collected with the treatment and two units of data were collected without the treatment.

Pre and post-test instruments are a great way to collect quantitative data. Quantitative data is the collection and analysis of numerical data (Mertler, 2020) and attempts to find cause and effect relationships within the study, meaning the relationships

between the independent and dependent variable (Wilson, 2018). The pre and post-test instruments were implemented before and after each unit that was taught. The comparison of pre and posttest scores can help build an understanding of the treatment's effect on students' learning within the units (Mertler, 2020).

All the pre/posttests given were created as multiple choice tests with questions at a middle school level focused on content from the unit and were given electronically in Schoology, a Learning Management System. There were four different pre/posttests that corresponded with four different content units: (a) pre and posttest cell unit, (b) pre and posttest genetics unit, (c) pre and posttest evolution unit, and (d) pre and posttest classification unit. For each unit, the pre and posttests were exactly the same, meaning they had the same content, length of ten questions, and same rigor. According to Sousa et al. (2017), it is important to have the two tests be similar to reduce bias. At the beginning of each unit, the pretest was given to students. Students were reassured that this was not for a grade, but a pre-assessment showing what they currently knew about the topics. Pre-assessment scores were recorded in a spreadsheet for later analysis. The unit was taught through lecture, notes, laboratory experiments, and hands on activities. Students reviewed and took their posttest after the unit had been concluded.

Non-Treatment Units: Pre and Post-Tests. In the study, the non-treatment units were cells and classification. The cell unit pre and post-test included questions that focused on types of cells, structure and function of organelles, and cellular functions such as diffusion, cellular respiration, and mitosis (Appendix B). The classification unit pre and post-test included questions on the classification of life from domain to species, scientific names, and dichotomous keys (Appendix C).

Treatment Units: Pre and Post-Tests. In the study, the treatment units were genetics and evolution. The genetics unit pre and post-test included questions about meiosis, chromosomes, and chromosome number. The test was vocabulary heavy because to understand genetics, students must know the vocabulary (ex. dominant and recessive, alleles, heterozygous, homozygous, complete dominance, incomplete dominance, and codominance). Students were expected to know how to do Punnett squares although answers were presented in multiple-choice form (Appendix D). Due to the novel being about mutations and genetic engineering, a pre and post-test for evolution was given as well. This was one of the main content areas of the novel, so a lot of valuable information came from this unit. As with the others, this was also a multiple-choice test. The students were expected to know adaptations, mutations, how genes are passed on, and different theories of evolution (Appendix E).

After the pre and posttests were given, the normalized gains were calculated. The normalized gain is a measure of conceptual understanding. It is calculated by subtracting the pretest score from the posttest score and dividing that answer by one hundred minus the pretest score. After all units had been calculated, the normalized gains were compared to see which units exhibited the largest gains in learning (Coghlan & Brydon-Miller, 2014). The largest gains showed the greatest learning that occurred at that time (Coghlan & Brydon-Miller, 2014).

Student Surveys

Surveys are another quantitative data collection method. Surveys are an effective way to gather information about the thoughts of a larger population (Mertler, 2020). Surveys also allow a large amount of data to be collected quickly and can be delivered in

several different ways such as over the phone, online, or face to face (Leman, 2015). For this study, an open ended survey via Google Forms was given to the students at the end of the semester. The survey asked questions that dealt with the students' learning from the entire year, and the techniques that they thought helped them learn best (Appendix F). It was important to get the students' opinions on their learning and for them to know what works best for them to learn. This survey contained questions that pertained to this capstone project as well as general questions that will continue to assist me in my future classes by giving insight into what the students felt was successful in my classroom.

Doing this survey gave me another way to look at the data. The data was sorted by what the students liked best, least, and how they felt about the novel in conjunction with science class. From doing the survey, it was beneficial to get the students' opinions as to how they were doing in class; whether the treatment helped them to learn better, and if they retained more through the treatment. This allowed me to gather data for both research questions and calculate the frequency counts of both survey question.

Cumulative Final Exam

Cumulative final exams are one way to measure students' retention, meaning their ability to recall what has been learned. According to the National Learning Laboratory (2020), there are different ways to increase knowledge retention. The lowest method would be lecture, followed by reading, audio visual, demonstration, discussion, learn by doing, and last, teaching others. With this project, the thought would be that the students would not be learning in the method of just lecture, reading, and regurgitation. Students

were expected to read a novel that related to the content and then applied the knowledge in diverse ways to see if this helped them remember the information better (Rinne, 2011). The cumulative final exam for this study helped me answer my research question, Does the teaching of science fiction in conjunction with science content lead to better retention of science content?

At the end of the school year, the students were given a cumulative final exam. This helped me to determine what the students learned and retained throughout the year. The questions that I asked on the exam for my capstone project were multiple choice (Appendix G). Because this was a cumulative final, this was given at the end of the school year. This final is considered a one-tailed test. A one-tailed test is often used to test a hypothesis that describes a relationship (Allen & Draeger Jr., 2018). With this project, the hypothesis is that the collaboration between English, in the form of a science fiction novel, taught with science content leads to better retention of the science concepts. After the final had been taken by the students, the questions were sorted, and percentages were calculated as to how well the students retained the information from the four different units.

DATA ANALYSIS

Results

Pre and Post-Tests

The students had four different units that were given pre and posttests *(N*=20*)*. Two of the units were during the time where students were reading the novel and two were not.

Non-Treatment Cell Unit. The first unit where data was collected was over cells. The range for the cell pretest was from a score of eight to one. The average score on the pretest was a four. After the cell unit was concluded, the students took a posttest in addition to a unit test within the class. For the posttest, the range of scores was zero to ten. The average was a six. Sixty-five percent of the subjects raised their scores on the test (*n*=13), 20% stayed at the exact same score (*n*=4) and 15% dropped their scores (*n*=3). The normalized gains were calculated for this unit. The average normalized gain for this unit was 0.33 (Figure 1).

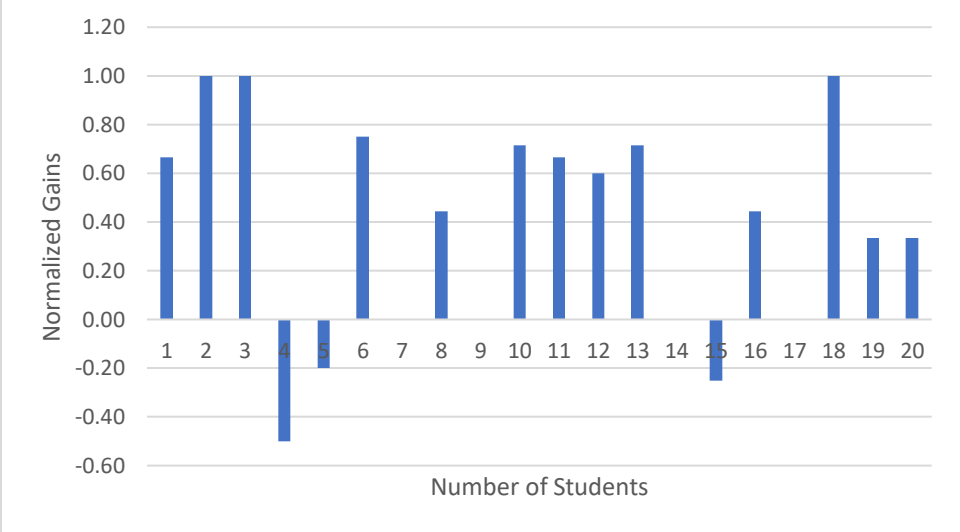

Figure 1. Normalized gains for the cell unit, (*N*=20).

Treatment Genetics Unit. The next unit that was covered was genetics. As with the cell unit, students were unfamiliar with most of the content. With the genetic pretest, there was a range in scores from a one to a nine. The average score for the pretest was a four. After the posttest was given, the scores were higher for most of the subjects than the pretest at 65 % (*n*=13), 25% of students did score lower than the pretest (*n*=5) and 10% of students scored the exact same (*n*=2). The range of the scores for the posttest was

from a two to a ten, so the range was the exact same as for the pretest. The average score for the posttest was a seven, three points higher than the pretest. The normalized gains were calculated for this unit with an average of 0.18 (Figure 2).

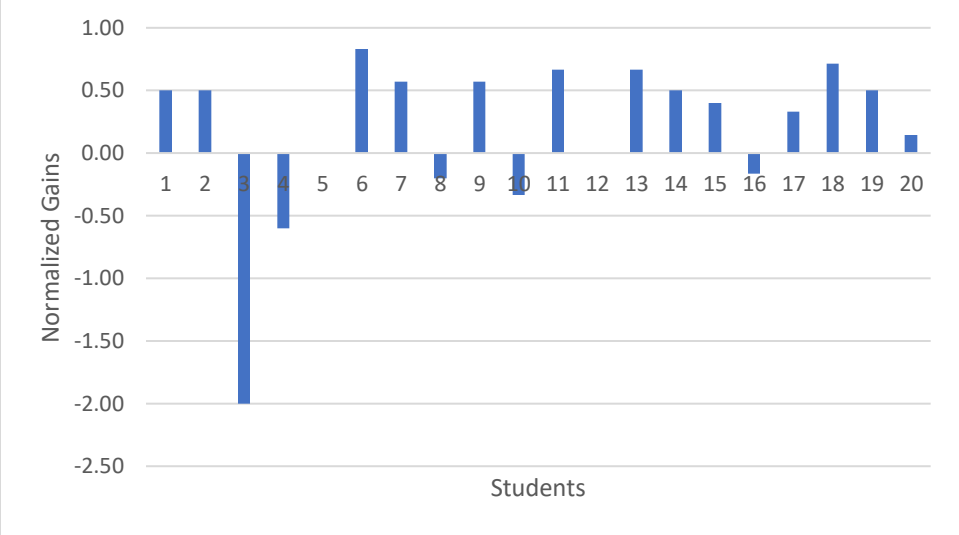

Figure 2. Normalized gains for the genetics unit, (*N*=20).

Treatment Evolution Unit. The next unit was the evolution unit. This unit received the treatment using the novel Maximum Ride which dealt with evolution of new species albeit species that were genetically modified and artificially selected. The students engaged in the content through notes, videos, readings, and hands-on activities. The students also developed their own special organisms that were adapted to have certain traits. The students had to figure out what environment the organism would live best in. The evolution unit focused on what evolution is, evidence for evolution, theories for evolution (Lamarck and Darwin's theory of natural selection), and human effects on evolution. As with every unit, students were exposed to vocabulary and concepts in the pretest that they were unfamiliar with. The range for the pretest was from a score of two to a score of eight. The average score being a five. After the unit was taught, the

students took a posttest over the same material as in the pretest. For this test, students scored on a range from one to eight with a mean of five as well. After both tests were taken, 55% of students scored higher on the posttest than pretest (*n*=11), 25% stayed the same (*n*=5), and 15% scored lower (*n*=4). The normalized gains were calculated for this unit with an average of 0.11 (Figure 3).

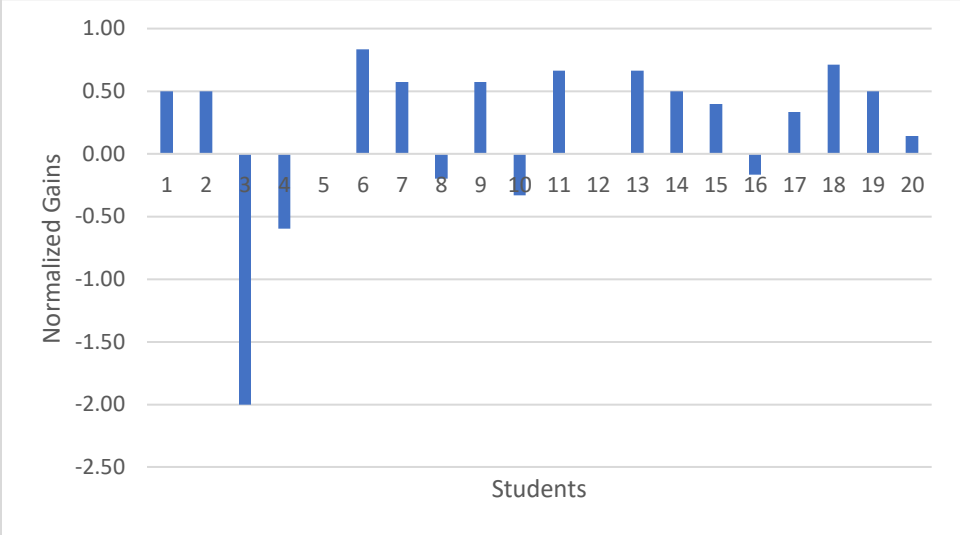

Figure 3. Normalized gains for the evolution unit, (*N*=20).

Non-Treatment Unit Classification. The last unit that the students were tested over was classification. This unit was completely brand new material to the students and was not included in the treatment. As with the other three units, the students were given a pre and posttest over the information. With the pretest, the average score was a three. After the posttest, the average score was a seven. Eighty percent of the students showed growth between the pre and the posttest(*n*=16), 10% of students received the exact same score (*n*=2), and 10% of students' scores dropped (*n*=2). The normalized gain for this was a 0.47 (Figure 4).

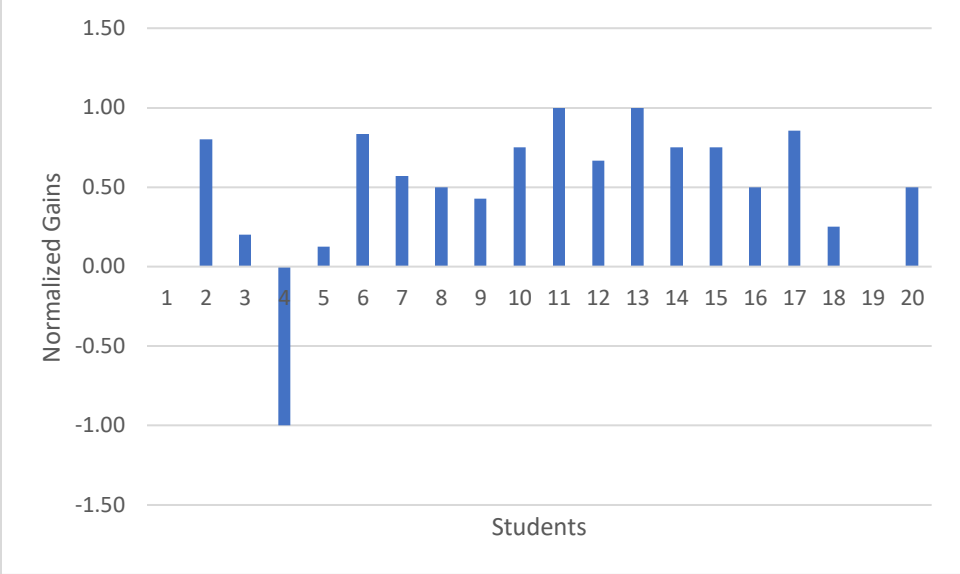

Figure 4. Normalized gains for the classification unit, (*N*=20).

Comparative Results of the Non-Treatment and Treatment Units. With all four units of the pre and posttests, the units with the highest normalized gains were the two units without the treatment. The classification unit at 0.47 and the cell unit at 0.33. The two units with the lower normalized gains were the evolution unit at 0.11 and the genetics unit at 0.18. When looking at the range of growth between the pre and posttests, the unit with the most growth was the classification unit (growing four points between the two tests), followed by the genetics unit (three points), the cell unit (two points), and evolution (grew by one point) (Figure 5).

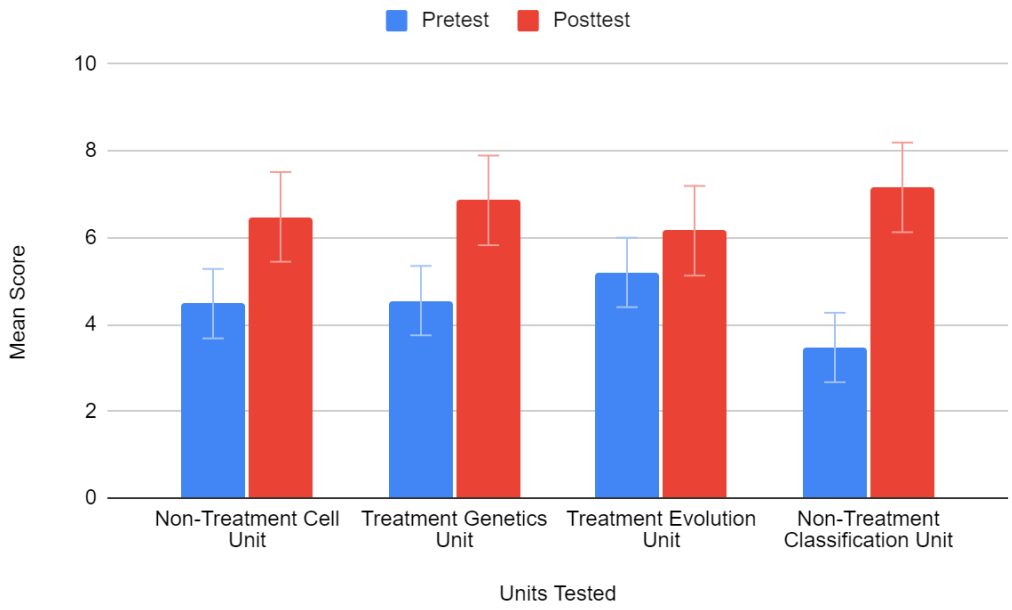

Figure 5. Growth between pre and posttests for all four units, (*N*=20).

Cumulative Final Exam

The students were given a cumulative final exam at the end of the year to see how much information they retained throughout the year. Part of this exam did include questions from the four units that had pre and posttests for this action research project. This was to see if the students retained more information from the units that corresponded with the novel in comparison to the units where the novel was not used.

The cumulative final exam was just ten questions covering a few questions from each of the four units: cells, genetics, evolution, and classification. The students scored between getting ten questions right to only four questions. The average for the class was a 7.5. When looking at the break down of the scores, the students scored the highest on the questions that dealt with both evolution, which was a treatment unit, and classification, which was a nontreatment unit, at 91%. This was followed by questions

over cells, a nontreatment unit. The average score for these questions was an 84%. Students scored the lowest on the genetic questions which was a treatment unit. The average score for students on this section was a 56%. This means that one of the treatment units (evolution) and one of the nontreatment units (classification) showed the greatest percentage of information retained.

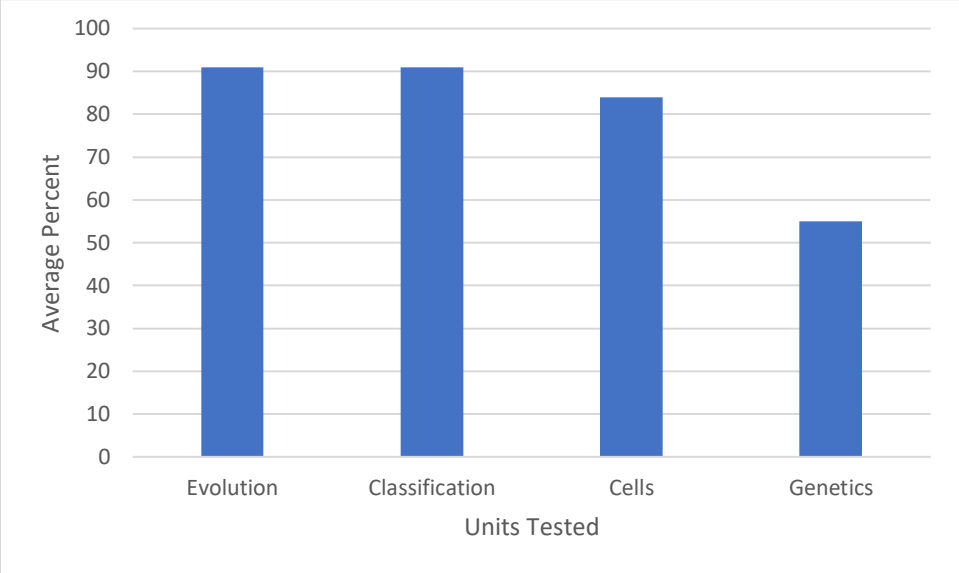

Figure 8. Percent correct on final exam, (*N*=20).

Student Survey

The students were given a survey at the end of the school year to see what they thought about the class, what activities were the most conducive to their learning, and what activities they most enjoyed. The opposite data was also collected. Students were honest about their opinions towards science class, activities, and what they thought helped them the most with their learning.

The question that pertained the most to this study was "Do you think that reading Maximum Ride by James Patterson helped you to learn science content like genetic engineering and evolution better? Why or why not?" The results were split. Of the 20

students that were surveyed, nine students said no. As to the reasoning as to why they do not think that the novel helped them in class, one student wrote "I do not think that it helped me because it didn't talk about how they genetically engineered them, and it was very fictional." A common complaint amongst the students who did not feel the novel was beneficial was due to the process not being explained, and it being too fictional or fantasy. A few students also commented that they did not feel they paid enough attention to the reading to gain anything from the book.

On the other hand, seven students felt that the novel did help them understand genetic engineering and evolution better. These students viewed their successes differently than the students who said that book did not help them. One student felt that they book helped with learning because "it made us ask more questions." Another student summed it up by saying "This is not meant to sound rude, but yes because the novel was literally about genetic engineering." One observation that was interesting about all three groups is that they were mixed among higher and lower achieving students.

There was a third group that I was not expecting which were the students who answered, "a little" or "yes and no." This group was comprised of four students, which means that it was almost an even split between the two groups. The students in this group commented that "A little but the things in the book were just really fake but I liked the book." Another student summed up the whole group's results by saying "Yes and no. Yes, because it told us about what happens when two genes are mixed but no because it didn't really explain it."

The students seemed to enjoy the book for its entertainment value; however, the majority of students would have liked to have learned and understood the process of genetic engineering better. And they were very curious on how realistic it would be to mix the genes of a bird with a human. They asked many questions about if humans could fly if they had wings, as well as what would happen to a true human/bird hybrid in society.

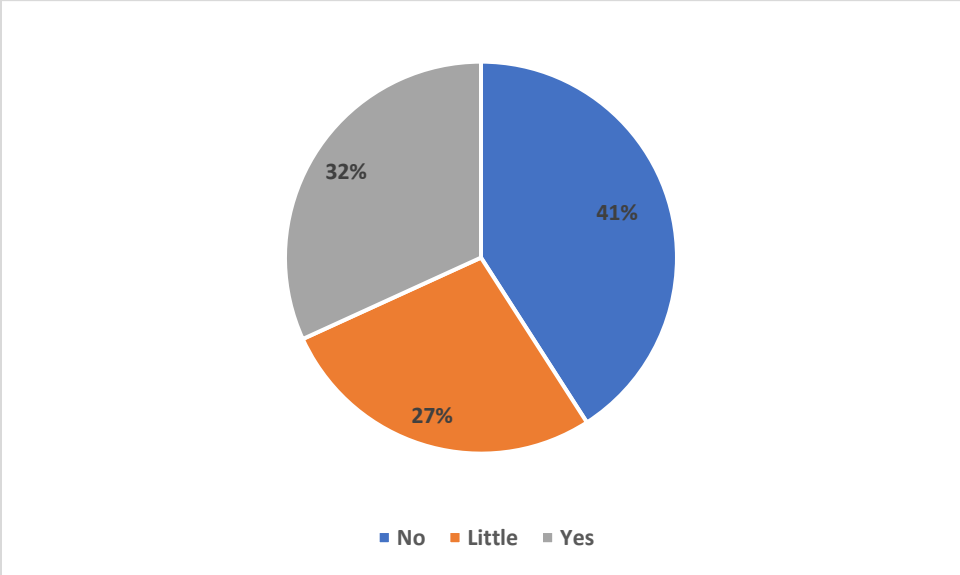

Figure 9. Percentage of student opinions towards novel, (*N*=20).

Claims From the Study

No Advantage to Learning Science Content

The first focus question that my project aimed to answer was "Does the collaboration between English and science improve science content knowledge?" To answer this question there was significant data to analyze. The first data that was analyzed was the results for the pre and posttests. The pre and posttest results were compared to understand the treatment effects on student learning within the units (Mertler, 2020). When looking at the pre and posttest data, the numbers were all over the place. When starting out with the first pretest over cells, students were overwhelmed, and this continued with all the units. For many of the students, this was the first time that they had heard the vocabulary and the processes were completely foreign to them. However, the majority did much better on the posttest once they had learned the unit. After the results were calculated, the students had the highest normalized gain for the nontreatment units of classification and cells. This would suggest that the treatment did not help the students in learning the material better due to the normalized gains for the treatment units being lower than the nontreatment units. However, it should also be noted that the differences between normalized gains was a difference of 0.36 above the treatment units.

Although the quantitative data did not show an advantage to the students learning through the collaboration between English and science, it was good for the students to see the connection between the two subjects. Often, students seem to view each separate class as its own entity. They do not see the ways that the classes are intertwined with

content and skills. I believe that this was a good project for students to see the ways that English and science are related in ways that they had not noticed before, and it was nice to see the students sharing information about the novel in my class and asking science related questions to the ELA teacher.

This project did have the students showing more interest within these two classes as well. According to a study of Norris & Phillips (2003), reading and writing in science classes can lead to better engagement as well as develop better scientific knowledge. Also, these collaborations can increase reading practice, interest, and understanding according to Alexander et al. (2008). Both of these things were observed within this group of students. They became quite interested in the breakthroughs in genetic engineering. They were often researching and sharing information on different projects within genetic engineering. There was also a huge interest in cloning: both the process and the ethics before this. This group wanted to know everything that was going on with it.

This project did not just bring about a greater interest in the concepts being taught in science class, students were also showing a greater interest in reading. In every class there are students who are known readers and will often share information on the books that they are reading. In comparison, during this project, several students were sharing the plot and details of Maximum Ride. There were many debates as to what the students thought were going to happen to the characters. Also, Maximum Ride is novel one in a series that consists of nine different books. After reading the first novel in class, some students went on to read all nine in the series. Although the collaboration between English Language Arts and Science did not lead to learning the science content better,

according to the data, it did lead to better interest in both ELA and science classes and concepts.

No Advantage to the Retention of Content

The second focus question that my project aimed to answer was "Does the teaching of science fiction in conjunction with science content lead to better retention of science content?" The final exam was given to observe the retention of the science content for each of the units. The final exam was a one-tailed test, which means that it is used to test a hypothesis that describes a relationship (Allen & Draeger Jr., 2018). After analyzing the results of the final exam, the results appeared inconclusive. The units where the students scored the highest were the evolution unit which was a treatment unit and the classification unit which was a nontreatment unit. The average of the students' scores was the exact same for those two units at 91% accurate. I do think that classification scored high due to being one of the last units that we covered before the final exam. The students had less time to forget the information in that unit. The next highest unit score was cells at 84%. Cells were also a nontreatment unit. The lowest scoring portion of the final exam was the genetics unit at 55%. I believe that part of the reason that genetics scored so low was due to the high amount of vocabulary that is part of genetics. Between the high amounts of new vocabulary and being one of the earlier units taught, I think this was a cause of the low retention percentage. With the two treatment units scoring the highest and the lowest, it is hard to make a definitive claim about the success of the treatment.

Qualitative data is data that is collected from interviews, surveys, and firsthand observations. This data helps researchers to determine the frequency of certain

characteristics (Given, 2012). By looking at the survey, students did feel that reading the book helped them to learn the science content. Although I did separate the survey results into yes, no, and a little. Overall, I would consider "a little" to be a yes as well. This means that eleven of the twenty students that were surveyed did feel that reading the novel did enhance their learning on these subjects.

However, I would still claim that the results were inconclusive. The students' and my perceptions were that there was a greater understanding of the content. However, the data does not support that claim due to the treatment units having the highest and lowest percentages of retention and a nontreatment unit having the highest percentage of retention as well.

Value of the Study and Consideration for Future Research

This study was beneficial in many ways. I saw the value of collaborating with educators teaching different subject areas within the same school. The students began to see the connections between the two classes and often shared insight that they gained in both. Students had questions on both sides of the collaboration. Their questions in their English class were about setting, characters, and foresight into the book. In science, they had questions about the genetically modified organisms, how realistic that would be, and physical limitations to the organisms, as well as ethical concerns.

The students were interested in different breakthroughs and discoveries within genetic engineering, and this led to more reading into articles about cloning. Plus, many of the students went on to read the rest of the Maximum Ride series, and there were many discussions into the adventures of the human/bird hybrids and the implications behind it.

With future research, I would like to work on more collaborations with the English Language Arts teacher with this novel. We were both new to the process and I think that working on it more each year would lead to better success. In the future, I want to cover the process of gene splicing and genetic engineering due to the fact that many students were frustrated that they did not get to know the process that the children in the novel went through to become a hybrid species. Also, I would be more intentional with my projects and assignments. The ELA teacher and I had talked but failed to implement a culminating final project at the end of the unit. I think that this would have helped me receive better data from my students. Plus, I think that it would have helped my students understand the project better and would have helped guide them better through the unit.

Impact of Action Research on the Author

I learned much throughout the process of this action research project. As was stated before, I enjoyed getting to work with an educator in a different subject area on this collaboration. This gave me insight into how different people with different areas of expertise view tasks differently. It also made me curious how it would be to work with different subject areas throughout the school.

It is always beneficial to evolve our teaching practices and to force ourselves out of our comfort zone to try new techniques that could be more beneficial to students. I believe that this is especially true being a seasoned teacher. It is easy to fall into the trap of teaching the way that we always have, doing the exact same activities, and forgetting that with each new group of students, we are getting new children who might learn differently. I need to always be pushing to try those new techniques and practices.

The students that I worked with for this action research project were new students to me. They challenged me in a way, that while frustrating, helped me grow as a teacher. I had never worked with a group quite like this group. I have worked with seventh grade students for the past six year, and this was the most immature group that I have worked with. I had to be very strict in the classroom and there could be no down time. Even transitions within the classroom had to be strictly monitored and regimented. This group also needed more prompting than the average class with motivation. Because of this, I was really frustrated that this was the group that I had used for this project. However, after I got more into the school year. I appreciated that I had a group where it was necessary to differentiate my instruction and teach differently than what I had grown accustomed to doing.

I also wish that I would have been more transparent with my students throughout this process. I went into my action research project with this crazy idea that the students should not be aware of what was going on. I am not sure why I thought this or that I thought I had to observe them in a "pure" form where they would not perform for the project. In hindsight, I think that this project would have been much more beneficial if the students would have been aware of what was happening, had the data shared with them, and had some buy in to the whole project. I believe that if I had done this, I would have seen a difference in the results and data, and I am hoping to do this project again in the future to see if this is true.

REFERENCES CITED

Alexander, J. (2012). Subject synergy: Collaborations between English and science: Joy Alexander explores way in which English and science can work together to promote enjoyment in both subjects and develop skills of reading and writing. *English Drama Media*, (22), 31+.

Alexander, J., Jarman, R., McClune, B., & Walsh, P. (2008). From rhetoric to reality: Advancing literacy by cross-curricular means. *Curriculum Journal, 19*(1), 23-35.

Alexander, P. A., Kulilowich, J. M., & Schulze, S. K. (1994). How subject-matter knowledge affects recall and interest. *American Educational Research Journal, 31*(2), 313-337.

Allen, M., & Draeger Jr, R. (2018). The SAGE encyclopedia of communication research methods.

Angelo, T. A., & Cross, K. P. (1993). *Classroom assessment techniques*. Jossey-Bass.

Avraamidou, L., & Osbourne, J. (2009). The role of narrative in communicating science. *International Journal of Science Education, 31,* 1683-1707. http://10.1080/09500690802380695

Boerman-Cornell, W. (2016). The intersection of words and pictures: Second through fourth graders read graphic novels. *The Reading Teacher, 70*(3), 327-335.

Brookhart, S. M. (2019). Formative assessment in teacher education. https://10.4135/9781529716627

Coghlan, D., & Brydon-Miller, M. (2014). The SAGE encyclopedia of action research. https://10.4135/9781446294406

Currivan, D. B. (2011). Conversational interviewing. https://10.4135/97781412963947

Geier, R., Blumenfield, P. C., Marx, R. C., Krajcik, J. S., Fishman, B., Soloway, E., &Clay-Chambers, J. (2008). Standardized test outcomes for students engaged in inquiry-based science curricula in the context of urban reform. *Journal of Research in Science Teaching, 45*(8), 922-939. http://hdl.handle.net/2027.42/61206

Given, L. M. (2012). The SAGE encyclopedia of qualitative research methods.

Grossman, P. L., Wineburg, S., & Woolworth, S. (2001). Toward a theory of teacher community. *Teachers College Record, 103(*6), 942-1012.

Hill, A. E. (2014) Using interdisciplinary, project-based, multimodal activities to facilitate literacy across the content areas. *Journal of Adult and Adolescent Literacy, 57*(6), 450-460.

Jackson, J. K., & Forsythe, M. (2020) Using trade books and biographies to bring the practices of engineering to life. *Science Scope, 44*(2), 30-35.

Kingston, S. (2018). Project based learning & student achievement: What does the research tell us?. *Buck Institute for Education, 1*(1).

Klein, S. B., & Kihlstrom, J. F. (1986). Elaboration, organization, and the self-reference effect in memory. *Journal of Experimental Psychology:General, 115*(1), 26-38.

Lannin, A., Juergensen, R., Smith, C., Abdelnaby, H., Van Garderen, D., Folk, W., Palmer, T., & Pinkston, L. (2020) Multimodal test sets to use literature and engage all learners in the science classroom. *Science Scope, 44*(2), 20-27.

Leman, J. (2015). Different kinds of quantitative data collection. https://10.4135/9781446268346

Martinez-Conde, S., & Macknik, S. L. (2017). Finding the plot in science storytelling in hopes of enhancing science communication. *Proceedings of the National Academy of Sciences, 114*(31), 8127-8129. https://10.1073/pnas.1711790114

Mertler, C. A. (2020). *Action research*. SAGE Publications, Inc.

Norris, S. P., & Phillips, L. M. (2003). How literacy in its fundamental sense is central to scientific literacy. *Science Education, 87*(2), 224-240.

Rinne, L., Gregory, E., Yarmolinskaya, J., & Hardiman, M. (2011). Why arts integration improves long term retention of content. *Mind, Brain, and Education, 5*(2), 89-96.

Rodriguez, G. E., Shoda, Z., Assour, H. R., Fischer, V., & Bailey, J. M. (2020). The survival games. *The Science Teacher, 88*(3), 18-22.

Rundus, D. (1971) Analysis of rehearsal processes in free recall. *Journal of Experimental Psychology, 89*(1), 63-77. https://10.1037/h0031185

Sousa, V., Lopes, M., Keenan, G., & Dunn Lopez, K. (2017). Challenges and solutions in conducting a randomized controlled trial with students. https://10.4135/9781526413512

Vrasidas, C., Avraamidou, L., Theodoridou, K., Themistokleous, S., & Panaou, P., (2015). Science fiction in education: Case studies from classroom implementations. *Educational Media International, 52*(3), 201-215. http://10.1080/09523987.2015.1075102

Wilson, S.R. (2018). The SAGE encyclopedia of communication research methods.

APPENDICES

APPENDIX A

MONTANA STATE IRB EXEMPTION

Thank you for your application. This email acknowledges receipt of the request for IRB Review and serves as the Approval Letter for your research. Your new **IRB Exempt Protocol # is LS112421-EX**.

Study Title: **The effects of teaching science fiction in conjunction with science content within the science classroom**

As the PI, it is your responsibility to facilitate subject understanding by informing subjects of all aspects of the project, providing an opportunity to ask questions, and describing risks and benefits of participation. Submit any new changes to the research protocol to the IRB via Amendment Form prior to implementing.

The research described in your submission is exempt from the requirement of additional review by the Institutional Review Board in accordance with 45 CFR 690.104(d). The specific paragraph which applies to your research is:

> (1) Research, conducted in established or commonly accepted educational settings, that specifically involves normal educational practices that are not likely to adversely impact students' opportunity to learn required educational content or the assessment of educators who provide instruction. This includes most research on regular and special education instructional strategies, and research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

APPENDIX B

PRE AND POSTTEST CELL UNIT

1. The basic building block of all living things are
    a. Tissues
    b. Cells
    c. Organ systems
    d. Muscles
2. The thin structure that surrounds a cell is known as
    a. Nucleus
    b. Cell membrane
    c. Cytoplasm
    d. Vacuole
3. The control center of the cell is the
    a. Cell wall
    b. Organelles
    c. Cytoplasm
    d. Nucleus
4. The movement of material from a more concentrated area to a less concentrated area is celled
    a. Osmosis
    b. Photosynthesis
    c. Respiration
    d. Diffusion
5. Small, round structures in a cell that make proteins are known as
    a. Cellulose
    b. Ribosomes
    c. Vacuoles
    d. Mitochondria
6. The movement of water through a membrane is called
    a. Diffusion
    b. Synthesis
    c. Osmosis
    d. Photosynthesis
7. The organelle that breaks down glucose to produce energy is
    a. Ribosome
    b. Lysosome
    c. Mitochondria
    d. Chloroplasts
8. The movement of materials through a membrane without the use of energy is known as
    a. Passive transport
    b. Photosynthesis
    c. Active transport
    d. Fermentation

9. The nucleus of the cell divides by the process of
    a. Mitosis

b. Osmosis
c. Diffusion
d. Respiration

10. Animal cells have all the following except
    a. Ribosomes
    b. Mitochondria
    c. Vacuoles
    d. Cell wall

APPENDIX C

PRE AND POSTTEST CLASSIFICATION UNIT

1. The science of classifying living things is
    a. Taxonomy
    b. Biology
    c. Astronomy
    d. Botany
2. Into how many kingdoms are organisms classified?
    a. Two
    b. Three
    c. Four
    d. Five
3. Viruses are made up of a piece of nucleic acid covered by
    a. A cell wall
    b. A protein coat
    c. A membrane
    d. Cytoplasm
4. All the following are kingdoms except
    a. Plantae
    b. Animalia
    c. Protista
    d. Viruses
5. Grouping things according to their similarities is called
    a. Classification
    b. Variation
    c. Specialization
    d. Mutation
6. Which of the following groups contains only one kind of organism?
    a. Phylum
    b. Species
    c. Genus
    d. Order
7. Plantlike organisms that lack chlorophyll (they are heterotrophs)
    a. Fungi
    b. Viruses
    c. Archaebacteria
    d. Protists
8. Unicellular organisms that are eukaryotes are
    a. Eubacteria
    b. Fungi
    c. Viruses
    d. Protists

9. Viruses can only reproduce
    a. Inside a living cell

b. Outside a living cell
c. Inside fungi
d. Outside a capsid

10. The classification level made up of related species is called a
    a. Phylum
    b. Class
    c. Species
    d. Genus

APPENDIX D

PRE/POSTTEST GENETICS UNIT

1. A gene combination in which a mixture of traits shows is called
    a. Purifying
    b. Incomplete dominance
    c. Hybridization
    d. Codominance
2. Traits that are inherited with sex chromosomes are
    a. Inherited traits
    b. Sex-linked traits
    c. Controlled traits
    d. Uncontrolled traits
3. An organism with two like genes for a trait is said to be
    a. Heterozygous
    b. Homozygous
    c. Dominant
    d. Recessive
4. A molecule of DNA contains all the following except
    a. Nitrogen bases
    b. Sugar
    c. Sulfur
    d. Phosphates
5. When the parents are homozygous dominant and homozygous recessive, all the offspring are
    a. Homozygous recessive
    b. Heterozygous
    c. Homozygous dominant
    d. Dominant
6. A dominant gene usually shows itself over a
    a. Homozygous gene
    b. Recessive gene
    c. Heterozygous gene
    d. Sex-linked trait
7. An organism receives chromosomes from
    a. The environment
    b. The atmosphere
    c. Its parents
    d. Mutations
8. A type of cell division that produces gametes is
    a. Replication
    b. Meiosis
    c. Heredity
    d. Codominance

9. Most of the genes for sex-linked traits are carried on the
    a. Y chromosome

b. Y gene
c. X chromosome
d. X gene

10. The sides of a DNA ladder are made up of
    a. Nitrogen bases
    b. Proteins
    c. Melanin
    d. Sugars and phosphates

APPENDIX E

PRE/POSTTEST EVOLUTION UNIT

1. The process by which organisms change over time is known as
    a. Adaptation
    b. Evolution
    c. Natural selection
    d. Variation
2. Differences among individuals in a species are called
    a. Adaptations
    b. Mutations
    c. Natural selection
    d. Variations
3. A sudden change in a gene is called
    a. An adaptation
    b. A mutation
    c. A variation
    d. Natural selection
4. A group of organisms that look alike and can reproduce among themselves is known as
    a. A species
    b. Ancestors
    c. Mutations
    d. Genes
5. Body structures that seem to have no function are celled
    a. Homologous structures
    b. Glands
    c. Vestigial structures
    d. Mutations
6. Special traits that help organisms survive in their environment are
    a. Adaptations
    b. Genes
    c. Mutations
    d. Fossils
7. Body parts that are similar in structure are called
    a. Homologous structures
    b. The fossil record
    c. Vestigial structures
    d. DNA evidence
8. Natural selection is also known as survival of the
    a. Species
    b. Variation
    c. Fittest
    d. Fossil

9. All modern humans belong to the species
    a. *Cro-magnon*

b. *Homo sapiens*
c. *Neanderthalensis*
d. *Humanoids*

10. Organisms that are no longer found as living species are said to be
    a. Untraceable
    b. Rare
    c. Extinct
    d. Endangered

APPENDIX F

STUDENT SURVEY

Student Survey

Fill out these questions honestly and completely. Your answers will stay anonymous, but please take the questions seriously.

1. What was your favorite thing to do in science class this year? Why?

2. What was your least favorite thing to do in science class this year? Why?

3. What lab and/or activities were your favorite? Why? Is this something that I need to remember to do with next year's class?

4. Was there a lab and/or activity that you did not enjoy doing? Why?

5. Do you think that reading Maximum Ride by James Patterson helped you to learn science content like genetic engineering and evolution better? Why or why not?

6. What were techniques or methods that helped you learn best in science? Why?

7. What techniques or methods were not as helpful to your learning? Why?

8. Of all the content that we learned in science this year, what topics do you feel you learned best and will remember longest? Why?

APPENDIX G

CUMULATIVE FINAL EXAM

1. When the parents are homozygous dominant and homozygous recessive, all the offspring are
    a. Homozygous recessive
    b. Heterozygous
    c. Homozygous dominant
    d. Dominant
2. A type of cell division that produces gametes is
    a. Replication
    b. Meiosis
    c. Heredity
    d. Codominance
3. All the following are kingdoms except
    a. Plantae
    b. Animalia
    c. Protista
    d. Viruses
4. A group of organisms that look alike and can reproduce among themselves is known as
    a. A species
    b. Ancestors
    c. Mutations
    d. Genes
5. A sudden change in a gene is called
    a. An adaptation
    b. A mutation
    c. A variation
    d. Natural selection
6. Special traits that help organisms survive in their environment are
    a. Adaptations
    b. Genes
    c. Mutations
    d. Fossils
7. The basic building block of all living things are
    a. Tissues
    b. Cells
    c. Organ systems
    d. Muscles
8. The movement of material from a more concentrated area to a less concentrated area is called
    a. Osmosis
    b. Photosynthesis
    c. Respiration
    d. Diffusion

9. An organism with two like genes for a trait is said to be
    a. Heterozygous

b. Homozygous
c. Dominant
d. Recessive

10. A type of cell division that produces gametes is
    a. Replication
    b. Meiosis
    c. Heredity
    d. Codominance