

THE EFFECTS OF COOPERATIVE-LEARNING STRATEGIES ON STUDENTS'  
UNDERSTANDING OF HIGH SCHOOL BIOLOGY

by

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Matthew P. Haack

July 2014

DEDICATION

This is dedicated to my family and friends. Without all of their help and support I would not have been able to complete this.

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## ABSTRACT

Seventeen students in one section of high school biology were the focus of a study on the effect of cooperative-learning strategies on student understanding and long-term memory, student and teacher attitudes and engagement. Through the use of cooperative-learning strategies students are tasked with working collaboratively towards a shared goal. Each lesson utilizes peer to peer learning and self-discovery. One nontreatment unit was taught using traditional, teacher-centered lessons and compared to two treatment units which were taught using cooperative-learning strategies. While data collected for all students' understanding yielded mixed results, data showed definitive improvements in student understanding for the high-achieving students. Results also showed improvement in long-term memory, and a modest increase in attitudes, and engagement for all students and teacher's attitude. Using cooperative-learning strategies in my classroom presented an initial challenge to both me and the students, but after the first treatment unit was completed familiarity with the strategies allowed for a higher level of engagement and understanding. Because of this, I am excited about continueing the use of cooperative-learning strategies into my teaching in the future.

## INTRODUCTION AND BACKGROUND

One issue I have struggled with in my four years of teaching has been student participation. During this time I have noticed that a sizable percentage of my students do not actively participate in my biology classes. This has been a point of frustration for me, as I have also noticed that this same group of students seems to struggle with performance in the class and also on state-level science assessments. In my biology classes, I am usually able to get most students involved with class laboratory exercises, which involves students working together in groups. But, when it comes to most other classroom learning, there seems to be a large level of disconnect, as it becomes nearly impossible to get the same level of participation.

For example, my students completed a lab activity on the properties of water in my introductory biology class. The day of the lab there were 19 students present in class, and all 19 of them completed the lab in its entirety. In the same class two days later, we completed a brief lecture on biological macromolecules, along with a short vocabulary exercise. On this day it was a struggle to get all 19 students to individually complete their guided notes, and I only received 14 completed copies of the vocabulary exercise. I believe that this lack of participation is directly linked to poor academic performance in my biology classes, which also contributes to a lower rate of passing for biology students on the state biology assessment that is a requirement for high school graduation.

To address this issue of participation, I completed background research on student participation within various classroom environments. This research shows a common trend, the implementation of well designed lessons that utilize cooperative-learning strategies can help improve student attitudes and participation. I have also noticed that

students like to work together. While cooperative learning is a term that can have many different meanings, in this case I defined it as the use of small structured groups of students who work together with specific resources toward a common goal (Topping & Ehly, 1998). The focus question of my project was: What are the effects of cooperative-learning strategies on students' understanding of high school biology concepts? To help support this project, I also asked the following subquestions: what are the effects of cooperative-learning strategies on students' long-term memory; what are the effects of cooperative-learning strategies on students' attitudes and motivations towards biology class activities; and what are the effects of cooperative-learning strategies on students' engagement in class activities. In addition to my focus on student engagement and achievement, I also wanted to know: what are the effects of cooperative-learning strategies on my attitudes towards teaching high school biology.

I teach 10<sup>th</sup>-grade biology at North East High School, which is located in the town of North East, Maryland. North East is located on the northern tip of the Chesapeake Bay; it serves a diverse community of families from Cecil County. The class in focus was a section of 10<sup>th</sup>-grade biology; this class contains 17 students that have exhibited varying levels of academic achievement.

My project proposed a positive benefit to the North East High School learning community. This is due to the fact that it addressed the need to improve student participation and achievement, with the long-term goals of improving scores on the state biology assessment and increasing the graduation rate. This project can also provide insight on new instructional strategies for other teachers at North East High School.

The members of my MSSE Capstone Committee provided critical feedback throughout the research and writing process. My committee chair was Dr. Peggy Taylor, Montana State University Masters of Science in Science Education (MSSE) Program Director. Dr. Jewel Reuter, of Montana State University served as my MSSE core and capstone advisor. Also, Joe Bradshaw of Montana State University served as the project reader on my committee. Dr. Marc Berman and Daniel Mazzella served as editors, critics, and supporters of my project. Marc is a good friend of mine and also currently serves as an assistant professor in the psychology department at University of South Carolina. Daniel is a fellow science teacher at North East High with 7 years of knowledge and experience.

### CONCEPTUAL FRAMEWORK

A review of the literature indicated that well designed cooperative-learning strategies utilize peer to peer learning and self-discovery. These strategies also help to create a positive learning environment that features students working collaboratively towards a shared goal. Research on the use of cooperative learning has yielded many interesting results. Some studies have shown an increase in student achievement and understanding, while others have linked the use of cooperative learning to improvements in teacher attitudes. In addition much of the research mentions the importance of having the proper structure with any cooperative-learning activity. This structure can help provide the student with a safe and open learning environment, while also ensuring more time on task during the activity.

Cooperative-learning strategies are based on social constructivism. Social constructivism can be defined as a form of learning in which students are fully involved

in a meaningful process that relates new ideas to a real-world context (Beck, 2006).

While it is important for students to apply their new knowledge to a real world context, it is equally important to examine how they acquired the knowledge in the first place.

Dewey (1916) demonstrated great insight when he stated, “We may secure motor activity and sensory excitation by keeping an individual by himself, but we cannot thereby get him to understand the meaning which things have in the life of which he is a part” (p. 47).

Simply stated, students can absorb plenty of content knowledge through individual and direct learning, but this knowledge will be useless without a deeper understanding that comes with social interaction and reflection.

One reason that cooperative learning is a successful teaching strategy is because of the high level of discourse and discussion that takes place between the students. In a traditional, teacher-centered classroom the discussion is led largely by the teacher with little chance for student driven discourse. While this method of teaching gives the instructor a quick way to deliver a large amount of content, it does not offer any type of guarantee that students will actually process and comprehend this content. The high level of discussion and discourse in a cooperative learning setting can help students to make important connections between personal interpretations and formal classroom content (Meyer & Woodruff, 1997). In addition, cooperative-learning strategies can help to improve long-term memory of when it is designed and implemented properly. A study of 107 undergraduate engineering students examined scores of a five question exam, once immediately following the instructional period and also again eight months later. Results from this study suggested that cooperative-learning strategies could help improve long-term retention of content for low and middle-ability students (Kvam, 2000).

Some research has shown that cooperative learning can lead to definitive gains in student achievement. For example, a study of 66 high school biology students demonstrated that peer collaboration increased the overall understanding of photosynthesis when compared to students who worked alone. In this study there is an emphasis placed on the importance of assigning appropriate roles for all group members; both cognitive and managerial roles should be considered when implementing a group activity. Also, it is important to allow students to debate a variety of ideas and also to provide them a safe environment in which to validate or invalidate these ideas (Lumpe & Staver, 1995).

Improvement in student achievement is not just limited to low and middle-ability students. A study of 34 high-ability fifth-grade students in a science class showed that students subjected to a cooperative learning environment had a higher level of achievement compared to those who were not (Johnson, Johnson, & Taylor, 1993). It seems that the interactions that occur within cooperative learning environment can help to boost self-esteem of the students involved, which in turn will help to increase confidence and academic achievement.

Improving students' attitudes and self-esteem about learning in a science classroom is a critical step in improving understanding. This can be achieved through the use of cooperative-learning strategies. A study conducted with 279 fifth-grade students found that students reported more favorable perceptions of cooperative learning when compared to traditional learning methods. Students in the study reported that they felt more challenged and stimulated, while also experiencing a higher level of recognition from the teacher (Law, 2011). In addition, students are not the only ones who can benefit

from cooperative learning. A study conducted with 15 life science teachers from secondary schools examined their use of cooperative learning in the classroom. The teachers were sent to a workshop to learn about cooperative learning approaches that could be used in their classrooms. Teacher attitudes were measured both preworkshop and postworkshop, and this research demonstrated that a large percentage of biology teachers who use cooperative-learning strategies felt that they should be used in place of direct instruction (Lord, 1994). Teacher attitudes had shifted, and they were more confident in using cooperative learning to help students in their own classrooms.

Cooperative learning can also affect student engagement in classroom activities. In one study of 113 undergraduate psychology students, participants reported a higher degree of engagement during cooperative learning as opposed to traditional classroom instruction (Peterson & Miller, 2004). Also, another study of 48 fifth-grade and sixth-grade math students found that students working in small cooperative groups spent more quality time on task compared to those in a traditional classroom setting (Mulryan, 1995).

While it is established that cooperative learning can be a very effective tool in the classroom, there is also a risk of failure in this undertaking. If the group activity is not well designed, there might not be any noticeable gains in student achievement or changes in students' attitudes. Also, if a teacher does not monitor the groups very carefully students may end up spending too much time discussing processes instead of concepts (Bianchini, 1997). To avoid this trap, teachers must consider delivering specific rubrics, standards, and guidelines to students when starting a project (Bianchini, 1997).

While there are potential downfalls to using cooperative-learning strategies, the positive net benefits will always shine through if the teacher is fully invested in creating

and encouraging a collaborative environment where students feel safe to share thoughts and ideas. Unlike the teacher-centered classroom, the classroom that embraces cooperative learning allows many different student interactions to occur concurrently throughout the room (Pratt, 2003). For these reasons, I have investigated the use of cooperative learning in my own classroom to help reach the goals I have set for both my students and myself. The use of cooperative-learning strategies also allowed for the examination of how my attitudes about teaching might change over time.

## METHODOLOGY

### Project Treatment

For this project there were two units that were completed and observed. The nontreatment unit was Science of Life. In this unit, students learned about the core concepts of biology including scientific language, characteristics of living things, properties of water, and important biological molecules. 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. The treatment was not applied to this unit and students were taught using a traditional teacher-centered lecture format, along with a small variety of content centered activities. The treatment units were Cell Structures and Processes and also Genetics. In these units, students learned about the core concepts of cellular biology including cell theory, cellular structures, cellular function, heredity, and genetics. The treatment was applied to these units and students were taught using cooperative-learning strategies.

In the nontreatment units, students were presented new material through direct instruction, using a mix of teacher-instructed notes and book readings. The concepts

taught in this unit were reinforced through a variety of activities including worksheets, demonstrations, simple classroom activities, and laboratory exercises. I modeled practice examples for the students and work was completed individually by students throughout the unit. During this unit the main focus was the delivery of biology content by the teacher and the development of student understanding of the content. One of the class activities, in which students demonstrate an understanding of the four biological macromolecules, is included in Appendix A. This activity lets my students work individually to create an original document that explains the structures and functions of the macromolecules learned about in class.

In the treatment units, students were taught using cooperative-learning strategies, including jigsaw, think-pair-share, and the gallery walk. In the jigsaw activities students were all given a topic to investigate, share findings with other researchers, and finally report their finding to their original group. The think-pair-share activities were used to give students access to small groups even during brief exercises at the beginning and end of class. These activities had students write down their own response to a specific prompt, pair with a partner to discuss their ideas, and finally share their findings with the class. The gallery walk was used to allow student groups to display their work in a fashion that allows for all classmates to read and reflect. During the jigsaw and gallery walk activities students were assigned specific roles; during the think-pair-share students were not assigned roles but were specifically tasked with meeting with their table partner to discuss the content. During the treatment units the teacher still delivered some content directly to the students, but much of the learning was centered around group work that utilized peer-to-peer learning with an emphasis on self-discovery. The cooperative-

learning strategies used in this unit attempted to create a positive learning environment that featured students working collaboratively towards a shared goal. This focus on collaboration allowed the students' learning to become student-centered, instead of the traditional teacher-centered system found in many classrooms.

During the first treatment unit students learned about cell structures and processes. In one of the treatment lessons students worked to learn about the human-body systems. Students were split into small groups, with approximately three students per group. No direct instruction was given to the students in regards to the content; instead students were assigned research on one specific human-body system per group. Within these groups students were given specific roles: Artist/Time Keeper, Researcher/Group Leader, or Writer/Resource Keeper. Students worked as a team to share their ideas and build a consensus about their knowledge of their group's human-body system. Students worked with their fellow group members to produce an informative life-size poster about their specific human-body system, along with an interactive note sheet to be shared with their classmates. The group posters were presented in class as part of a gallery walk, thus, allowing the students to showcase their work in an open and safe environment. To help make expectations clear students were given an instructional handout before the start of the project. The handout for this activity is found in Appendix B. Student roles were assigned and expectations were discussed for each group member's role. Also, students were held accountable for not only the finished group work, but also their own individual contributions to the group via a simple peer review. During the project the teacher circulated the room to work with each group and ensure they were on track. After the

project was finished, student groups were given individualized extension questions to help ensure a greater understanding of the content.

In the second treatment unit students learned about genetics. In one of the treatment lessons students worked to learn about genetic mutations and DNA technology. Students were split into small groups, with approximately four students per group. No direct instruction was given to the students in regards to the content; instead students were assigned to both a jigsaw home group and also an expert group. Within these groups students were given a specific task to complete. Before joining their expert groups, students were instructed to read their expert content twice to familiarize themselves with it. Next, students worked as a team in the four different expert groups to gain a deeper understanding of the specific content and also to create a summary to share with their home groups. With their expert group summaries in hand, students returned to their jigsaw home groups to report their findings. To help make expectations clear, students were given an instructional handout before the start of the lesson. The handout for this activity is found in Appendix C. During the project I circulated the room to work with each group and ensure they were on track. After the project was finished, student groups were given individualized extension questions to help ensure a greater understanding of the content.

The use of cooperative-learning strategies was effective for this class, due largely to the fact that the students bought into the system and also felt comfortable learning from each other. In a classroom environment that utilizes cooperative-learning strategies, it is critically important for the students to be willing to learn from each other. There must be a certain level of trust among classmates and also a willingness to take chances

all of which took place during the treatment unit. Student expectations during group activities were all clearly outlined, and brief activities such as think-pair-share helped to establish trust between students and their classmates. With all of these factors working to help move students towards their common goal, the level of classroom learning was raised and maintained throughout the unit.

### Data Collection Instruments

The students who participated in this project were all from North East High School, located in North East, Maryland. North East High School is a public school with a population of 1059 students of which 88% are identified as Caucasian, 8% African American, 1.8 % Hispanic, and the remaining 2.2% other minority groups. The school is diverse in regards to socio-economic status with 27% of students qualifying for the free or reduced lunch program. The class was held from 7:42- 9:18 AM each day. This class is a very diverse group of students overall, being a class of 17 students, with 7 being female and 10 male. It is approximately 11% African-American, 6% Hispanic, and 83% Caucasian. The class is comprised of mostly 10<sup>th</sup>-grade students, but does include three juniors. This is a very social group of students; they get along well with each other and enjoy robust class discussions. Also, they also are a hard working group and have a great sense of humor. In addition, there are a wide range of levels of motivation found within this group. Some students work diligently every day in class, while others do not make a consistent effort. It is for these reasons that I selected this group to participate in this project.

To answer my focus question and subquestions most effectively, all data were collected using three different methods for each individual question. This process allows

for data triangulation and a more complete comparison of results. The Data

Triangulation Matrix can be found in Table 1.

Table 1  
*Triangulation Matrix*

Focus Questions	Data Source 1	Data Source 2	Data Source 3
<i>Primary Question:</i>			
What are the effects of cooperative-learning strategies on students' understanding of high school biology concepts?	Pre and postunit student capstone project target assessments	Pre and postunit student concept interviews	Pre and posttreatment student surveys
<i>Subquestions:</i>			
What are the effects of cooperative-learning strategies on students' long-term memory?	Post and delayed unit student capstone project target assessments	Post and delayed unit student concept interviews	Post and delayed unit student surveys
What are the effects of cooperative-learning strategies on students' attitudes and motivations towards biology class activities?	Instructor field observations pre and posttreatment	Pre and posttreatment student interviews	Pre and posttreatment student surveys
What are the effects of cooperative-learning strategies on students' engagement in class activities?	Instructor field observations during both treatment and nontreatment units	Pre and posttreatment student interviews	Pre and posttreatment student surveys
What are the effects of cooperative-learning strategies on my attitudes towards teaching high school biology?	Colleague observations during both treatment and nontreatment units	Teacher reflection journal with prompts	Pre and posttreatment teacher survey

Within the triangulation matrix, all sources of data have been displayed. This includes data from the perspective of students, teacher, and colleague. Sources of quantitative and qualitative data were used throughout the action project, including a focus on attitude and motivations. This mix of data types, data collection methods, and perspectives all helped to ensure the data collected would be reliable and free of bias.

In order to assess the effects of cooperative-learning strategies on students' understanding of biology concepts, a preunit and postunit assessment were administered before both the treatment and nontreatment units. The unit assessments can be found in Appendix items D, E, and F. In addition, student surveys and student concept interviews were also used to help address this focus question. The student survey tool can be found in Appendix G and the student concept interviews found in Appendix H, I, and J. To assess the effects on cooperative-learning strategies on students' long-term memory, both post and delayed unit assessments, interviews, and surveys were administered to the students 14 days after the first treatment unit was completed.

To help assess student attitudes and motivation, field observations of student behaviors were done once during both the treatment and nontreatment units. Prompts for these observations can be found in Appendix K. In addition, student surveys were administered to the entire class both before and after the treatment. Also, there were six students that were selected for the interview process. Demographically this group was fairly diverse, as 17% were African-American and 83% were Caucasian. Out of the six selected students, two were high achievers, two were average students, and two were students who struggled throughout the units. Students were selection randomly from the subgroups for this process and this diverse group of learners was selected to allow for an

accurate representation of the class as a whole. The questions asked during this individual interview can be found in Appendix L. The data collected from the surveys and interviews was critically important to the entire research process as both tools provide for a high level of insight into the students thinking before, during, and after the units. Without the data from these data collection instruments, there would be many questions that could not be addressed or answered.

To assess the effects of cooperative learning on the teacher's attitudes towards teaching, three different data collection tools were used: a teacher journal, teacher survey, and colleague observations. A weekly teacher reflection journal was kept for the duration of the project. Prompts for these journal entries can be found in Appendix M. A teacher survey, found in Appendix N, was completed both pre and posttreatment. In addition, a colleague was invited into the classroom once per unit to make observations of the teacher's interactions with the class. The prompts for this observation can be found in Appendix O.

This project began in the week of January 22, 2014. The nontreatment unit, Science of Life, was completed in 3.0 weeks. The first treatment unit, Cell Structures and Processes, was completed in 3.0 weeks. The second treatment unit, Genetics, was completed in 2.5 weeks. The project was completed in its entirety by March 26, 2014. A complete general timeline for this project can be found in Appendix P.

## DATA AND ANALYSIS

All of the data for this study were collected using various methods to allow for triangulation of the final results. In order to investigate how cooperative learning affects my students' understanding of high school biology concepts, I utilized pre and postunit

assessments, pre and postunit concept interviews, and pre and posttreatment surveys.

The overall results of the pre and postunit assessments are found in Table 2.

Table 2

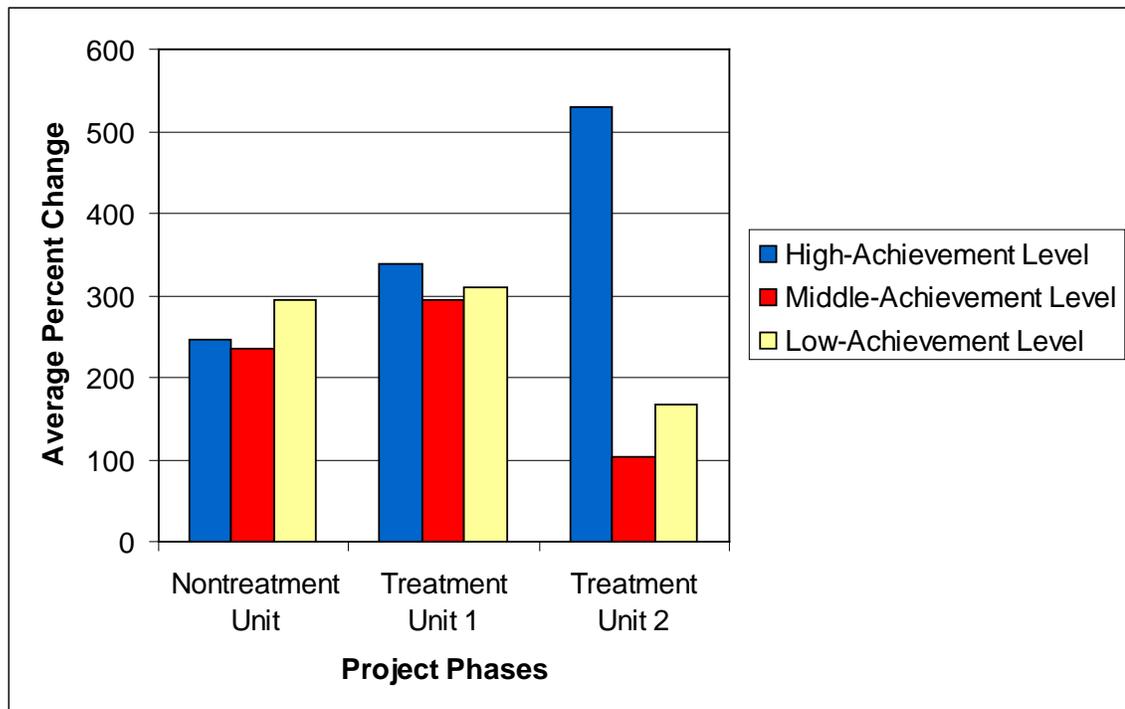
*Pre and Postunit Assessment Average Scores, Percent Change, and Normalized Gain Scores in Each Unit for the Entire Class (N=17)*

Nontreatment				
	Preunit	Postunit	Percent Change (%)	Normalized Gain
All (N=17)	20.3	62.8	265.4	0.55
High (n=3)	21.3	67.0	246.7	0.62
Middle (n=6)	25.3	69.2	235.6	0.61
Low (n=8)	16.1	56.5	294.8	0.48
Treatment 1				
	Preunit	Postunit	Percent Change (%)	Normalized Gain
All (N=17)	11.9	40.9	309.0	0.34
High (n=3)	19.3	69.3	339.2	0.63
Middle (n=6)	11.0	38.8	293.9	0.31
Low (n=8)	9.9	31.8	308.9	0.20
Treatment 2				
	Preunit	Postunit	Percent Change (%)	Normalized Gain
All (N=17)	22.1	56.9	208.0	0.44
High (n=3)	19.3	77.7	529.9	0.68
Middle (n=6)	27.7	55.7	102.2	0.39
Low (n=8)	18.9	50.1	166.6	0.40

A comparison of the entire class averages from each unit shows that the treatment units did not seem to have sizable gains in test scores compared to the nontreatment unit. In fact, the data shows that for the entire class averages the highest normalized gain occurred in the nontreatment unit. But, there was a large percent gain in treatment unit 2 class average score that exceeded both other units' increases. It should be noted that students in the treatment unit 1 began the unit at a much lower level than both the nontreatment unit and treatment unit 2. This low preunit score for the class allowed for a large percent change, even though the class averages for the postunit score were lower than both other units. Also, the normalized gains were lower for both treatment units.

There was an increase between treatment unit 1 and 2, which may indicate that the treatment, cooperative learning, was becoming more effective even though it was still less than the nontreatment.

A closer analysis of the results was yielded when the class was divided into groups of high, middle, and low-achieving students. Effects on the three different groups of learners varied with each unit. While the middle and low-achieving groups actually saw a decrease in the normalized gain scores, the high-achieving group did see an increase during both treatment units. Figure 1 shows the percent change in pre and postunit assessment scores during each unit for high, middle, and low-achieving students.



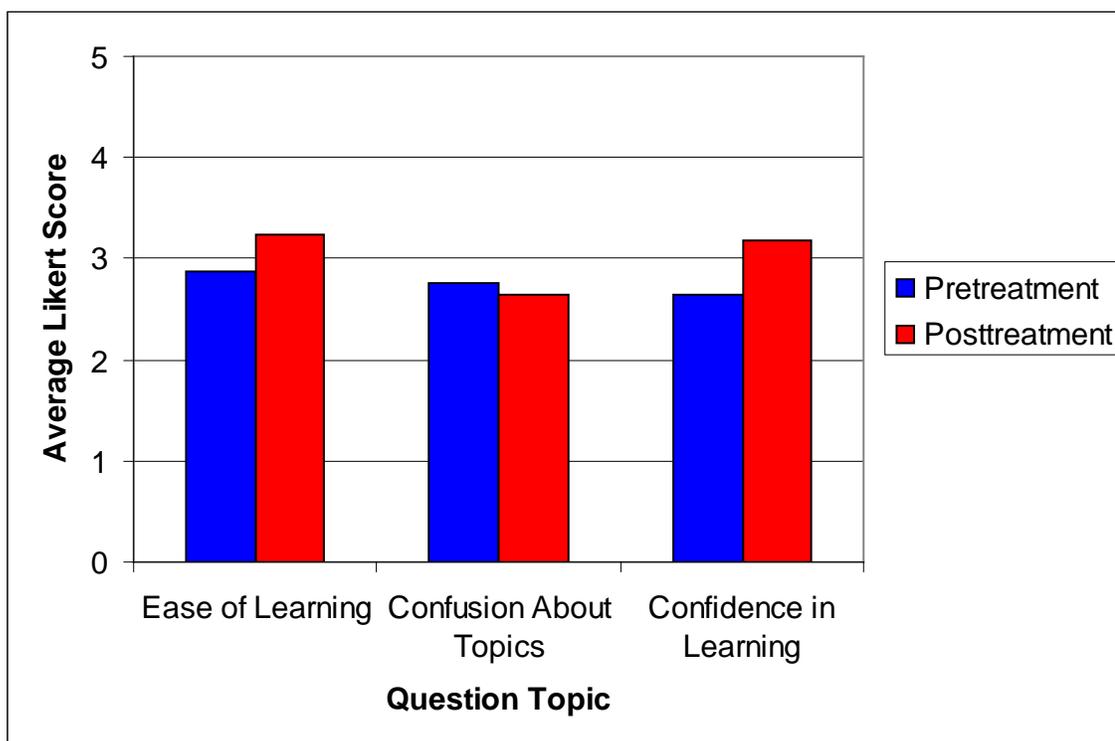
*Figure 1.* Percent Change in Pre and Postunit Assessment Scores According to Academic Achievement Level ( $n=3$  for High-achievement Level,  $n=6$  for Middle-achievement Level,  $n=8$  for Low-achievement Level).

All achievement levels showed an increase in percent change from the nontreatment unit compared to the first treatment unit. But, the middle and low-

achieving groups of students both showed a decrease in percent change during second treatment unit compared to the first treatment unit. The second unit did cover complex topics such as transcription, translation, and mutations and this definitely had an impact on student achievement in the middle and low-achieving groups. The largest percent change was in the high-achievement level group of students, who actually saw a sharp increase in percent change during both treatment units.

A deeper analysis of the normalized gain scores also yielded more insight into the results. The high-achievement group saw the most consistent change in normalized gain score as they moved their score up in each unit when compared to the previous unit score. The middle and low-achieving groups did not have the same type of results and they both saw a decrease in normalized gain scores when comparing the nontreatment and treatment units.

Another tool I used to assess students' understanding of biology concepts was a pre and posttreatment survey. Within this survey I asked students to rate their perceived ease of learning in biology, their perceived level of confusion about biology topics, and their overall confidence in learning science concepts. The students rated their views on these topics using a Likert scale. Students reported an increase from the pretreatment to the posttreatment in both their ease of learning biology concepts and also their overall confidence in learning science concepts. In addition, students reported a lower level of confusion when learning about biology concepts after the treatment units were completed. All of these results are found in Figure 2.



*Figure 2.* Average Likert Scale Scores Showing Students' Perceived Ease of Learning Biology Concepts, Level of Confusion in Biology Class, and Confidence in Learning Science Concepts Both Pre and Posttreatment ( $N=17$ ). *Note.* Likert Scale 5=Strongly Agree, 4=Agree, 3=Neutral, 2=Disagree, 1=Strongly Disagree.

The final tool I used to assess the level of my students' understanding of biology was a pre and postunit concept interview. A typical response for the low and middle-achieving students showed very little understanding before the nontreatment unit. For example, when students were asked how the four main biological molecules were important to life on earth, one low-achieving student responded, "It is important to life because it keeps life going and keeps people alive." It is true that biological molecules are critical to the functioning of living cells, but the student cannot explain why this statement is true. A middle-achieving student also answered the same question by saying, "They help humans survive and keep everything in check." Overall, both groups grasped

the importance of the biological molecules but they could not provide evidence to support their ideas.

After the nontreatment unit was completed, the same low-achieving student answered this question by saying, “They help sustain life and what makes up some parts of the human body.” This student recognized that the biological molecules do have specialized roles within living cells, but she could not specifically identify the molecules and their roles. The same middle-achieving student also responded by saying, “We need all of these in our body to help get optimum health.” This student stressed the importance of the molecules to life but did not give any supporting evidence to back up her statement.

The low and middle-achieving students did show some gains in understanding during the treatment units. For example, before the first treatment unit students were asked to explain why plants are so important to life on earth. One low-achieving student answered by saying, “They are food and they can make oxygen.” When asked the same question again after the first treatment unit was complete the student replied, “They help feed plant eaters; they help make oxygen; they give homes for animals.” The student did not expand the explanation of their answers the second time around, but they did provide an additional piece of evidence to help support their answer.

The high-achieving students showed a higher level of understanding in the concept interviews. Before the nontreatment unit students were asked how the human body uses each of the four main biological macromolecules. One high-achieving student responded by saying, “They are used for DNA, getting energy, and reproducing cells.”

The students answer did identify some key functions for the molecules within the human body, but it did not specify which molecules help with each specific function.

After the nontreatment unit was finished the same high-achieving student was asked the same question. The student responded by saying, “Proteins are used for muscle, lipids for fat, carbs for energy, and nucleic acid for both DNA and RNA.” This response gave specific examples of how the molecules are used by the body but still was not a complete answer. The student did not provide any explanation of how the specific molecules full the roles that he outlined in his response and still showed a lack of depth of understanding for this topic.

High-achieving students demonstrated a large improvement in understanding during the treatment units. For example, before the second treatment unit students were asked how DNA is decoded by living cells. One high-achieving student responded by saying, “It works like a computer would; it reads the code and then executes it.” This answer provides a nice analogy to the function of DNA in the cell but does little to provide an actual mechanism for the DNA to transfer its code within the cell.

The same high-achieving student was asked the same question after completion of the second treatment unit. This time around the student responded by saying, “It uses the mRNA and travels to the ribosome where the mRNA meets up with the tRNA to make proteins.” This answer shows a high-level of understanding in regards to DNA and the processes of transcription and translation within the cell. This level of comprehension was not seen in the concept interviews from the low and middle-achieving groups of students, and this trend is backed up by the normalized gains data from Table 2. In addition, the high-achieving student group also demonstrated definitive gains in average

percent change from the preunit to postunit scores in both treatment units. All three of these data sources were used to triangulate the results for this group.

In addition to gathering data about student understanding, I also used post and delayed unit assessments, post and delayed concept interviews, and post and delayed student surveys to collect data on the effects of cooperative-learning strategies on students' long-term memory. Due to the time constraints of the project delayed data collection only occurred following the completion of the nontreatment unit and the first treatment unit. While this was not ideal, it did provide enough reliable data to help complete our analysis on long-term memory.

The post and delayed unit assessments were used to examine the students' retention of concepts from each unit 14 days after the completion of the unit. The data from these assessments is found in Table 3.

Table 3  
*Post and Delayed Assessment Average Scores and Percent Change in Each Unit for the Entire Class (N=17)*

Nontreatment			
	Postunit	Delayed unit	Percent Change (%)
All (N=17)	62.8	45.9	-22.5
High (n=3)	67.0	62.7	-6.9
Middle (n=6)	69.2	42.0	-35.4
Low (n=8)	56.5	42.5	-18.6
Treatment 1			
	Postunit	Delayed unit	Percent Change (%)
All (N=17)	40.9	38.8	-3.6
High (n=3)	69.3	66.7	-5.3
Middle (n=6)	38.8	37.5	-4.0
Low (n=8)	31.8	29.4	-2.7

The data clearly shows both delayed unit assessments resulted in an overall decrease in assessment scores, but that the treatment unit delayed results were much closer to the post unit scores when compared to the nontreatment unit results. Specifically, the data shows that students were better able to retain concept knowledge after the treatment unit, as there was a decrease of only 3.6% as opposed to a decrease of 22.5% for the nontreatment unit. In addition, there was a smaller normalized gain for the nontreatment unit when compared to the treatment unit.

When the data was sorted by student groups (high, middle, and low-achieving) a deeper analysis was also completed. Changes occurred in student scores for all three groups and there is a noticeable change for the middle and low-achieving students. Both of these groups experienced a large decrease in scores during the post and delayed assessments in the nontreatment unit. This gap in post and delayed scores was decreased by over 30% and 15% for the middle and low-achieving groups, respectively, in the first treatment unit. Post and delayed scores for the treatment unit did not experience any significant change for the high-achieving students within the first treatment unit. These data show that the middle and low-achieving groups experienced benefited greatly from the cooperative-learning strategies, in terms of long-term memory.

Post and delayed concept interviews were also used to examine the effects of cooperative-learning strategies on students' long-term memory. The results of these interviews showed aligned with the results of the post and delayed assessments, as middle and low-achieving students experienced a higher retention rate during the treatment unit. For example, in the post unit concept survey for the nontreatment unit students were asked to describe some real-life examples of the four main biological macromolecules.

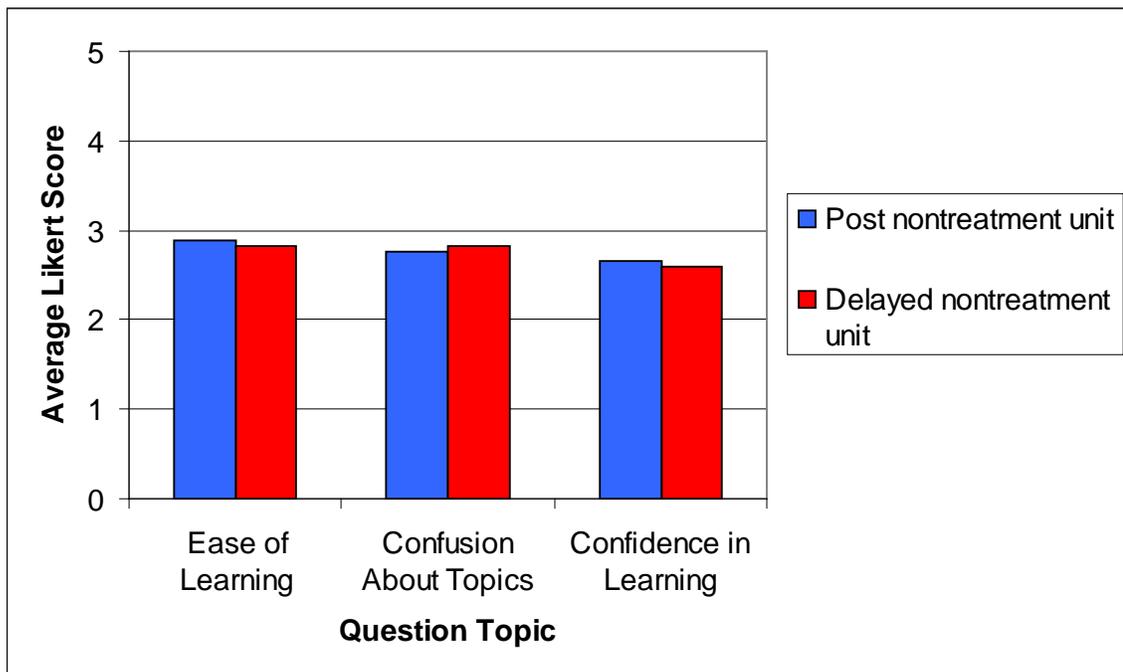
One low-achieving student responded by saying, “Proteins are enzymes, lipids are fats, carbohydrates are sugars, and nucleic acids make DNA.” This response did an adequate job of providing four examples of the biological macromolecules and avoided any common misconceptions. During the delayed unit concept survey for the nontreatment unit the same student responded again by saying, “proteins are enzymes, carbs can be sugars, lipids are starches, and nucleic acids make your stomach acid.” This type of response was typical among both the low and middle-achieving groups and it showed a sizable amount of content knowledge being absent, as well as the presence of a misconception about nucleic acids.

During the treatment unit students in the middle and low-achieving groups experienced less of a drop in content knowledge during the delayed interviews. For example, students were asked to describe some ways that plant and animal cells are similar to each other. One middle-achieving student responded by saying, “Both are cells, both are the building blocks of life, both use energy to survive, and both are eukaryotic.” This answer demonstrates that the student has a basic knowledge about common structures in both plant and animal cells and also simple understanding about the cell as the basic unit of life. In the delayed interview the same student responded to the same question by saying, “Both are living cells, both use energy, and both have a nucleus.” This answer does not contain any misconceptions, but it does show a small drop in overall comprehension.

The high-achieving group did not experience any noticeable difference between the treatment and nontreatment units during the post and delayed concept interviews.

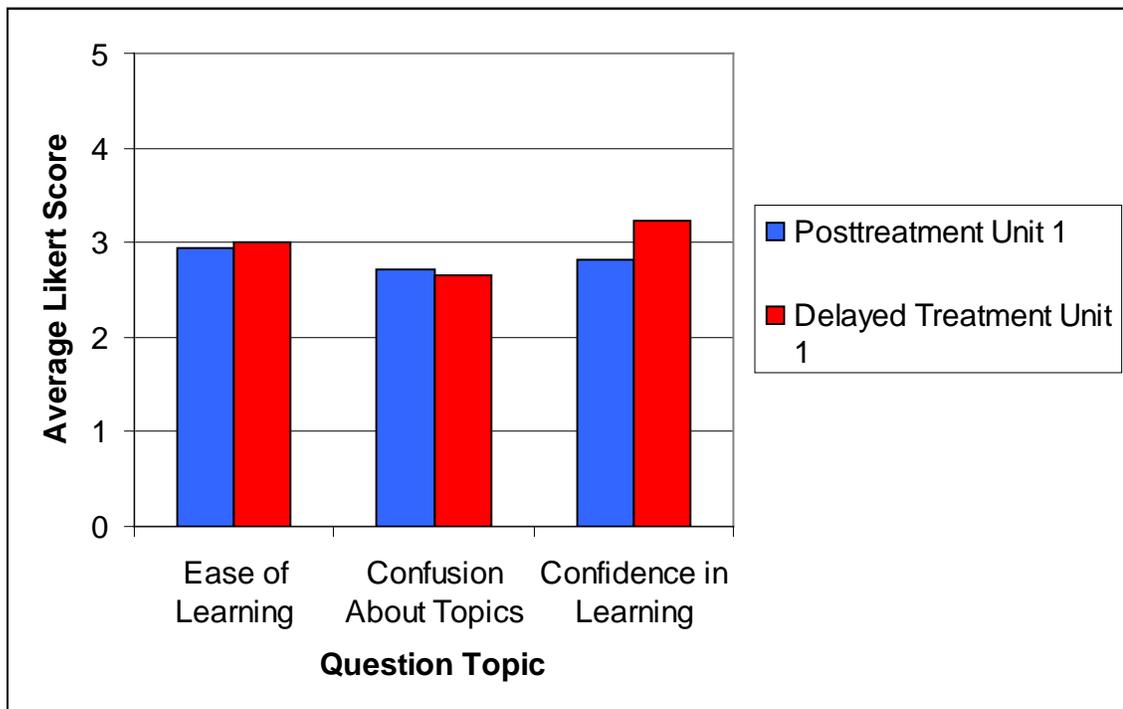
Students in this group showed a small, but noticeable, drop in content knowledge during both the treatment and nontreatment units.

The final data source for this subquestion was the use of both post and delayed student surveys. Within this survey I asked students to rate their perceived ease of learning in biology, their perceived level of confusion about biology topics, and their overall confidence in learning science concepts. Once again, the students rated their views on these topics using a Likert scale. There were no clear findings from the comparison of the post nontreatment and the delayed nontreatment survey results. Scores from both surveys were very similar for all three questions and the results of this nontreatment surveys can be found in Figure 3.



*Figure 3.* Average Likert Scale Scores Showing Students' Perceived Ease of Learning biology Concepts, Level of Confusion in Biology Class, and Confidence in Learning Science Concepts during both Post and Delayed Nontreatment Unit ( $N=17$ ). *Note.* Likert Scale 5=Strongly Agree, 4=Agree, 3=Neutral, 2=Disagree, 1=Strongly Disagree.

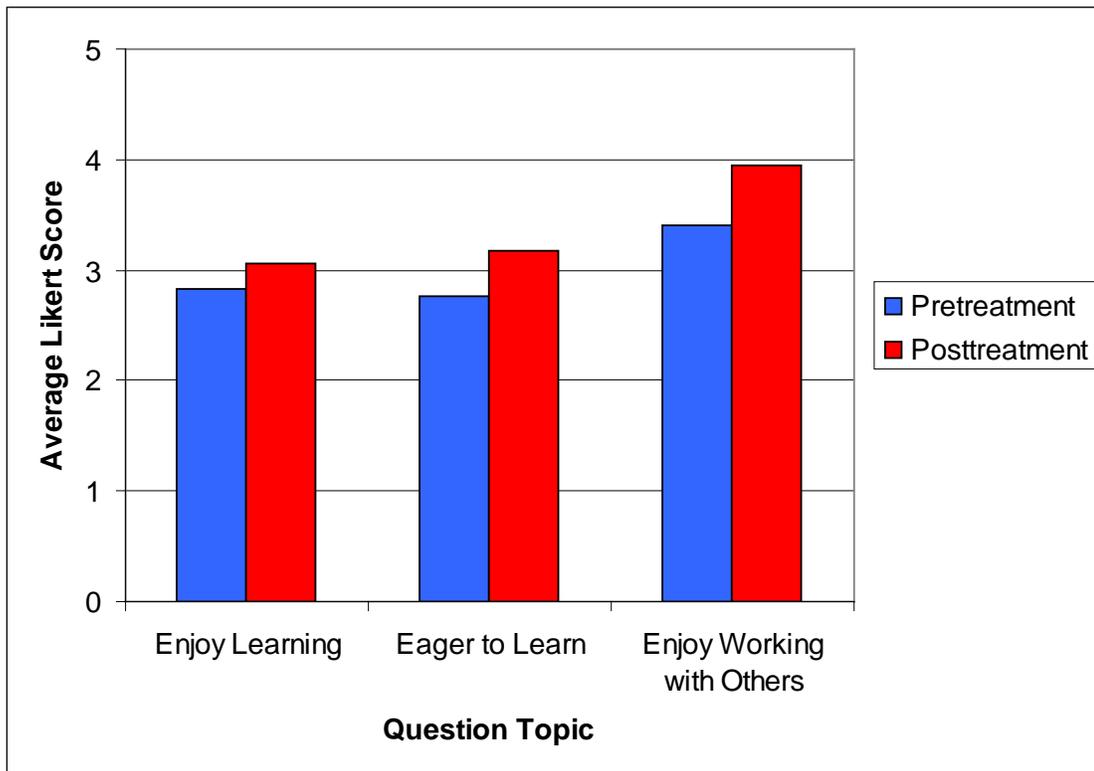
The data from the post and delayed treatment unit surveys did yield some noticeable results. While there was not much change in regards to the students' perceived comprehension and confusion about biology topics, there was a noticeable increase in the overall student confidence. On the delayed treatment surveys students reported a higher level of confidence in their abilities to learn science concepts. This result might be related to the fact that the delayed treatment survey occurred once the students had become more familiar and confident in using the cooperative-learning strategies within our class environment. Results of the posttreatment and delayed treatment surveys can be found in Figure 4.



*Figure 4.* Average Likert Scale Scores Showing Students' Perceived Ease of Learning biology Concepts, Level of Confusion in Biology Class, and Confidence in Learning Science Concepts during both post and delayed treatment unit 1 ( $N=17$ ). *Note.* Likert Scale 5=Strongly Agree, 4=Agree, 3=Neutral, 2=Disagree, 1=Strongly Disagree.

Another subquestion examined the effects of cooperative-learning strategies on students' attitudes and motivations towards biology class activities. One way this was assessed was through the use of instructor field observations both before and during the treatment. In my pretreatment observation I had noted that, "Some students voiced their displeasure with taking notes again." In this pretreatment unit teacher directed notes were utilized frequently and it seemed that this method invoked some negative attitudes in students.

My observations showed a slight change in attitudes during the treatment units. For example, during the first treatment unit I had noted that, "Students had energy and looked eager to participate in the jigsaw activity." This energy and eagerness showed a shift in attitudes from the nontreatment unit when compared to the treatment units. This shift in attitudes was also seen in the student survey results. In all three survey questions relating to student attitudes there was a positive change that occurred. Data are found in Figure 5.



*Figure 5.* Average Likert Scale Scores Showing Students' Attitudes on Enjoying Learning, Eager to Learn, and Enjoying Working with Others Both Pre and Posttreatment ( $N=17$ ). *Note.* Likert Scale 5=Strongly Agree, 4=Agree, 3=Neutral, 2=Disagree, 1=Strongly Disagree.

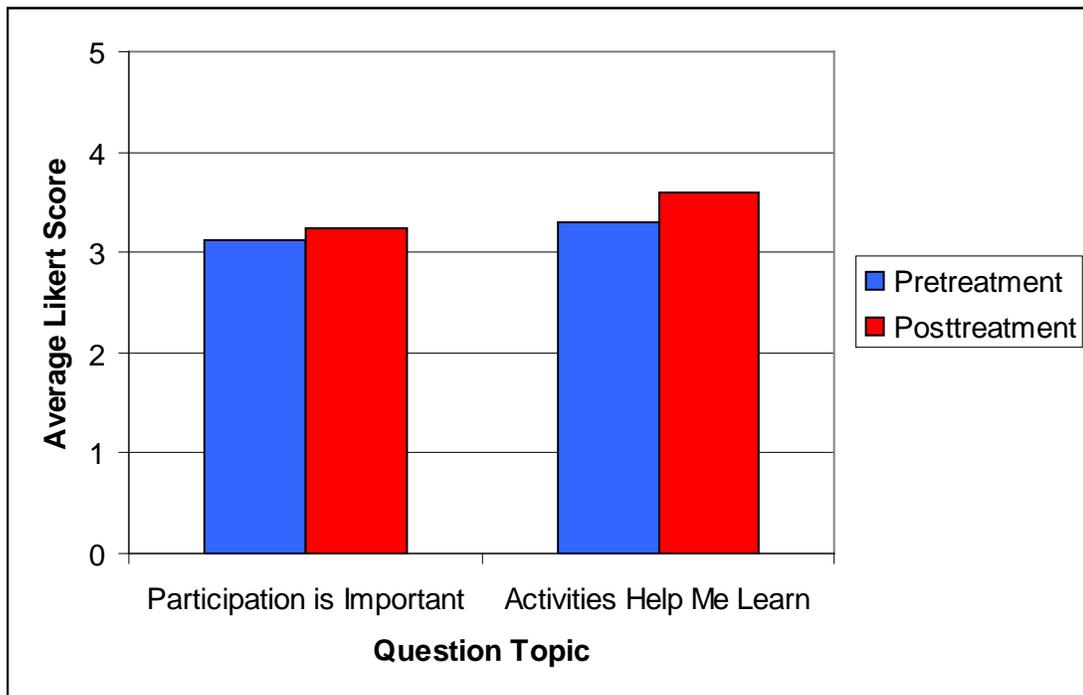
The last data set used to analyze student attitudes and motivations was the pre and posttreatment student interviews. In the pretreatment interviews students were asked if they feel that they can be successful in biology class. One student responded by saying, "Sometimes because it can be easy, but most other times it is hard." This same student responded differently during the posttreatment interview when they reported that, "Yes, because most of the time we do things to help me be successful." This response showed a positive shift in student attitudes after the treatment units were completed.

While attitudes did shift during this project was noted that student motivations did not shift. In both the pre and posttreatment student surveys students overwhelmingly

indicated that their key motivation for the class was to try and receive credit and/or pass the class.

The next subquestion in this project examined the effects of cooperative-learning strategies on students' engagement in class activities. The instructor field observation during the nontreatment unit noted that, "Most students were fully engaged." This level of engagement did not seem to change during the field observations from the treatment units, as it was noted that, "All groups were fully engaged in the activity." The instructor field observations did not yield any detailed insights into a possible change of engagement levels from the pre to posttreatment.

Student surveys, both pre and posttreatment, were also utilized to further analyze this subquestion. In the surveys it was evident that students placed a higher value on participation during the treatment units when compared to the nontreatment unit. In addition, students also indicated a higher confidence in the value of participation during the treatment units. Data are found in Figure 6.



*Figure 6.* Average Likert Scale Scores Showing Students' Ratings on Importance of Participation and Perceived Learning Value of Participating in Class Activities Both Pre and Posttreatment ( $N=17$ ). *Note.* Likert Scale 5=Strongly Agree, 4=Agree, 3=Neutral, 2=Disagree, 1=Strongly Disagree.

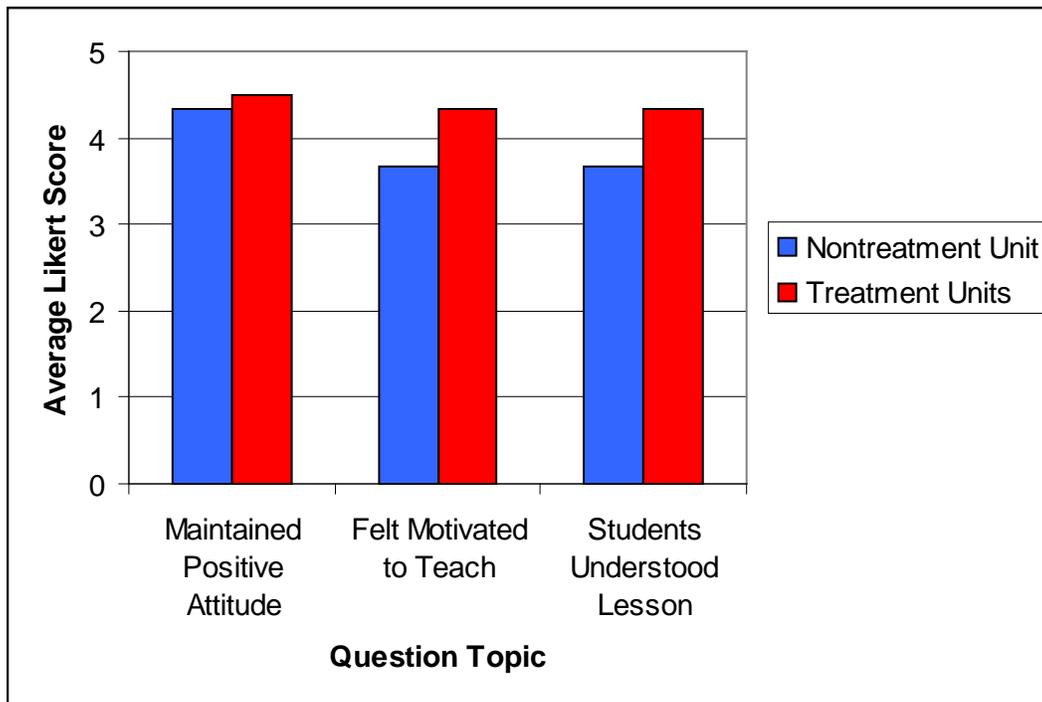
Student interviews, both pre and posttreatment were also used to analyze this subquestion. In the pretreatment interviews students were asked what class activity helps them learn most. One student responded by saying, "Activities don't really help me." This same student responded differently during the posttreatment interview when they said, "Group work because it's where I get the most info." This response showed a shift in the engagement level of the student, as she now placed a higher value in being engaged during activities in the treatment unit.

The final subquestion analyzed the effects of cooperative-learning strategies on my own attitudes towards teaching high school biology. The help assess my attitudes colleague observations occurred once during each unit. These observations helped to

provide insight from the perspective of another science teacher in our building. My colleague commented on my attitudes during the nontreatment unit by saying, “Mr. Haack stayed positive and empowered students to try and answer questions throughout the lesson.” During the first treatment unit my colleague also noted that, “Mr. Haack’s positive attitude helped to create a comfortable and safe environment for students to answer questions.” These observations showed that throughout the project I was able to maintain a positive attitude during my biology class.

Pre and posttreatment teacher surveys were also used to examine my own attitudes. In the pretreatment survey I commented on my feelings to be motivated to become a better teacher by saying, “I strive to do my best everyday in my classes.” This response showed a positive attitude towards my efforts to become a better teacher. Later, in the posttreatment survey I commented on the same question by saying, “I enjoy finding new strategies to help my students learn.” This new response not only showed a positive attitude, but it also mentioned specific ways that I might meet this goal.

A weekly teacher journal was also recorded during the nontreatment and treatment units. Three questions directly related to teacher attitudes were asked on this journal form and my attitudes did seem to shift according to the data. Slight improvements in overall attitude, levels of motivation, and perceived student understanding were shown when comparing the nontreatment unit to the two treatment units. Data from these journal entries are found in Figure 7.



*Figure 7.* Average Likert Scale Scores Showing Instructor's Views on Maintaining a Positive Attitude, Feeling Motivated to Teach, and Perceived Student Comprehension During Both Nontreatment and Treatment Units ( $N=9$ ). *Note.* Likert Scale 5=Strongly Agree, 4=Agree, 3=Neutral, 2=Disagree, 1=Strongly Disagree.

#### INTREPRETATION AND CONCLUSION

The goal of this project was to examine the effects of cooperative-learning strategies on students' understanding of high school biology concepts. After reviewing all available data it can be concluded that cooperative-learning strategies can have a positive impact on students' comprehension, but that this increase will not be felt equally among all student groups and through all biology content. While the high-achieving group of students showed improvements in both percent change of unit assessment scores and also normalized gain scores, it should be noted that results for middle and low-achieving groups were inconclusive. This would suggest that, based on data from this

project, high-achieving students stand to benefit the most from the use of cooperative-learning strategies.

In regards to the effects on students' long-term memory the data showed that all students stood to benefit from the use of cooperative-learning strategies. Students retained more concept knowledge after the treatment unit, with the middle and low-achieving student groups showing the greatest improvements in retention. While there was only one treatment unit's worth of delayed assessment data to compare, the data that were collected showed clear results in this case.

Student attitudes also seemed to improve during the treatment units, while student motivations remained static. Data showed that students maintained a more positive attitude throughout the treatment units when compared to the nontreatment. This also ties in with the observed improvement in the level of student engagement. In addition, my own attitudes shifted toward the positive according to data from the journal reflections. All of these data show that student and instructor alike both improved their attitudes as the treatment units were completed.

To improve this project, I would find another data source to help examine the effects on students' long-term memory. The post and delayed student surveys became redundant and it seemed that the students felt overloaded with surveys during this project. Also, the language on the student surveys needed to be improved. There were not enough questions on the survey that directly addressed the issue of student engagement and this made it difficult to gauge how it changed from the pre to posttreatment.

Another improvement could be made by increasing the number of instructor field observations. These observations were not intrusive to the students and did not take too

much time away from the teacher. More importantly, they helped provide critical insight into how the activities were actually affecting the students' day to day happenings. More data points here would be useful in assessing student attitudes, motivations, and level of engagement in the class.

One final change that I would investigate would be the possible inclusion of some multiple choice questions as part of the unit assessments. While relying on multiple choice questions alone would be a bad idea, due in part to student guessing, the use of multiple choice questions could provide another supplemental data point for the pre, post, and delayed unit assessments. Well written questions can minimize any gains from student guessing and some students who are not strong or confident writers might actually receive a more reliable overall score.

#### VALUE

This project allowed me to see some of the positive effects of using cooperative-learning strategies. These data showed that some students increased their understanding through the use of cooperative-learning strategies. Moving forward I had to ask myself if there was a way to tweak the strategies used in this project in order to more consistently help all of my students achieve these gains in comprehension. There are no clear answers to this question, as a variety of factors all affected the final results of this project.

It is helpful to know that these strategies can be applied to other classes that I teach at North East High School. Most semesters I teach an equal mix of both honors and regular biology sections- I am interested in using some of the cooperative-learning techniques with these classes in an effort to improve student learning outcomes. Since there are other teachers at my school who teach similar groups of students it would be

useful and applicable to share my findings with them as well. Our science department is always working to find and utilize successful teaching strategies and my findings could have a positive impact on our effectiveness as instructors.

It seems that there are many unanswered questions that remain now that this study has been completed. Could my results be duplicated if there was a larger sample size? With a small class (17 students) it seems that there was a greater chance for outliers to play a more prominent role in the data. Student attendance was an issue with this group and so were student tardies to class. With the class taking place during the first block of the school day I have a couple of students who were constantly tardy or even absent from my class (as they didn't sign into school until after first block was over). A larger sample size or even spreading the research across multiple class sections might have helped to remove this bias from the data and possibly change the overall results.

Another question would relate to the students themselves. Would my results be similar if the project was completed with a completely different group of students? The group that I selected for this study had a wide range of learners with various strengths and weaknesses. What if the study was completed with a more homogenous group, such as one of the high-achieving sections of honors biology? It would be interesting to see results from this type of study with a high-achieving group of students.

This project has helped me to realize how my own teaching methods need to be constantly evaluated and reevaluated. Each group of students is different and within each group there are subgroups that all might have different needs, strengths, and weaknesses. My job as a teacher is to continue to find new and creative strategies that will best address the specific needs of my students. Completing this study has allowed me to

reflect on my past teaching and to realize that I rarely stray far from my comfort zone. If I am comfortable with one teaching strategy then I continue to use it- without getting feedback from my students to verify its effectiveness. Now I feel more comfortable to try new things as teacher and I also feel more confident in finding ways to gauge the effectiveness of my class instruction. These learned lessons are invaluable to me as I strive to continue to grow and develop as a teacher and educator throughout my career.

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APPENDICES

APPENDIX A

MARCOMOLECULES CLASS ACTIVITY

## Macromolecules Class Activity

Macromolecules Class Activity- Mr. Haack's Biology:

\*Using your book and notes as informational resources, put together a creative and original song, rap, comic strip, short story, or cartoon (if you have other ideas see Mr. Haack first) that provides key concepts and ideas about all four macromolecules we learned about in class. You are free to choose which format to use, but this will be completed as an individual class activity (no groups or partner work). See Mr. Haack for any questions that you might have along the way!

\*Your original piece should be both informative and interesting. It should somehow include all of the following:

- the names of all four major macromolecules
- the functions of all four major macromolecules
- the structure of all four major macromolecules
- real-world examples of all four major macromolecules
- explain the differences between monomers and polymers
- explain the differences between monosaccharide and polysaccharide

Use this paper as your rubric for the assignment- you will need to include all listed items to receive full credit. Be creative with this assignment and have fun!

APPENDIX B  
HUMAN-BODY SYSTEMS PROJECT

## Human-Body Systems Activity

My group's body system is \_\_\_\_\_.

### Human Body Systems Projects

You and your group must become experts on your specific body system. Using your book, class notes, and media center resources you will need to put together a poster that will be presented to the rest of your class as part of our Gallery Learning Walk.

**In your poster you should include all of the following:**

- **A large diagram of the organ system, including all of the key organs that make up your body system, shown within the setting of the human body.**
- **Explanation of the functions of each of those organs.**
- **Explanation of how the body system is vital to survival of the human body and maintaining homeostasis.**
- **Explanation of how your body system interacts with at least 3 other systems of the human body.**
- **At least 8 interesting facts about your body system.**

\*The poster will be graded for both content and also readability/overall presentation.

**\*\*\*\*Along with your poster your group must produce a note sheet that your classmates can follow along with as they move from station to station. This note sheet should cover ALL of the most important material on your poster (you will have to summarize and prioritize here), and each student should be able to keep their own copy to have in their notes (and use to study with). The note sheet should be typed or written in pen, it should be no more than one page long. (Mr. Haack will make copies for the entire class)**

Group Roles will include:

Artist/Time Keeper

Researcher/Group Leader

Writer/Resource Keeper

Also, all group members will serve as peer evaluators after the project has been completed.

**My Role for this project is:** \_\_\_\_\_

APPENDIX C

DNA MUTATIONS JIGSAW ACTIVITY

## DNA Mutations Jigsaw Activity

DNA Mutations and Technology Activity

**My expert group is:** \_\_\_\_\_.

**My jigsaw home group is:** \_\_\_\_\_.

**MY JIGSAW HOME GROUP ROLE:** \_\_\_\_\_  
(Group Leader/Group Timer/Group Writer/Group Resource Manager)

This activity will require you to interact with 2 different peer groups- your Expert Group and your Jigsaw Home Group. To complete this activity you will have to follow each step carefully:

**STEP 1-** By yourself silently read over your Expert Group Reading and write down any questions that you have about the reading. Next read the same material again and look for anything that you might have missed the first time through.

**STEP 2-** When time is up (watch for Mr. Haack's signals), please meet with your Expert Group and bring your reading content with you. With your Expert Group work together to create your own summary sheet that you can take back to your jigsaw home group. While working with your group and writing the summary sheet think about the following questions:

- How can I put these ideas/concepts into my own words?
- Is what I'm saying going to help my home group learn the material?

**STEP 3-** When time is up, please meet with your Jigsaw Home Group and bring your summary sheet and reading content with you. Within your home group please take turns to share your findings from the Expert Group. Discuss your summary with the group and also talk about what you learned from the other Expert Group members.

APPENDIX D

NONTREATMENT PRE, POST AND DELAYED UNIT 1 ASSESSMENT

## Nontreatment Pre, Post and Delayed Unit 1 Assessment

1. Brine shrimp can be found almost anywhere in the world in inland saltwater. They are completely absent from oceans and are not closely related to true shrimp. They can live in water having several times the salinity of seawater, but they can also tolerate water having only a tenth of the average salt concentration found in the ocean, which is approximately 0.0035 percent. The concentration of salt in water affects the hatching of brine shrimp eggs. A scientist wants to determine the best conditions in which to hatch the shrimp eggs.

You have been tasked with designing an experiment to determine what conditions would be best for raising brine shrimp in a laboratory. In your design, be sure to include:

- independent and dependent variables
- describe control and variable group
- the materials that will be used
- the type of data that will be collected
- how the data will be used to evaluate the salt requirements of brine shrimp

2. Describe the importance of water to living systems. Be sure to include the following:

- List at least four unique properties of water
- How each property of water affects life on Earth
- Diagram a water molecule and label the parts

APPENDIX E

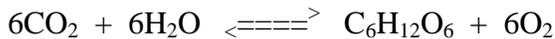
TREATMENT PRE, POST AND DELAYED UNIT 1 ASSESSMENT

## Treatment Pre, Post and Delayed Unit 1 Assessment

1. All organisms are classified as either prokaryotic or eukaryotic. Explain how to determine if a given biological sample contained prokaryotic or eukaryotic cells. Be sure to include in your answer:

- the structures you would expect to find in each cell type
- examples of the organisms that would contain each of these cell types
- the instruments you would use to determine if a cell was prokaryotic or eukaryotic

2. The reaction below shows the relationship between photosynthesis and aerobic respiration. Explain why it is vital that plants and animals be included in a self-sufficient ecosystem.



Be sure to include:

- the reactants and products for the reactions
- where each of the reactants and products come from
- how each of the reactants and products are used by organisms
- how each of the reactants and products are cycled

3. Scientists are currently investigating Europa, one of the moons of Jupiter, in the search for life outside of planet earth. Europa is very cold and encased in ice, but there is evidence to suggest that Europa has liquid water and might harbor life deep in below this icy outer shell.

Use the above information to describe a potential life form that might exist on Europa. In your description please include:

- what structures would the potential life form have
- how would the potential life form obtain energy
- how the potential life form would reproduce

APPENDIX F

TREATMENT PRE AND POST UNIT 2 ASSESSMENT

## Treatment Pre and Post Unit 2 Assessment

1. Develop a Punnett square using the following scenario: A heterozygous tall pea plant is crossed with another pea plant that is also heterozygous tall. Tall pea plants (T) are dominant to short pea plants (t).

- Create a Punnett square to show all the possible heights for offspring.
- Describe the phenotypic ratio of the offspring.
- Describe the genotypic ratio of the offspring.

2. Describe the DNA molecule in terms of structure and function. Be sure to include in your description:

- The components of the nucleotide
- The shape of the DNA molecule
- Include a labeled sketch of DNA
- Explain the main function of DNA
- Describe the process of DNA replication

3. Mutations of cellular DNA can lead to a helpful adaptation, a disruptive change, or cause no change in the organism. Using a simple eukaryotic algae as your sample organism, design and describe three possible DNA mutations that could affect the algae in the ways mentioned above. Be sure to include:

- What type of mutation occurred
- The specific ways that the mutation affects the organism
- Will this mutation persist in the population?

APPENDIX G  
STUDENT SURVEY

## Student Survey

This survey is voluntary and will not affect your class grade

1 = Strongly Disagree    2 = Disagree    3 = No Opinion    4 = Agree    5 = Strongly

Agree

- |  |           |
|--|-----------|
| 1. I find concepts in Biology class to be easy to learn.   | 1 2 3 4 5 |
| 2. I enjoy learning about Biology.   | 1 2 3 4 5 |
| 3. I am often confused when learning about concepts in Biology class.  | 1 2 3 4 5 |
| 4. I think that concepts learning in Biology have real-world importance.   | 1 2 3 4 5 |
| 5. I think that participating in class is important.   | 1 2 3 4 5 |
| 6. I am confident in my abilities to learn science concepts.   | 1 2 3 4 5 |
| 7. I am eager to learn about new ideas and concepts in Biology class.  | 1 2 3 4 5 |
| 8. I think that activities in biology class help me to learn.  | 1 2 3 4 5 |
| 9. I am confident in my abilities to complete class activities in Biology class.   | 1 2 3 4 5 |
| 10. I enjoy working with other students in Biology while learning new concepts.  | 1 2 3 4 5 |
| 11. What types of class activities did you find most interesting?<br>Why do you enjoy these types of activities?                                 |           |
| 12. Please describe your motivation for being successful in Biology class. Please be specific and list any and all motivations you can think of. |           |

APPENDIX H

NONTREATMENT STUDENT CONCEPT INTERVIEW

Nontreatment Student Concept Interview

The four main biological macromolecules are:

Proteins      Lipids      Carbohydrates      Nucleic Acids

What are some real life examples of these molecules?

How are these molecules important to life on earth?

Why is it important to have an understanding of the structure and function of these four molecules?

Explain how our bodies use each of the four main biological macromolecules.

A new single-celled species is discovered to use only three of the four biological macromolecules. Use your knowledge of the biological macromolecules to describe which of the macromolecules would most likely not be used by the organism. Also, explain how this proposed organism might function without the use of this molecule.

APPENDIX I

TREATMENT UNIT 1 STUDENT CONCEPT INTERVIEW

Treatment Unit 1 Student Concept Interview

Plant and animal cells are both different in terms of structure, function, and how they obtain energy.

What are some ways that plant and animal cells are similar to each other?

What are some ways that plant and animal cells are different from each other?

Why is it important to have an understanding of the structure and functions of both plant and animal cells?

Explain why plants are so important to life on earth.

APPENDIX J

TREATMENT UNIT 2 STUDENT CONCEPT INTERVIEW

Treatment Unit 2 Student Concept Interview

Deoxyribonucleic acid (DNA) is sometimes referred to as the “blueprint for life”.

What is meant by this phrase?

How is this “blueprint” decoded by living cells?

Why is it important to have an understanding of DNA and its functions?

APPENDIX K  
STUDENT OBSERVATION PROMPTS

Student Observation Prompts

Date \_\_\_\_\_ Class Lesson \_\_\_\_\_

1 = Strongly Disagree 2 = Disagree 3 = No Opinion 4 = Agree 5 = Strongly Agree

1. Students are engaged in class activities. 1 2 3 4 5

Comments:

2. Students are willing to share their ideas with the class. 1 2 3 4 5

Comments:

3. Students are motivated to learn. 1 2 3 4 5

Comments:

4. Students are showing negative attitudes towards the lesson. 1 2 3 4 5

Comments:

5. Students are excited to participate in class activities. 1 2 3 4 5

Comments:

What types of class activities seem to best motivate the students?

Were there any negative attitudes present during the lesson? If so, describe them.

Overall Comments:

APPENDIX L  
STUDENT INTERVIEWS

Student Interview

1. What do you enjoy about biology class? Explain.
2. If you could change anything about biology class what would it be? Explain.
3. What class ACTIVITY helps you learn most? Explain.
4. What makes you want to learn biology the most? Explain.
5. What do you find to be most useful about this class? Explain.
6. Do you think that biology is important to your everyday life? Explain with examples.
7. Do you feel that you can be successful in this class? Explain why or why not.
8. Is there anything else you think I should have asked or is there anything else you would like for me to know? Please state and answer.

APPENDIX M  
TEACHER JOURNAL PROMPTS

Teacher Journal Prompts

1 = Strongly Disagree 2 = Disagree 3 = No Opinion 4 = Agree 5 = Strongly Agree

1. I maintained a positive attitude during today's lesson. 1 2 3 4 5

Comments:

2. I felt motivated to teach today's lesson. 1 2 3 4 5

Comments:

3. My students seemed to understand today's lesson. 1 2 3 4 5

Comments:

What types of class activities seem to best motivate the students?

Were there any negative attitudes present during the lesson? If so, describe them.

APPENDIX N  
TEACHER SURVEY

Teacher Survey

1 = Strongly Disagree 2 = Disagree 3 = No Opinion 4 = Agree 5 = Strongly Agree

Comments:

1. I have high confidence in my teaching abilities. 1 2 3 4 5

Comments:

2. I enjoy coming to school each day. 1 2 3 4 5

Comments:

3. I enjoy working with my students each day. 1 2 3 4 5

Comments:

4. I feel motivated to become a better teacher. 1 2 3 4 5

Comments:

5. I feel motivated to help my students achieve. 1 2 3 4 5

Comments:

6. My attitude contributes to student learning. 1 2 3 4 5

Comments:

What is my motivation to help my students achieve?

What are the key factors that contribute to my motivations as a teacher?

APPENDIX O  
COLLEAGUE OBSERVATION PROMPTS

Colleague Observation Prompts

Date\_\_\_\_\_ Class Lesson\_\_\_\_\_

1 = Strongly Disagree 2 = Disagree 3 = No Opinion 4 = Agree 5 = Strongly Agree

1. The teacher is motivated to help students. 1 2 3 4 5

Explain.

2. The teacher is engaging the students in the lesson. 1 2 3 4 5

Explain.

3. The teacher has a positive attitude throughout the lesson. 1 2 3 4 5

Explain.

How does the teacher's attitude change throughout the lesson?

How could there be improvements in the teacher's attitudes or motivations?

Overall Comments:

APPENDIX P

GENERAL TIMELINE

## General Timeline

Start Project Implementation: January 22, 2014  
January 22- Introduction to Biology  
Nontreatment Unit Preassessment, Preunit Student Survey, Student Concept Interviews  
January 23- Scientific Method  
January 24- Paper Towel Inquiry Lab  
January 28- Characteristics of Living Things  
January 29- Biology Prefixes & Scientific Notation  
January 30- Inorganic Molecules/Properties of Water  
January 31- Properties of Water Lab  
February 3- pH Investigation  
February 4- Macromolecules  
1<sup>st</sup> Observation by Colleague  
February 5- Enzymes  
February 7- Nontreatment Postunit Assessment, Pretreatment Student Survey and Student Interviews  
February 10- Treatment Unit 1: Treatment Unit Preassessment, Preunit Student Concept Interviews, and Pretreatment Teacher Survey.  
February 11- Microscopes  
February 12- Microscopes Lab  
February 13- Cell Structure & Organelles  
February 20- Human Body Systems  
2<sup>nd</sup> Observation by Colleague  
February 21- Nontreatment Unit: Nontreatment Delayed Post Assessment, Delayed Concept Interview, Delayed Student Survey  
February 24- Cell Membrane  
February 25- Active and Passive Transport  
February 26-27- Photosynthesis  
February 28- March 3- Cell Respiration  
March 4- 5- Mitosis  
March 6- Treatment Unit 1: Postunit Assessment, Postunit Student Survey and Student Concept Interviews  
March 7- Treatment Unit 2: Treatment Unit Preassessment and Student Concept Interviews  
March 10- Mendelian Genetics  
March 11- Meiosis  
March 13- Sex-Linked Traits  
March 17- DNA & RNS  
March 19- DNA Mutations and DNA Technology, 3<sup>rd</sup> Observation by Colleague  
March 20- Transcription & Translation  
March 25- Treatment Unit 2: Postunit Assessment and Student Concept Interviews, Posttreatment Student Survey and Student Interviews, Posttreatment Teacher Survey

March 26- Treatment Unit 1: Treatment Delayed Post Assessment, Delayed Concept Interview, Delayed Student Survey

**End Project Implementation: March 26, 2014**