THE USE OF CASE STUDY STYLE QUESTIONS AS A MEANS OF IMPROVING ACADEMIC ACHIEVEMENT AND ATTITUDE

by

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DEDICATION

I would like to dedicate my paper, research, education, and career to my family. I hope to continue to make my family proud through my dedication to my profession and to the time I spend sharing the values they have shared with me.

ACKNOWLEDGEMENT

I would like to acknowledge the hard work, effort, time, and consideration put forth over the duration of the last three years in helping me become a better educator and person. I would like to thank my advisor, Marcie Reuer, for her guidance and patience over the course of the last year in helping me prepare, conduct, and finalize my action research project. I would also like to recognize the efforts of Dr. Peggy Taylor and Diana Patterson for organizing and directing a brilliant program that is accessible to teachers across the world. I would like to personally thank Dr. Elinor Pulcini for introducing me to the world of Microbiology and taking the time to advise my work. I would also like to thank Lindsay Hall for assisting all of us with the proper formatting of our papers. My school, R.L. Patton High School, and administration also deserve recognition for supporting the implementation of my action research treatment and the patience they have provided me through the last few years as I learned to balance teaching, coaching, and studying. And again, I would like to show my appreciation and gratitude for my family's support. Thank you for supporting my love for science, teaching, and growing as a person. I could not have done any of this without all of your support.

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ABSTRACT

The focal point of this action research project was to address the growing issues surrounding student attitude present in the high school science classroom. Many students struggle with connecting the science content explored in high school science classes with their personal lives and fail to make connections with real world applications. To improve student attitude an attempt was made to increase the student-content personal connection with the use of case study style questioning. Case studies, real world scenarios that demonstrate application and relevance to content being studied, have proven to be very successful in improving students' scores, attendance, and attitudes with their use at medical and professional schools. Case study style questions were drafted to be used as warm up activities for a unit on Genetics in a standard level Biology course. One class would receive the case study style questions and another would not, to act as a control group for comparison. Students who received the case study treatment showed little difference in academic achievement when compared to the control group. However, data collected from surveys and interviews demonstrated shifts in student attitudes. Students reported feeling more personally connected, comfortable, and interested in the content explored with case studies. Future work is needed to better outline the effects of case studies on academic achievement and will provide opportunities for future action research projects.

INTRODUCTION AND BACKGROUND

I teach at R.L. Patton High School in Morganton, North Carolina. Morganton is a small town of 16,807 residents and is the seat for Burke County. The city of Morganton is considered a part of the Hickory-Lenior-Morganton Statistical Metropolitan Area. According to city-data.com (2016), the per capita income for the city is approximately $18,830, with about 14% of the residents below the poverty line. The city has a wide range of employment opportunities; Case Farms' processing plant, corporate and local farms, state operated disabled and psychiatric hospitals, the North Carolina School for the Deaf, small manufacturing plants, and a growing tourism industry. R.L. Patton High School is one of four high schools in Burke County, serving about 1,000 students.

Students at Patton High struggle with understanding the application and relevance of science content learned in the classroom to real-world scenarios, potential careers, and their personal lives. I believe this is largely due to their previous science courses being designed with or primarily focused on rote memorization skills for improved performance on standardized summative assessments. This style or method of teaching science has left a lot of these students with little to no skills in being able to apply, remember, or appreciate the conceptual practicality of their science courses.

I want to improve the students' understanding of the value of applied science such that they will improve their long-term retention, foster new critical thinking and problem solving skills, as well increasing student engagement and attitude.

Case studies and case study style readings are stories that contain complex, real world situations that present problems and issues that must be addressed or resolved by

the readers according to the Eberly Center for Teaching Excellence & Educational Innovation at Carnegie Mellon University (2015). My research addressed whether or not others have been able to successfully tackle these shortfalls through the use of case studies, science based reading exercises, and the study of real world applications. For my research and the development of my conceptual framework I focused on the use of daily case study style questions to address the following research questions.

1. How do case studies affect a student's academic achievement?
2. How do case studies improve a student's attitude towards science?
3. How do case studies help students connect content to real world applications by improving scientific literacy?

CONCEPTUAL FRAMEWORK

The following review of literature was conducted to construct an intervention plan that applied the use of case study style questions to improve students' understanding and appreciation for the functionality of science. The studies, theories, and methods reviewed focus on increasing student academic achievement, assisting in the development of critical thinking skills, and fostering a general improvement in attitude towards the discipline of science.

The use of case studies and scientific literature are important components in strengthen a student's ability to exercise proper inquiry-based problem solving and argumentative skills (Llewellyn, 2013). These basic principles are the foundation for applying science learned in the classroom to scientific, technological, and engineering problems experienced in the field. Studies have shown that these forms of student-

centered learning provide a far more enriching experience for the students. These student-centered, inquiry-based objectives can lead to major improvements in students' examination scores according to the review of 225 studies conducted by Freeman (2014).

The first issue reviewed in the literature was how the mastery of science-centered inquiry, concepts, and content can be improved through the use of nonfiction and fiction based case studies. Case studies offer teachers and instructors a way of blending the true nature of science with necessary content.

One study conducted by Martin (2004) stressed the importance of understanding the application of basic chemistry principles in medicine for pre-medical students in a General Chemistry course using case studies, "an integrated knowledge of chemistry and biology is essential to understanding, diagnosing, and treating illness" (pg. 1). Martin (2004) also went on to describe the value of these patient based case studies as a means of reviewing and practicing the use of basic chemical principles throughout the course of the study.

Case studies also offer a way to improve student retention of key concepts necessary for understanding application-based examinations. A study used case studies as a method of teaching evolutionary significant principles to a biology course of 66 students using a pre and post assessment to measure growth. The pre-assessment average score for the class was 2.9 out of a total of 10 while the post-assessment average was 5.9 out of 10 (White, 2013).

The practices can help students exercise their understanding of vocabulary as well and can provide teachers with a diagnostic test for evaluating reading comprehension.

Case studies offer students the opportunity to "build on multiple sources of information to learn words through repeated exposures." (Echevarria, 2013). The studies reviewed demonstrated the growth potential offered by case studies and the opportunity presented by their use to help strengthen academic language.

The second area of research was focused on whether or not student-centered readings were able to help students develop stronger critical thinking and problem solving skills for use in making personal decisions related to science. Using case studies is an interdisciplinary approach that allows students an opportunity to formulate solutions to complex problems in addition to considering varying points of view (Varasidas, 2015).

Case studies can be used to help students build a strong personal understanding. If students are to make informed decisions they must understand the nature of science, it limitations, and its tentative behavior (Allchin, 2012). Bruner states that a "narrative is used to refer to a way of sculpting and structuring information through expressions of different media into readily understood forms that guide learners' comprehension, and to a cognitive mode that learners use to make sense out of information or experience." (as cited by Varasidas, 2015, pg. 202) Students equipped with these acquired skills can then begin to understand science as a "social enterprise", being one governed by personal perceptions and agendas (Fisher, 2008). Individuals who are capable of understanding science's tentative explanations and the motives driving research will be more likely to use informed decision making when producing a solution to a problem.

One study used case studies as a way of engaging 63 university level science students in discussing ethical issues surrounding science, with 90% of the students

providing positive feedback in regards to not only understanding the science but being able to agree on a solution for the proposed problems (Fisher, 2008). According to Allchin (2012), students "need to know how to probe the epistemic structure of scientific claims, to discern reliable ones from suspect ones." (pg. 905) All students, whether they pursue scientific careers or not, will have to make decisions based or related to science during their lifetimes and these skills can be strengthen through the use of case studies.

The third problem addressed in the review of literature was the need for a change in student attitude towards science and the scientific method. Case studies can help improve attitudes towards science by addressing the need for more student-centered and inquiry-based teaching methods. A study conducted by the University of Buffalo showed that about 30-40% of students across the county in major university will earn poor scores in their introductory level science courses driving them away from STEM related fields of study (Herreid, 2005). The decrease is enthusiasm and poor performances are indicative of a teaching strategy or method that damages students' perception of science.

Studies looking at intervention programs based around case studies at the university level have shown an increase in attendance levels from less than 50% for traditional teacher-centered lectures to nearly 100% attendance levels for courses using student-centered case study based instruction (Herreid, 2005). These findings were further supported by another application of case study based instruction and research performed by Martin (2004) involving university level chemistry courses, "the clinical case also generated many office visits from students who shared their own or relatives' medical experiences with questions pertaining to the relevant chemical principles." (pg.

1471). Considering the research and literature that was reviewed there is an obvious correlation between the use of case studies and student participation.

Enthusiasm and personal interest can also be improved in the classroom through the use of case study, literature, or narratives pertaining to science. According to the studies conducted by Varasidas (2015), “the analysis of the data showed that students created mental images of the story that seemed to have created the basis of their understanding of the learning activity. These mental images represented an emotional attachment to their characters, which again created an emotional goal for solving different assignments.” (pg. 212) Students can benefit from the boost in motivation and attitude related to the use of case studies and content-based readings in a classroom setting.

In conclusion, the use of case studies as a means of improving concept understanding, problem solving skills, and student participation levels are a very useful in any science classroom. These techniques can be used for diagnostic tests and a way for improving the retention of complex interrelated concepts over the course of a semester or academic career as displayed by White’s (2013) research, “these findings support the hypothesis that students who have an understanding of genetic, molecular, and cellular evolutionary mechanisms will have a better understanding of evolution.”

White and colleagues (2013) developed concepts necessary to understanding evolution amongst the cooperating professors; field tested the case studies and assessments on higher-level biology classes, and administered the tested assessments to an introductory biology course as a means of evaluating the efficacy of their case study

treatment. They were successful in improving their students' understanding of evolution using the case studies. The use of a pre and post assessment of concepts in addition to the use of case studies offered valuable insight into whether or not the application was successful.

According to the NGSS (2013) there are "too few students entering STEM majors and careers at entry levels", and this could largely be due to the problems mentioned earlier in regards to traditional teacher-centered lecturing techniques (pg. 4). Case study intervention plans could be the solution to the growing deficit in scientific literacy and enthusiasm in our schools by improving student performance, argumentation, and attitudes.

There were many methods discussed in the literature as to how a teacher should apply and evaluate the effectiveness of case studies in the science classroom. The methods that appeared to be most successful were ones centered on discussions, interviews, attitude surveys, and pre and post assessments.

METHODOLOGY

For this intervention and application of research-based techniques I used two sections of biology classes. 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. One of the sections examined was a standard level Biology class that will be referred to as Section A, with a class size of 30 students. The other section, Section B, was also a standard level Biology class containing

28 students. Most of these students belonged to lower-middle class, broken, struggling or poverty stricken families.

The intervention plan was built around the use and application of daily content relevant case study style questions. I used the case study style questions for daily content reinforcement in one of the two sections of Biology. One class will be prompted with a case study style warm up question to begin each class period for the duration of the Genetics unit. The case study will focus on one of the various patterns of inheritance discussed in the Genetics unit, which will require students to identify relevant information, assign alleles, construct and perform a successful cross, and interpret the results. The other section of Biology will be provided a series of crosses that have already had the alleles defined and will not have background information in regards to the significance of the interpretation. The case study style questions focused on the application of the content specific vocabulary and concepts being mastered for each particular pattern of inheritance; they were built and modeled around real world scenarios, including relevant information.

Both quantitative and qualitative data was collected throughout the unit using various instruments (Table 1) to address whether or not the daily use of case studies improved both academic achievement and attitude.

Table 1
Triangulation Matrix – Focus Questions and the Corresponding Data Collection Instruments

FOCUS QUESTIONS	COLLECTION INSTRUMENTS		
DO CASE STUDIES INCREASE ACADEMIC ACHEIVEMENT?	PRE & POST GENETICS KNOWLEDGE SAMPLE	OBSERVATIONS & NOTES DURING CASE STUDY TREATMENTS	TIME SPENT ON TREATMENTS AND KNOWLEDGE SAMPLES
DO CASE STUDIES IMPROVE STUDENT ATTITUDE?	PRE & POST GENETICS UNIT SURVEY	OBSERVATIONS & NOTES DURING CASE STUDY TREATMENTS	EXIT INTERVIEWS
DO CASE STUDIES HELP STUDENTS CONNECT CONTENT TO THE REAL WORLD?	PRE & POST GENETICS UNIT SURVEY	OBSERVATIONS & NOTES DURING CASE STUDY TREATMENTS	EXIT INTERVIEWS

Students from both of the Biology sections participated in the pre Genetics Knowledge Sample during the first lesson of the Genetics unit (Appendix A). The Genetics Knowledge Sample contains two sections, one comprised of multiple-choice questions and the other focusing on free response style questions. The multiple-choice section contains sixteen questions addressing various aspects of genetics and the patterns of inheritance that will be discussed throughout the unit. The free response section of the Genetics Knowledge Sample contains a question requiring students to complete a successful cross and interpret the results. The completed Punnett square was awarded a total of 5 points and the correct interpretation received another 5 points for a total of 10 for a successful answer. The second free response question prompted the student with a case study style word problem that they had to work out and interpret. The other free response question was scored using a similar point assignment. On the day before their official unit exam the same students were asked to participate in the post Genetics Knowledge Sample as a means of both review and data collection. Each student's scores from the pre and post Genetics Knowledge Sample were compared to calculate the normalized gain and percent increase in attempt to measure the growth of the student's

content understanding. The Biology section that received the case study treatment had the pre, post, and the calculated normalized gains compared to that of the section that did not receive the treatment. The comparison of the average normalized gains between the treatment group and control group was used to measure the efficacy of the treatment applied.

The qualitative data was collected from observations, notes, student surveys, and an exit interview.

Other researchers focused their evaluations on the resulting discussions. The use of case studies in Fisher's (2008) study focused on the participatory approach to active learning based on discussion and reasoning of ethics and the student prescribed solutions. These focused group discussions and observations provide a valuable tool in assessing whether or not student participation, enthusiasm, and comprehension levels increased as a result of participating in the case study intervention. Each warm up treatment question and the control group questions was discussed as a class so that students could share their reasoning and techniques for completing the problems. Teacher observations and notes were collected to gauge student involvement, attitude, and overall effectiveness of discussion.

Students from both Biology sections also participated in a pre and post Genetics Unit Survey (Appendix B). The students completed the survey on the first day of the lesson and after completing the final unit exam. The Genetics Unit Survey was used to assess comfort level and familiarity with Genetics, attitude towards reading and science, and familiarity with case study style questioning. The Genetics Unit Survey contains

eighteen questions, each containing a Likert Scale response system; *Strongly Disagree(-2), Disagree(-1), Neutral (0), Agree(+1),* and *Strongly Agree(+2).* The students' pre and post survey scores were used to measure any shifts in attitude between the beginning and the end of the unit. The section scores from the treatment group were averaged and compared to the average scores of the control group to see whether or not the treatment affected student attitude.

After the students had completed the lessons supplemented with case studies they were randomly selected to participate in the Exit Interview that was used to collect data from the students' perspective (Appendix C). Students were selected from both sections to participate in the Exit Interview that addressed similar questions and prompts found in the Unit Survey. The Exit Interview allowed students to share their level of comfort, attitudes, and responses in greater detail. Observations and notes were taken during the interviews. Attitudes towards genetics, science, and case studies were categorized as *negative, neutral,* or *positive* to allow for a qualitative comparison between the treatment and control group.

DATA AND ANALYSIS

The first focus question to be addressed using the analysis of the data collected was whether or not the case study treatment affected the academic achievements of the experimental group. This question was addressed using the scores from the Genetics Knowledge Sample, classroom notes and observations, and the time students spent completing both treatments and knowledge samples.

The Genetics Knowledge Sample pre and post tests were used to collect data on the academic achievements and improvements made by both the control and experimental treatment Biology classes over the course of the unit on Genetics. The post Genetics Knowledge Sample test scores (Figure 1) for the class receiving the case study treatment had an average of 71.4% with a standard deviation of 17.3 (*N=30*).

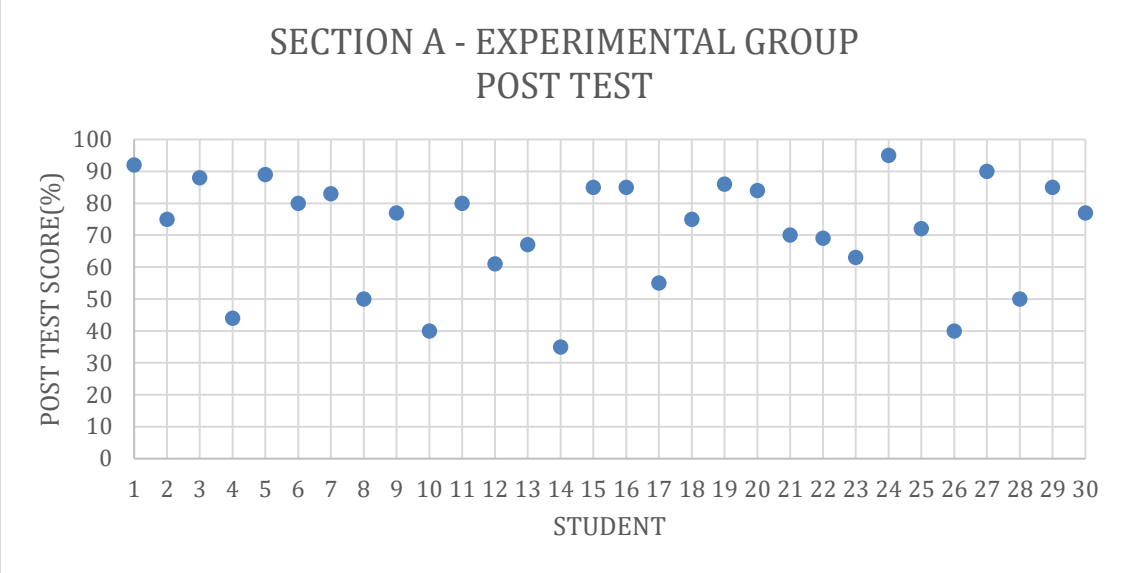

Figure 1. Experimental group genetics knowledge sample post-test scores. This scatter plot shows the post test scores for the class of 30 students who participated in the treatment, (*N*=30).

The post scores for the treatment group average were 21.4 points higher than the 50.1 average of the pre scores. The class that did not receive the case study treatment had post test scores (Figure 2) with an average of 69.3% with a standard deviation of 18.5 (*N=28*).

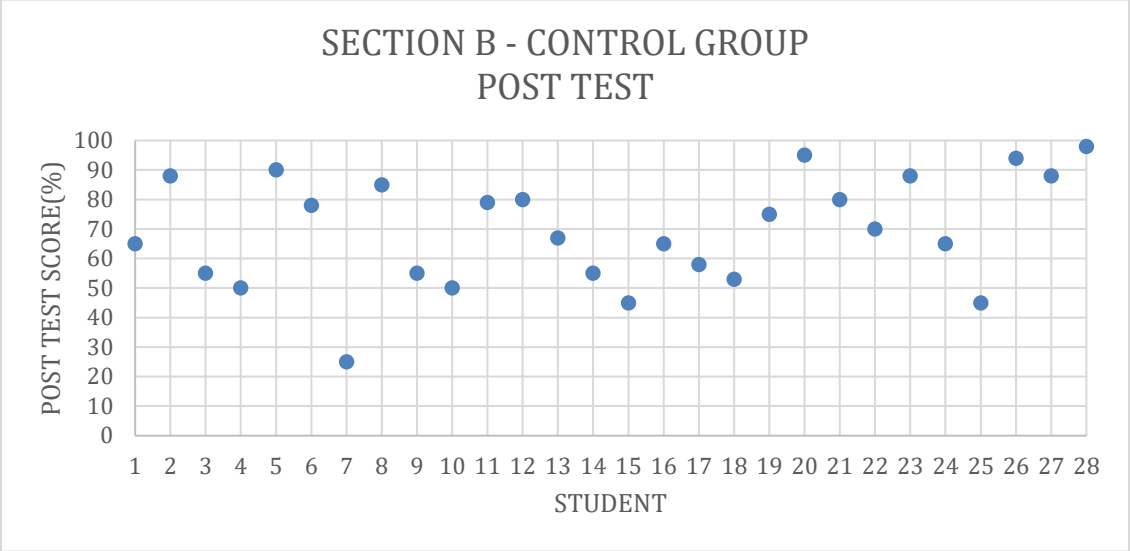

Figure 2. Control Group Genetics Knowledge Sample Post-Test Scores. This scatter plot shows the post test scores for the class of 28 students who did not receive the treatment, (*N*=28).

The post scores average for the control group was 22.1 points higher than the pre score average of 47.2. However, with the close averages and the overlapping deviations the post test scores revealed little to no significance between the experimental and control groups in regards to their academic achievement on the knowledge sample.

The students' post test scores from both groups were analyzed and normalized gains were calculated to be used in determining the potential affects of the case study treatment on academic achievement. The calculated normalized gains for the experimental group (Figure 3) produced a wide range of results with some students showing a -28.6% decrease between their pre and post test scores while others produce normalized gains as high as 83%.

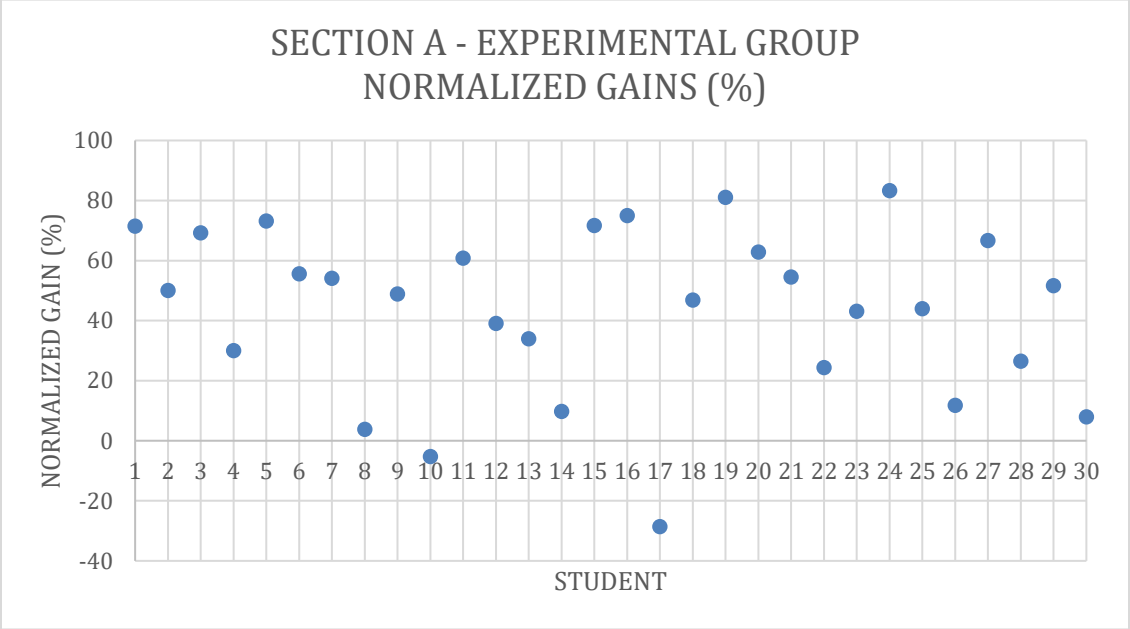

Figure 3. Experimental Group Calculated Normalized Gains. Normalized gains represented as percentages for the Genetics Knowledge Sample post test scores, (N=30).

The calculated normalized gains (Figure 4) for the control group also produced a wide range with calculated gains as low as -10% and as high as 90.5%.

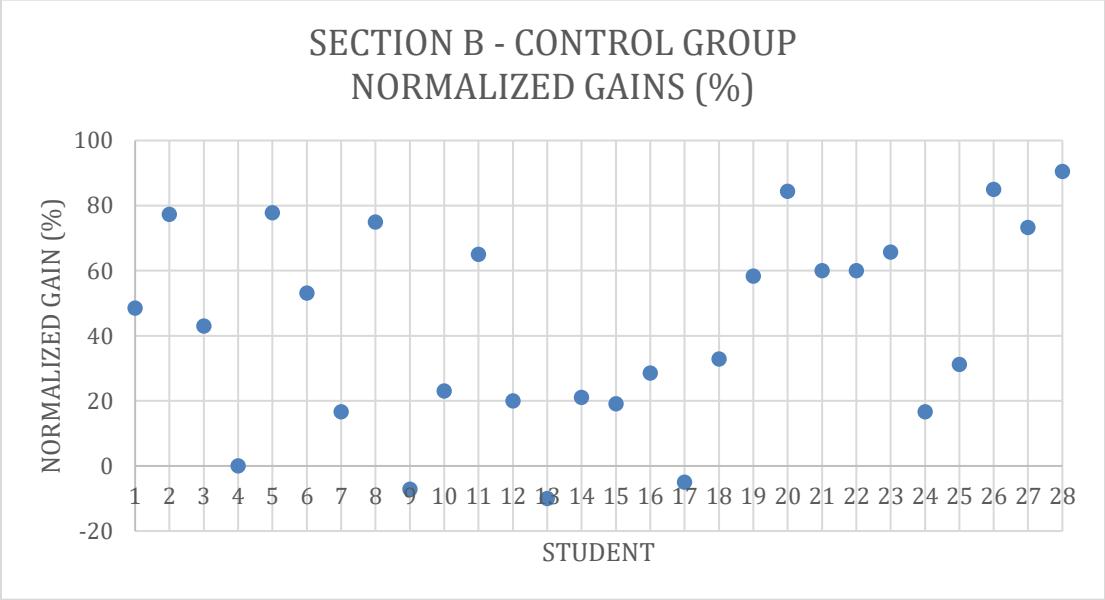

Figure 4. Control Group Calculated Normalized Gains. Normalized gains represented as percentages for the Genetics Knowledge Sample post test scores, (N=28).

However, after carefully considering the calculated normalized gains averages (Table 2) for both groups and performing a independent, two-tail, unequal variance t-test using the average normalized gains from both groups the differences between the groups proved insignificant, $t(56)=0.91$, $p=0.365$.

Table 2.
The Average Normalized Gains for the Experimental and Control Groups

	Experimental	Control
Average Normalized Gain	43.9	38.2
Standard Deviation	30.6	27.8
_____	_____	_____
Total Independent Samples 58 Degrees of Freedom 56	Independent t-test 0.91 Critical t-value 2.00	P value = 0.365 Accept Null Hypothesis

Since the statistical analysis produced a p value of 0.365 which exceeds the accepted p value of 0.05 for significance the null hypothesis of both groups' differences being attributed to random variance rather than the case study treatment must be accepted.

In addition to data collected from knowledge samples notes and observations were collected during the case study treatments. The greatest disparity observed during the duration of the Genetics unit during the warm up activities was the level of observed frustration. Both the control and experimental groups struggled initially to complete the

warm up activities however the experimental group displayed a greater degree of frustration with each successive day. The frustration was greatest amongst students who struggled with the basic use and application of Punnett squares even without the case studies. These students struggled with the mechanics of the Punnett squares and seemed even more frustrated by the pair challenge of deciphering the case study applications. The students in the experimental group who seemed to master the basic Punnett square mechanics appeared to be indifferent, and at times rather annoyed by the case studies. However, there were a few students who were deeply engaged by the case studies and would often refer back to them in various class discussions as a means of supporting a claim or answer to a question. The time spent on the warm up activities and knowledge samples for both groups were 10 minutes and 40 minutes respectively. Extra time was only needed and administered for students who already required extended time as the result of a 504 or IEP program, all other students were able to complete assignments within the allotted amount of time.

The second research question was focused on how the use of case studies would affect student attitudes towards science, the unit content, as well as the application of science in real world scenarios. The students' attitudes in the experimental group was monitored using a pre and post Genetics Unit Survey, direct classroom observations, and Exit Interviews. The data collected with the pre and post Genetics Unit Survey provided a measure of attitude towards various questions (Table 3) presented both before and after the completion of the treatment period using a Likert style scale; *Strongly Disagree(-2), Disagree(-1), Neutral (0), Agree(+1),* and *Strongly Agree(+2).*

Table 3.
Genetics Unit Survey Pre and Post Treatment Questions Used to Measure Attitude

#	GENETICS UNIT SURVEY QUESTIONS
1	BIOLOGY IS A SUBJECT I ENJOY LEARNING ABOUT
2	I ENJOY READING
3	I ENJOY REAIDNG ABOUT SCIENCE
4	GENETICS IS A TOPIC I AM FAMILIAR WITH
5	I HAVE LEARNED ABOUT GENETICS IN SCHOOL IN A PREVIOUS CLASS/COURSE
6	GENETICS IS A TOPIC I ENJOY LEARNING ABOUT
7	I AM FAMILIAR WITH THE VARIOUS PATTERNS OF INHERITENCE
8	I FEEL COMFORTABLE USING MY KNOWLEDGE OF GENETICS TO UNDERSTAND PATTERNS OF INHERITENCE WE SEE IN NATURE
9	I FEEL COMFORTABLE USING MY KNOWLEDGE OF GENETICS TO UNDERSTAND PATTERNS OF INHERITENCE WE SEE IN THE HUMAN POPULATION
10	I ENJOY WORD PROBLEMS AND QUESTIONS THAT USE REAL WORLD EXAMPLES IN ALL OF MY CLASSES
11	I ENJOY WORD PROBLEMS AND QUESTIONS THAT USE REAL WORLD EXAMPLES IN SCIENCE CLASS
12	I PREFER LEARNING ABOUT CONCEPTS WITHOUT WORD PROBLEMS OR QUESTIONS THAT USE REAL WORLD EXAMPLES IN ALL OF MY CLASSES
13	I PREFER LEARNING ABOUT CONCEPTS WITHOUT WORD PROBLEMS OR QUESTIONS THAT USE REAL WORLD EXAMPLES IN MY SCIENCE CLASSES
14	I UNDERSTAND AND FEEL COMFORTABLE WITH CASE STUDIES
15	I FIND READING CASE STUDIES IN MY CLASSES TO BE EXCITING
16	I FIND READING CASE STUDIES IN MY SCIENCE CLASSES TO BE EXCITING
17	I FIND READING CASE STUDIES TO BE HELPFUL IN MY CLASSES
18	I FIND READING CASE STUDIES TO BE HELPFUL IN MY SCIENCE CLASSES

The survey was collected and organized into a pre treatment and post treatment table (Table 4) for further analysis.

Table 4.
Pre and Post Treatment Response from the Treatment Groups Genetics Unit Survey

	PRE	**POST**	PRE	**POST**	PRE	**POST**	PRE	**POST**	PRE	**POST**
	STRONGLY DISAGRE	**STRONGLY DISAGREE**	DISAGREE	**DISAGREE**	NEUTRAL	**NEUTRAL**	AGREE	**AGREE**	STRONGLY AGREE	**STRONGLY AGREE**
1	*16.7*	**13.3**	*13.3*	**13.3**	*23.3*	**20**	*30*	**36.7**	*16.7*	**16.7**
2	*13.3*	**1.3**	*16.7*	**23.3**	*26.7*	**23.3**	*30*	**26.7**	*13.3*	**13.3**
3	*16.7*	**16.7**	*20*	**23.3**	*16.7*	**13.3**	*33.3*	**33.3**	*13.3*	**13.3**
4	*20*	**6.7**	*16.7*	**13.3**	*20*	**26.7**	*26.7*	**30**	*16.7*	**23.3**

5	*16.7*	**16.7**	*50*	**43.3**	*13.3*	**23.3**	*20*	**16.7**	*0*	**0**
6	*6.7*	**6.7**	*3.3*	**6.7**	*26.7*	**13.3**	*50*	**53.3**	*13.3*	**20**
7	*33.3*	**6.7**	*13.3*	**10**	*16.7*	**16.7**	*33.3*	**50**	*3.3*	**16.7**
8	*30*	**6.7**	*16.7*	**10**	*20*	**15.7**	*30*	**53.3**	*3.3*	**13.3**
9	*13.3*	**6.7**	*16.7*	**10**	*23.3*	**16.7**	*40*	**53.3**	*6.7*	**13.3**
10	*6.7*	**6.7**	*3.3*	**6.7**	*16.7*	**13.3**	*46.7*	**53.3**	*26.7*	**20**
11	*3.3*	**3.3**	*3.3*	**3.3**	*6.7*	**6.7**	*56.7*	**56.7**	*30*	**30**
12	*33.3*	**40**	*20*	**46.7**	*36.7*	**6.7**	*10*	**6.7**	*0*	**0**
13	*26.7*	**43.3**	*23.3*	**46.7**	*40*	**3.3**	*10*	**6.7**	*0*	**0**
14	*10*	**10**	*13.3*	**23.3**	*30*	**30**	*33.3*	**23.3**	*13.3*	**13.3**
15	*13.3*	**16.7**	*23.3*	**30**	*26.7*	**16.7**	*23.3*	**26.7**	*13.3*	**10**
16	*16.6*	**10**	*20*	**16.7**	*16.6*	**13.3**	*33.3*	**43.3**	*13.3*	**16.7**
17	*10*	**10**	*3.3*	**10**	*16.7*	**10**	*53.3*	**53.3**	*16.7*	**16.7**
18	*10*	**6.7**	*3.3*	**3.3**	*16.7*	**10**	*53.3*	**46.7**	*16.7*	**33.3**

Note: *Responses from survey questions shown as percentages from treatment group, (N=30). Red indicates a decrease and Green indicates an increase from pre to post treatment.*

Survey questions were examined to determine trends or shifts in students' attitudes towards reading, genetics, case studies, and the use of case studies in the science classroom. Students' attitudes towards the use of case studies and real world applications

showed a shift in acceptance, which is indicated by the change in responses for questions 12, 13 (Figure 5), and 16 (Figure 6).

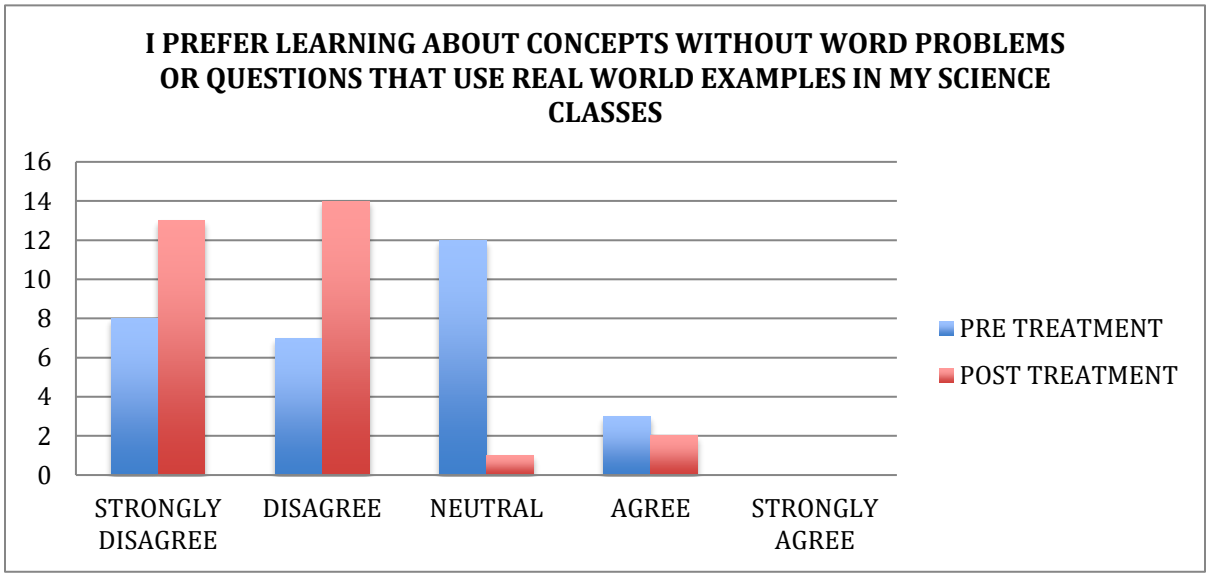

Figure 5. Pre and post response from question 13, Genetics Unity Survey. Reponses from pre and post survey shown as number of response based on the Likert Scale, (N=30).

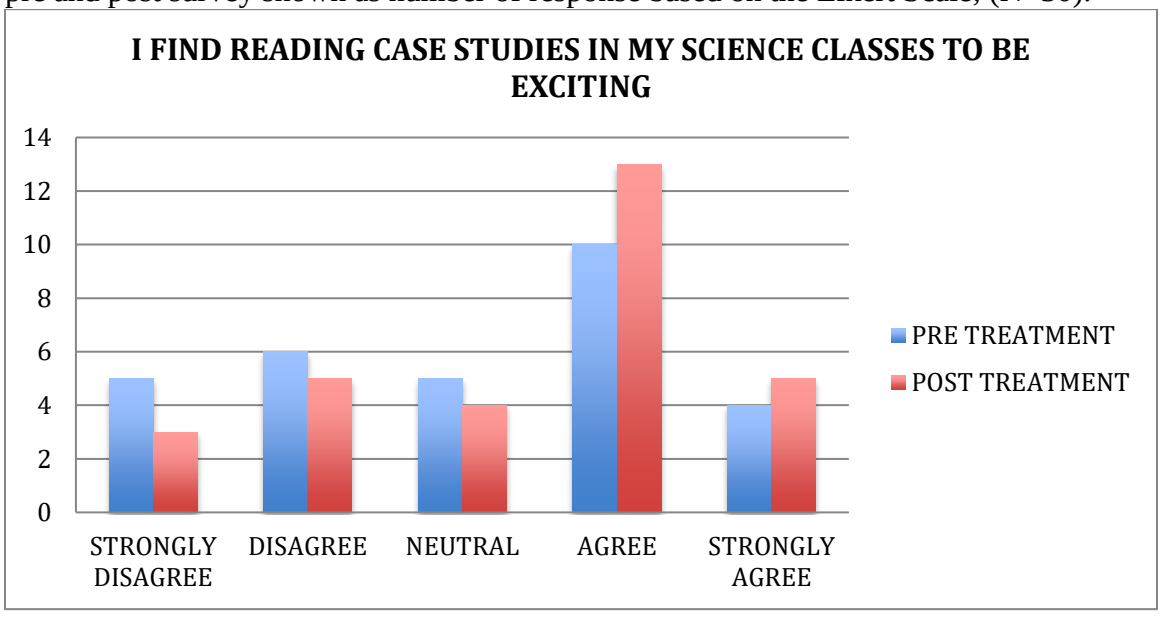

Figure 6. Pre and post response from question 16, Genetics Unity Survey. Reponses from pre and post survey shown as number of response based on the Likert Scale, (N=30).

The survey questions addressing student attitudes towards the general discipline and subject matter taught also showed a shift in the positive direction also shown in questions number 1 (Figure 7) and 8 (Figure 8).

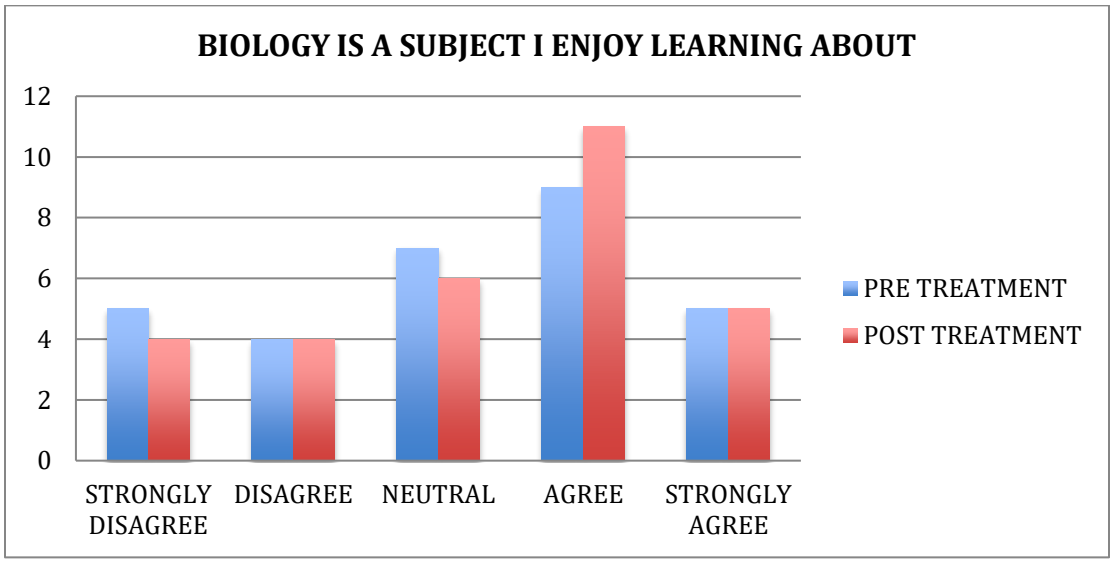

Figure 7. Pre and post response from question 1, Genetics Unity Survey. Reponses from pre and post survey shown as number of response based on the Likert Scale, (N=30).

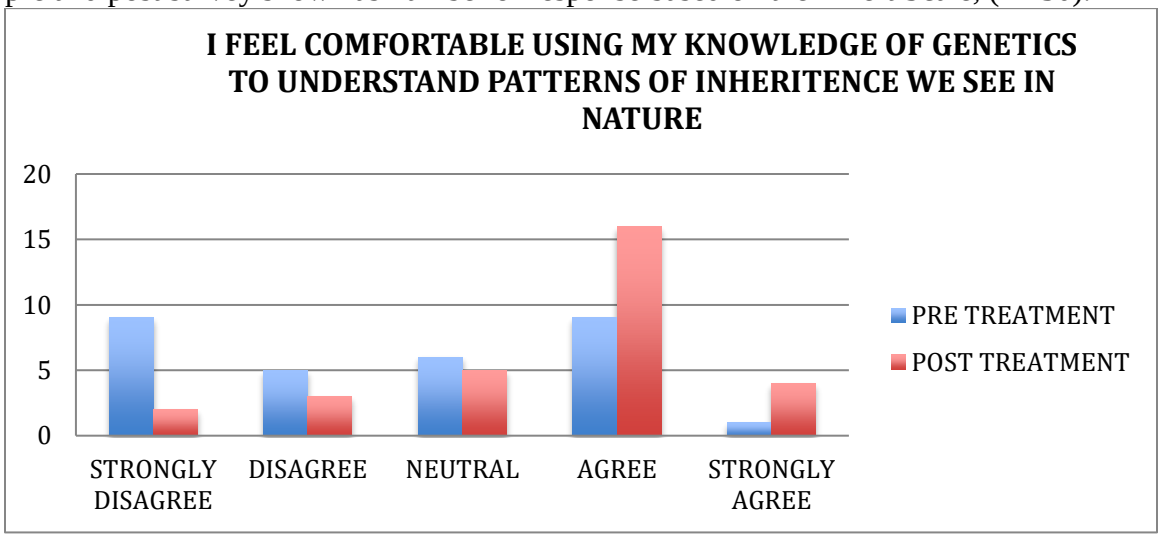

Figure 8. Pre and post response from question 8, Genetics Unity Survey. Reponses from pre and post survey shown as number of response based on the Likert Scale, (N=30).

The survey responses addressing reading and reading in science did not show any major positive changes with a 3.3% shift from neutrality to disagreement (Figure 9) to the prompt, “I enjoy reading about science.”

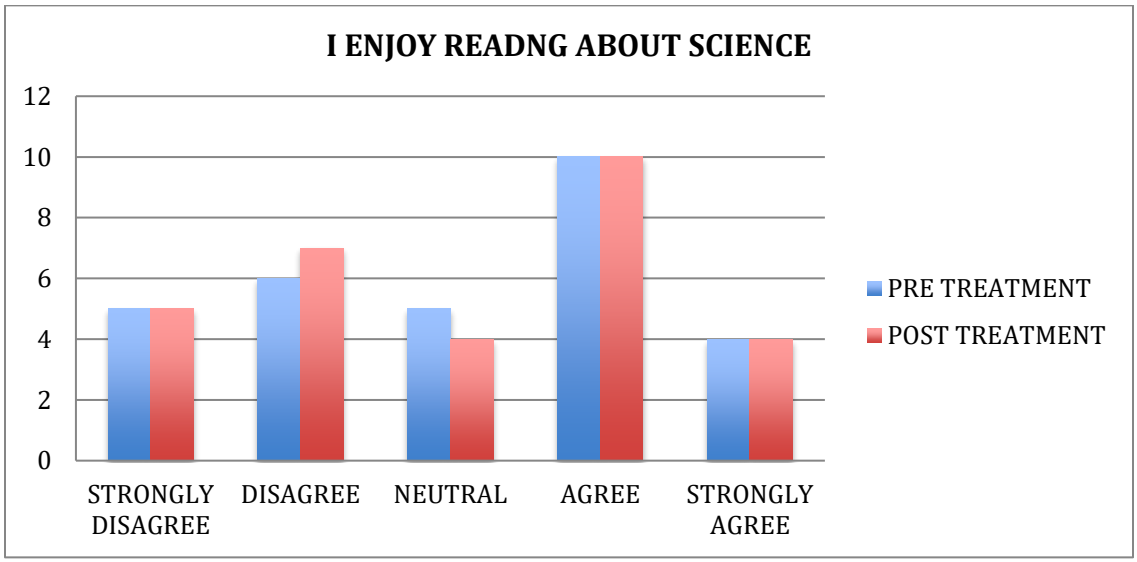

Figure 9. Pre and post response from question 3, Genetics Unity Survey. Reponses from pre and post survey shown as number of response based on the Likert Scale, (N=30).

In general there was a positive shift in attitude towards the inclusion of case studies in the science classroom, the application of concepts taught during treatment, and towards the discipline of science in general.

The exit interviews were used a means of gathering student constructed responses to help aid in interpreting the treatments effectiveness overall and as to whether or not the students were able to make personal, real world connections through the case studies. The exit interviews and survey responses were taken into consideration when evaluating the effectiveness of case studies in improving students’ abilities to integrate content into their own lives. Many of the student responses to the interview questions were positive and did

not seem forced as a means of pleasing the teacher. The students were randomly selected and pulled in the hall for quick, recorded interviews.

Questions such as, “What was your favorite part of the genetics lessons?”, produced a variety of answers with most making a connection with real world applications. For example, one student responded to the aforementioned question with “I really liked learning about all of the crazy diseases that are out there. I hope I don’t have any and need to ask my grandparents if they know.” The student shows a connection between the specific diseases outlined in the case studies and his/her own life. The students also reported direct connections between the treatment lessons and their own futures as indicated by responses to the question, “Did you enjoy using the case studies?” One student answered with, “Yes but they take forever. I like if we only have to do a few. I really liked talking about blood type because I want to be a nurse.” Event students who seemed challenged by the case study treatments reported enjoying the content, “I have a hard time understanding what the questions want but if I get help I like figuring it all out. The diseases are cool to learn about.” Other questions, such as “Do you feel like they helped (case studies) you remember and understand the unit?”, showed similar responses; “I recognized the disease but sometimes made dumb mistakes working out the math. I think if the question asks about jus the kids and not the percentage I would get them all right.“

Some students did respond negatively to some of the Exit Interview questions showing a general level of frustration with both the case studies and content. The question, “Do you feel comfortable answering the multiple choice questions about

Genetics? Why?", produced responses similar to this student's answer "I sometimes cannot set up the squares right and mess up. I think it is because there are many different letters to us and I get confused reading." Other questions prompted similar responses, "I really do not like reading that much and felt like we read all the time. We read more in this topic than the others. The stuff was cool but I like science and labs. Maybe use them for experiments."

The common themes of responses were that the information in the case studies was interesting and meaningful, but that the students struggled with the added reading and time necessary to complete case study style genetics problems.

INTERPRETATION AND CONCLUSION

There were both major and minor findings made from the collection and analysis of the action research conducted. One of the points of contention I had with my data was as to whether or not the case study treatment actually influenced academic achievement. The class that received the treatment did produce a higher average, 71.4%, on their post treatment evaluation when compared to the control group, 69.3%. However, when the t-test, standard deviations, and normality of the data collected was considered the null hypothesis of the experiment had to be accepted. According to the averages and normalized gains no major claims could be made about the effectiveness of case studies as a means of increasing academic achievement.

When you consider the survey and interview responses one cannot simply ignore the increase in confidence towards case studies, genetics, and science. The lack of disparity between the experimental group and control group could have been the result of

the amount of time spent on case study style problems and not the mechanics themselves. Students charged with the daily case study style treatment questions worked fewer problems because of the time required to read each question which resulted in less overall experience and less time to revise each individual problem.

The effectiveness of case studies in increasing students' attitudes, enthusiasm, and interest in science was affirmed by the data collected during the observations, surveys, and exit interviews. Students reported enjoying the case studies despite the challenges presented by the extra reading. There were clear, positive shifts in the pre and post survey questions addressing biology, genetics, and case study use in science classrooms. The exit interviews also reported numerous positive affirmations from the students in regards to their own shift in attitudes towards science and genetics. The negative feedback was subtle, with most suggesting a less frequent use of case studies rather than complete removal. This would suggest that any negative shift in attitude during the treatment was due to disdain for the repetitive nature of the treatment rather than the treatment tool itself.

Many students displayed and shared their personal connections with the case studies and content throughout the treatment process. The classroom observations and exit interview questions offered a substantial amount of data suggesting that the treatment did in fact help students make personal, real world connections with the content. Many students shared anecdotal evidence to support discussions of case studies and even spent time outside of class gathering information about their families for use in classroom

activities. Classroom participation in discussions was higher than normal during the treatment period and much higher than the control group.

When comparing the findings and observations of the action research conducted many similarities become apparent with the research conducted to design the research methodology. Both Varasidas (2015) and Fisher (2008) made claims about the use of case studies increasing social awareness and invest in the topics being learned. The students in the experimental group receiving the treatment displayed a far greater emotional attachment than the control group, bringing up family issues and personal anecdotes often. With the noticeable rise in enthusiasm provided by the case study treatment the problems and claims made by the NGSS (2013) in regards to their being too few students interested in the STEM fields could potential be resolved. Even with the students struggling with the content their recognition of the concepts could fuel future interests in science related fields, increase willingness to engage in scientific literature, and potentially improve citizen involvement with the scientific community. The lack of academic achievement provided by the case study treatment may in fact be due to the lower reading level when you compare the data to studies conducted by White (2013) whose use of case studies was applied to an advanced level biology course at the collegiate level.

When all of the data is considered the trends observed suggest that the lack of disparity in exam scores being the result of time constraints and reading abilities rather than true effectiveness. The frequency of the case studies may have exhausted the students who were already struggling with the language, reading, or mechanics necessary

to successfully complete the questions. Perhaps a more beneficial application of case studies would follow a less frequent pattern and be used a means of differentiating instruction to exercise the higher reading levels that may be present in a standard level biology classroom. These case studies could also be made into other forms of media or translated into other languages to help students with the transition of practicing problem solving mechanics in isolation to real world applications. Teacher constructed videos centered around case study style questioning may help alleviate the stress imposed by the increased reading required by most case studies.

VALUE

I have found the entire action research process from start to finish to have been extremely valuable for me as a student, teacher, and life long learner. I have had one of the hardest, most challenging years of my life this year and feel incredible about surviving everything that was placed upon my shoulders. The research, design, and application of my experiment have helped foster a deeper desire for personal improvement as a professional. My project has taught me many hard lessons about time management and creating detailed schedules to balance all of my responsibilities appropriately. I have started using Google calendar in addition to my hand written calendar to keep track of all of my deadlines, due dates, competitions, and other obligations, which has helped tremendously.

I also learned a lot about the power of effective note taking and data collection in terms of reflecting daily on my lessons. My observations and data collection methods that I developed for the classes being studied started to migrate into other aspects of my life. I

started taking daily notes for my other classes and the sports I was coaching. I have started using Excel to analyze data more frequently and feel far more proficient in its use. I hope to continue using these notes taking skills and the reflective process in general in the years to come.

Anytime a scientist conducts an experiment or makes observations the variables need to be considered, especially when attempting to derive a conclusion from the data collected. I feel that the process necessary to conduct my action research project has made me a better scientist. I have increased my overall awareness to factors that might contribute to the results of experiments and even more so when they involve human participants. Humans are dynamic, complicated systems that require all aspects of behavior, motivation, and preference to be considered when involved in action research. I have developed a stronger sense of perception for these human variables that might affect my students. I have also felt competent reading people but feel as if I do so now with a more refined, scientific approach. This has helped me give both my students and athletes more individualized attention when it is most needed.

I do plan on taking everything I have learned from this project and implementing into my professional philosophy. I also plan on revising the frequency of case studies used in my action research project and reapplying the study to my honors and standard level biology courses for the 2017-2018 school year. I was impressed with the effectiveness of the case studies and enjoyed the general increase in enthusiasm for science. I truly think with a little bit of modification the treatment could be highly effective in boosting moral, maintaining interest, and potentially supporting long term

content retention. If time allows, I would also like to create a series of case study style videos for my classes that would be specific to the content discussed in class. These videos could also be made with subtitles or translated manuscripts that would offer options for our English language-learning students. I think with the completion of the M.S.S.E program I will now have the skills and rediscovered free time to dive deeper into my teaching methodologies and discipline.

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APPENDICES

APPENDIX A

GENETICS KNOWLEDGE SAMPLE

GENETICS KNOWLEDGE SAMPLE
CONTENT ASSESSMENT

MULTIPLE CHOICE

1. HOW ARE SOME PHYSICAL AND PHYSIOLOGICAL TRAITS PASSED FROM ONE GENERATION TO THE NEXT?

    A. THE TRAITS ARE LEARNED DURING THE FIRST FEW YEARS OF THE INFANTS LIFE FROM THE PARENT
    B. THE TRAITS ARE INHERITED BY THE TRANSFER OF ADULT SOMATIC CELLS FROM THE PARENT TO THE OFFSPRING
    C. THE TRAITS ARE INHERITED BY THE TRANSFER OF DNA IN GAMETIC CELLS FROM THE PARENT TO THE OFFSPRING
    D. ALL TRAITS ARE ACQUIRED FROM THE ENVIRONMENT

2. WHAT PROCESS OR TYPE OF CELL DIVISION PRODUCES THE CELLS REQUIRED FOR SEXUAL REPRODUCTION?

    A. KYPHOSIS
    B. MITOSIS
    C. MEIOSIS
    D. METAMORPHOSIS

3. FOR A TRAIT OR PHYSICAL CHARACTERISTIC TO BE PASSED FROM ONE GENERATION TO THE NEXT IT MUST BE?

    A. HERITABLE
    B. BENEFICIAL
    C. GOOD
    D. DETRIMENTAL

4. OUR TRAITS ARE DETERMINED BY OUR GENES, WHICH ARE UNIQUE SEGMENTS OF DNA THAT CODE FOR SPECIFIC PROTEINS. A SINGLE GENE CAN HAVE MULTIPLE VERSIONS KNOWN AS?

    A. SPECIES
    B. CENTROILES
    C. ENZYMES
    D. ALLELES

5. THE GENES OR SET OF GENES RESPONSIBLE FOR AN ORGANISM'S SPECIFIC TRAITS IS KNOWN AS?

A. ALLELOPATHY
B. PHENOTYPE
C. GENOTYPE
D. POLYTYPE

6. THE PHYSICAL EXPRESSION OR SPECIFIC TRAIT PRODUCED BY A SET OF GENES IS KNOWN AS?

   A. ALLELOPATHY
   B. PHENOTYPE
   C. GENOTYPE
   D. POLYTYPE

7. CERTAIN TRAITS OR CHARACTERISTICS CAN “OVER-POWER” OTHERS. FOR EXAMPLE, THE SHAPE OF PEA PLANT SEEDS CAN EITHER BE ROUND OR WRINKLED. THE ROUND SEED SHAPE OFTEN *MASKS* THE WRINKLED SHAPE, PRODUCING RARER OCCURANCES OF WRINKLED SEEDS. WHAT TYPE OF INHERITENCE DOES THIS DEMONSTRATE?

   A. SIMPLE DOMINANCE
   B. CO-DOMINANCE
   C. POLYGENIC INHERTIANCE
   D. INCOMPLETE DOMINANCE

8. CERTAIN TRAITS OR CHARACTERISTICS CAN “BLEND” TOGETHER. FOR EXAMPLE, THE SNAPDRAGON FLOWER CAN BE RED, WHITE, OR PINK. WHEN A RED SNAPDRAGON IS CROSSED WITH A WHITE SNAPDRAGON ALL OF THE RESULTING OFFSPRING WITH DISPLAY THE PINK CHARACTERISTIC. WHAT TYPE OF INHERITENCE DOES THIS DEMONSTRATE?

   A. SIMPLE DOMINANCE
   B. CO-DOMINANCE
   C. POLYGENIC INHERTIANCE
   D. INCOMPLETE DOMINANCE

9. CERTAIN TRAITS OR CHARACTERISTICS CAN BOTH BE EXPRESSED SIMUTANEOUSLY. FOR EXAMPLE, CERTAIN BREEDS OF COW CAN DISPLAY THREE DISTINCT COLORATIONS; RED,

WHITE, AND ROAN (BOTH RED AND WHITE). A ROAN COW HAS BOTH RED AND WHITE HAIR, EXPRESSING BOTH TRAITS AT THE SAME TIME. WHAT TYPE OF INHERITENCE DOES THIS DEMONSTRATE?

A. SIMPLE DOMINANCE
B. CO-DOMINANCE
C. POLYGENIC INHERTIANCE
D. INCOMPLETE DOMINANCE

10. CERTAIN TRAITS OR CHARACTERISTICS CAN BE THE RESULT OF MANY GENES BEING EXPRESSED. FOR EXAMPLE, HUMAN HEIGHT RANGES FROM EXTREMELY TALL TO EXTREMELY SHORT, WITH A MAJORITY OF INDIVIDUALS BEING OF AVERAGE HEIGHT. WHAT TYPE OF INHERITENCE DOES THIS DEMONSTRATE?

A. SIMPLE DOMINANCE
B. CO-DOMINANCE
C. POLYGENIC INHERTIANCE
D. INCOMPLETE DOMINANCE

11. WHAT DETERMINES THE BIOLOGICAL GENDER OF A HUMAN?

A. ENVIRONMENT
B. PARENTAL PREFERENCE
C. CHROMOSOMES
D. PRENATAL NUTRITION

12. TRAITS AND CHARACTERISTICS THAT ARE DETERMINED BY GENES ASSOCIATED WITH GENDER ARE KNOWN AS?

A. AUTOSOMAL
B. SEX-LINKED
C. GENDER TYPED
D. ANAEROBIC

13. WHAT ARE THE TWO CLASSIFICATIONS GIVEN TO HUMAN CHROMOSOMES?

A. AUTOSOME AND SEX-LINKED
B. AUTOSOME AND GENDER TYPED
C. AUTOSOME AND ANAEROBIC

D. AEROBIC AND ANAEROBIC

14. CERTAIN CHARACTERISTICS CAN BE VERY COMMON AMONG POPULATIONS, SHOWING UP IN EVERY GENERATION AND AFFECTING BOTH MEN AND WOMEN EQUALLY. THESE CHARACTERISTICS WOULD BE CONSIDERED TO BE?

    A. AUTOSOMAL, DOMINANT
    B. AUTOSOMAL, GENDER TYPED
    C. SEX-LINKED, DOMINANT
    D. AUTOSOMAL, RECESSIVE

15. CERTAIN CHARACTERISTICS CAN BE VERY RARE AMONG POPULATIONS, SKIPPING GENERATIONS AND AFFECT BOTH MEN AND WOMEN EQUALLY. THESE CHARACTERISTICS WOULD BE CONSIDERED TO BE?

    A. AUTOSOMAL, DOMINANT
    B. AUTOSOMAL, GENDER TYPED
    C. SEX-LINKED, DOMINANT
    D. AUTOSOMAL, RECESSIVE

16. CERTAIN CHARACTERISTICS CAN BE VERY RARE AMONG POPULATIONS, SKIPPING GENERATIONS AND ARE MORE LIKELY TO BE EXPRESSED AMONG MEN. THESE CHARACTERISTICS WOULD BE CONSIDERED TO BE?

    A. AUTOSOMAL, DOMINANT
    B. SEX-LINKED, AUTOSOMAL
    C. SEX-LINKED, RECESSIVE
    D. GENDER TYPED, RECESSIVE

FREE RESPONSE

17. COMPLETE AND INTREPRET THE FOLLOWING CROSS

TT – TALL PEA PLANTS
tt – SHORT PEA PLANTS
Tt – TALL PEA PLANTS

Tt (POLLEN) x tt (EGG)

WHAT ARE THE POTENTIAL HEIGHTS FOR THE PEA PLANT OFFSPRING?

18. A MAN WAS APPROACHED BY A WOMAN CLAIMING TO BE PREGNANT WITH HIS CHILD. THE MAN, HAVING HAD BEEN IN A RELATIONSHIP WITH THE WOMEN PREVIOUSLY, ACCEPTS THE CONSEQUENCES OF THEIR ACTIONS AND ASSUMES THE ROLE AS A CARING, EXPECTING PARENT. THE TWO PARENTS ATTEND REGULAR CHECK UPS AND CLASSES DURING THE PREGANCY TO PREPARE FOR THE BIRTH OF THEIR CHILD. DURING THIS TIME MEDICAL INFORMATION FROM BOTH PARENTS IS COLLECTED BY THEIR DOCTOR INCLUDING BLOOD TYPE, HEIGHT, WEIGHT, ETC. WHEN THE BABY IS FINALLY BORN MEDICIAL INFORMATION IS COLLECTED FROM THE CHILD AS WELL. THE MAN IS APPROACHED BY THE DOCTOR AND ASKED TO CONFIRM THE INFORMATION HE PROVIDED. THE MAN CONFIRMS THAT HIS BLOOD TYPE IS AB AND THAT HIS PARTNER, THE MOTHER, IS TYPE A. THE DOCTOR REVEALS TO THE MAN THAT THE BABY'S BLOOD TYPE IS O. WHY IS THE DOCTOR CONCERNED?

APPENDIX B

GENETICS UNIT SURVEY

GENETICS UNIT SURVEY

ATTITUDE SURVEY

1. BIOLOGY IS A SUBJECT I ENJOY LEARNING ABOUT

    a. STRONGLY DISAGREE
    b. DISAGREE
    c. NEUTRAL / NOT SURE
    d. AGREE
    e. STRONGLY AGREE

2. I ENJOY READING

    a. STRONGLY DISAGREE
    b. DISAGREE
    c. NEUTRAL / NOT SURE
    d. AGREE
    e. STRONGLY AGREE

3. I ENJOY REAIDNG ABOUT SCIENCE

    a. STRONGLY DISAGREE
    b. DISAGREE
    c. NEUTRAL / NOT SURE
    d. AGREE
    e. STRONGLY AGREE

4. GENETICS IS A TOPIC I AM FAMILIAR WITH

    a. STRONGLY DISAGREE
    b. DISAGREE
    c. NEUTRAL / NOT SURE
    d. AGREE
    e. STRONGLY AGREE

5. I HAVE LEARNED ABOUT GENETICS IN SCHOOL IN A PREVIOUS CLASS/COURSE

    a. STRONGLY DISAGREE
    b. DISAGREE
    c. NEUTRAL / NOT SURE
    d. AGREE
    e. STRONGLY AGREE

6. GENETICS IS A TOPIC I ENJOY LEARNING ABOUT

    a. STRONGLY DISAGREE
    b. DISAGREE
    c. NEUTRAL / NOT SURE
    d. AGREE
    e. STRONGLY AGREE

7. I AM FAMILIAR WITH THE VARIOUS PATTERNS OF INHERITENCE

    a. STRONGLY DISAGREE
    b. DISAGREE
    c. NEUTRAL / NOT SURE
    d. AGREE
    e. STRONGLY AGREE

8. I FEEL COMFORTABLE USING MY KNOWLEDGE OF GENETICS TO UNDERSTAND PATTERNS OF INHERITENCE WE SEE IN NATURE

    a. STRONGLY DISAGREE
    b. DISAGREE
    c. NEUTRAL / NOT SURE
    d. AGREE
    e. STRONGLY AGREE

9. I FEEL COMFORTABLE USING MY KNOWLEDGE OF GENETICS TO UNDERSTAND PATTERNS OF INHERITENCE WE SEE IN THE HUMAN POPULATION

    a. STRONGLY DISAGREE
    b. DISAGREE
    c. NEUTRAL / NOT SURE
    d. AGREE
    e. STRONGLY AGREE

10. I ENJOY WORD PROBLEMS AND QUESTIONS THAT USE REAL WORLD EXAMPLES IN ALL OF MY CLASSES

    a. STRONGLY DISAGREE
    b. DISAGREE

c. NEUTRAL / NOT SURE
d. AGREE
e. STRONGLY AGREE

11. I ENJOY WORD PROBLEMS AND QUESTIONS THAT USE REAL WORLD EXAMPLES IN SCIENCE CLASSES

a. STRONGLY DISAGREE
b. DISAGREE
c. NEUTRAL / NOT SURE
d. AGREE
e. STRONGLY AGREE

12. I PREFER LEARNING ABOUT CONCEPTS WITHOUT WORD PROBLEMS OR QUESTIONS THAT USE REAL WORLD EXAMPLES IN ALL OF MY CLASSES

a. STRONGLY DISAGREE
b. DISAGREE
c. NEUTRAL / NOT SURE
d. AGREE
e. STRONGLY AGREE

13. I PREFER LEARNING ABOUT CONCEPTS WITHOUT WORD PROBLEMS OR QUESTIONS THAT USE REAL WORLD EXAMPLES IN ALL OF MY CLASSES

a. STRONGLY DISAGREE
b. DISAGREE
c. NEUTRAL / NOT SURE
d. AGREE
e. STRONGLY AGREE

14. I UNDERSTAND AND FEEL COMFORTABLE WITH CASE STUDIES

a. STRONGLY DISAGREE
b. DISAGREE
c. NEUTRAL / NOT SURE

d. AGREE
e. STRONGLY AGREE

15. I FIND READING CASE STUDIES IN MY CLASSES TO BE EXCITING

a. STRONGLY DISAGREE
b. DISAGREE
c. NEUTRAL / NOT SURE
d. AGREE
e. STRONGLY AGREE

16. I FIND READING CASE STUDIES IN MY SCIENCE CLASSES TO BE EXCITING

a. STRONGLY DISAGREE
b. DISAGREE
c. NEUTRAL / NOT SURE
d. AGREE
e. STRONGLY AGREE

17. I FIND READING CASE STUDIES TO BE HELPFUL IN MY CLASSES

a. STRONGLY DISAGREE
b. DISAGREE
c. NEUTRAL / NOT SURE
d. AGREE
e. STRONGLY AGREE

18. I FIND READING CASE STUDIES TO BE HELPFUL IN MY SCIENCE CLASSES

a. STRONGLY DISAGREE
b. DISAGREE
c. NEUTRAL / NOT SURE
d. AGREE
e. STRONGLY AGREE

APPENDIX C

EXIT INTERVIEW

EXIT INTERVIEW

HOW DO YOU FEEL ABOUT GENETICS IN GENERAL?

WHAT WAS YOUR FAVORITE PART ABOUT THE GENETICS LESSONS?

DO YOU FEEL COMFORTABLE ANSWERING MULTIPLE CHOICE QUESTIONS ABOUT GENETICS? WHY?

DO YOU FEEL COMFORTABLE ANSWERING FREE RESPONSE OR WORLD PROBLEMS ABOUT GENETICS? WHY?

DID YOU EVER USE CASE STUDIES IN CLASS BEFORE OUR GENETICS UNIT? EXPLAIN.

DID YOU ENJOY USING THE CASE STUDIES?

DO YOU FEEL LIKE THEY HELPED YOU REMEMBER AND UNDERSTAND THE UNIT?

DO YOU THINK I SHOULD CONTINUE TO USE CASE STUDIES TO TEACH GENETICS?

DO YOU THINK I SHOULD USE CASE STUDIES MORE OFTEN?

IS THERE ANYTHING ELSE YOU WOULD LIKE TO SHARE?