

EFFECTS OF THE USE OF PEER COLLABORATION IN
CREATING A STUDENT CENTERED BIOLOGY CLASSROOM

by

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DEDICATION

This project is dedicated to all of my past, current and future students who have managed to slip through the cracks. I am constantly working and will continue to work to try to find ways to catch you.

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ABSTRACT

In this investigation student performance was compared in terms of students working individually and students working in collaborative groups. The areas being looked at were content knowledge learned, content knowledge retained, student motivation and teacher motivation. Preassessments, assessments and postassessments as well as student interviews and student surveys were all used to determine if students performed better or were more motivated when working with collaborative groups. The data was analyzed as a whole group cluster and was also broken down into three performance clusters representing the low, medium and high performing students. Keeping a journal throughout the research process and asking a colleague to observe my attitude and interactions with the students measured teacher motivation. In contrast to what I thought the data would represent, all groups showed greater gains in content learned when working individually. However, when content knowledge retained was analyzed, students retained the knowledge learned better when they worked in collaborative groups. Students were also more motivated and expressed that they preferred to work in collaborative groups more than working individually. As a teacher, I also enjoyed my teaching more and interacted with the students more when the students were working in collaborative groups.

INTRODUCTION AND BACKGROUND

After teaching high school science for 13 years, I can honestly say that I love my job. Throughout my career, I have had the opportunity of teaching in very rural schools and in urban, inner-city schools. I am inspired to work with students at all levels and find a great deal of satisfaction in building relationships with my students while providing them a quality education. From the beginning of my career I have struggled with the question of how I can help all students engage in their own education and become successful students and people.

The amount of effort that my students put into their own education affects my attitude and my teaching. One of the concerns that I have felt is that students are not actively engaging in their education. In trying to help my students engage in their own education, I would like to better understand their motivations toward school and learning. I also would like to incorporate activities that not only have the students completing their work but that will have them discussing the subject content with their classmates.

Our high school recently adopted a 1:1 iPad initiative through which each student was given an iPad. As teachers, we were instructed to implement the iPads as another learning tool in our toolbox, reduce the amount of paper copies that we produce, and expand the classroom beyond the walls of the school building. Although I was excited about the opportunities that the iPads would provide, I was a little concerned about the students becoming insular in their learning and not communicating with each other about the content that we were covering in class.

I strive to challenge and engage learners rather than teach information to be memorized. I have observed that when students actively engage in the curriculum, and make connections between their own lives and what they are learning, they understand the concepts better and retain the information longer. I have also noticed that when students either teach the content to another student or when they learn from another student, they tend to remember the information better. I would like to help my students become successful in more than just a science classroom, I would like to help them be successful in life by building a deeper understanding of the world around them and applying that knowledge to make informed, educated decisions.

These observations led me to formulate the focus questions for my capstone project. My project focus question was: What are the effects of an increased use of peer collaboration on students' understanding of high school biology concepts? To give depth and breadth to my project, my subquestions included; what are the effects of an increased use of peer collaboration on students' long-term memory of biology concepts; what are the effects of an increased use of peer collaboration on student's interest and motivation; and what are the effects of an increased use of peer collaboration on my motivation as a teacher?

In a student-centered classroom, where collaborative learning is in place, the teacher is more than just a presenter and lecturer, the teacher places the students in the center of the learning process and provides the student with content, scaffolding, and opportunities to independently learn the content. Peer collaboration within the classroom consists of students working together on assignments, projects, decision-making, and

daily discussions. Classrooms that incorporate collaborative learning have students placed in small groups based on some criteria such as ability, gender or natural aptitudes, or the groups can be heterogeneously mixed.

The purpose of this project was to increase student learning and long-term memory, as well as student and teacher motivation. As the teacher, I wanted to help my students do more than endure their time in science and wanted to help them become active participants in the learning experience. The skills that it takes to be an active learner can also be transferred to the students' other classes and to their lives.

CONCEPTUAL FRAMEWORK

If you have ever spent time in a high school science classroom, you have likely seen that glazed-over look that students tend to get when they are sitting through yet another lecture. Studies have shown that student neither hear nor understanding what is being said during lectures. Barbara Lom (2012) paraphrased Mark Twain when he summarized a lecture as "A transfer of information from a professor's lecture notes to the student's notes without passing through the minds of either." (p. 64) The education system in America has evolved, in many classrooms, to a passive transfer of information where learning and application is secondary to the passing on of information. There has been much concern and debate about science education in America, evidenced by the development and adoption of the Next Generation Science Standards (NGSS Lead States, 2013). According to Cartier, Passmore and Stewart (2010) "When science instruction is incomprehensible and uninspiring it fails the most basic mission of science education" (p. 394). Creating a learning environment that encourages students to become active

participants in the learning process is the goal of a student-centered classroom.

The concept that students learn by doing and interacting has been theorized for a long time. One of the theories that emphasizes this is Social Constructivism. The theory behind Social Constructivism emphasizes the importance of interactions between students when building new knowledge. To increase learning through Social Constructivism, students need to relate the information being taught to their cultural and societal environment. According to Keaton and Bodie (2011) learning increases when students can communicate and share the learning experience. In a research project conducted by Summers and Volet (2010) it was found that developing knowledge with group work does not necessarily increase higher order thinking, but those students who actively engage with their group members learn at a higher rate than their classmates who do not engage with their group members.

For learning to become meaningful, teachers must provide the opportunity for students to engage in the learning process, ask questions about the content, and link new knowledge to prior knowledge. Liftig (2014) stated that science could no longer be treated as something that students pick up on their own. Students must be taught how to interact with the content, how to ask connecting questions, and how to put new knowledge into the proper frame of reference. As teachers, we can no longer just pass the content to the students, we need to engage the students in inquiry and learning.

In an article reporting on the effects of cooperative learning in a science classroom, Lin (2006) stated that students benefit from working in groups, expressing their understanding and building new knowledge, and improving their communication

skills in scientific thinking and processing. Working within student groups also helps the students become more invested and engaged in their education.

Learning within collaborative groups has also been shown to help students retain the knowledge learned for longer than knowledge gained through independent work.

Duren and Cherrinton (1992) found that students who worked collaboratively were able to remember and apply problem-solving strategies in a pre-algebra class. They also found that students who worked in cooperative groups were more likely to remember and use problem-solving strategies in later units, supporting that these strategies were in their long-term memories.

Student motivation is a key factor in student learning. Urdan and Schoenfelder (2006) propose that enhancing student motivation requires the teacher to play an integral role in classroom management and classroom community development. Schunk and Zimmer (2007) found that the social environment within a classroom could influence the students' affective domains and behaviors. In trying to identify student motivation in a science classroom, Velayutham and Aldridge's (2012) research suggested that when students collaborate with each other in class their motivation is increased.

There have been numerous studies conducted in trying to determine the greatest factors in student success in school. Carey (2004) identified the single most important factor in student success is the teacher. In a research project studying the effects of a student-centered classroom on student and teacher motivation, MacCallum (2009) stated that his research showed that creating a student centered classroom where students help each other was empowering to the teacher and validated the desire and passion to

educate. In creating a student-centered classroom, I hope to increase both my and my student's motivation.

Moving from a teacher-centered classroom to a student-centered classroom requires a shift in the teacher's thinking and planning. A review of the literature indicates that the teacher's role in a traditional classroom focuses on direct delivery of instruction. In contrast, the teacher's role in a student-centered classroom lies in the structuring and setup of the learning environment (Peters, 2009). According to Tanner (2009) numerous studies have shown that traditional lecture style teaching is not as effective for student learning and content retention as active, student-centered classrooms and student-centered learning activities.

The research indicated that students learn more and retain that knowledge longer when they have the opportunity to learn in collaborative groups compared to learning in isolation. Davis (1999) found the following:

The benefits of collaborative group work can include increased participation by students in all components of the course, better understanding and retention of materials, mastery of skills essential to success in the course or in a career, and increased enthusiasm for self-directed learning – the kind of enthusiasm that can spur students on to independent research or honors projects. (p. 3)

This statement summarizes the goals of my capstone project, which are to use peer collaboration to increase student involvement, student memory retention, and student motivations and to keep myself excited about the next phase of my career.

METHODOLOGY

In trying to determine how a student-centered classroom with the use of peer collaboration affected my students as compared to the nontreatment, teacher-centered

approach, I completed a nontreatment unit and two treatment units. The nontreatment unit covered a unit on the cell cycle and mitosis. The treatment units covered a unit on meiosis and a unit on basic Mendelian genetics. In my experience, students have either done very well or poorly, with few average performances, when I have taught these concepts. As I have reviewed test and quiz scores from past years, I found that 54% of students scored at a B range or better, 34% of students scored at a D or F range and only 12% of students scored in the C range. After thinking through this and discussing it with my colleagues, I believe that these results have to do with the fact that students simply try to memorize this content rather than understand it or conceptualize it. It was my goal to help students learn the content at a deeper level and retain that knowledge longer by incorporating peer collaboration techniques.

Participants

Star Valley High School (SVHS) is located in Afton, Wyoming and is made up mostly of middle class, farming families. There are 705 students who attend SVHS and approximately half of them go on to attend the local community college or a university. Star Valley High School has recently received the national Blue Ribbon High School award, and was the top performing high school on the state testing in the 2013-2014 school year. I chose to complete my capstone project with four of my 10th grade biology classes, consisting of 72 students. The group of students that comprised my research group consisted of 42 boys and 30 girls, nine of which are currently on an IEP. All of the students who are on IEP's and participated in my capstone project are fairly high functioning and only require minimal accommodations.

Intervention

The nontreatment unit consisted of a unit covering the steps to mitosis and describing and recognizing what happens to the chromosomes during each phase of the cell cycle. As part of this nontreatment unit, the students worked independently in a traditional teacher-centered classroom. As the teacher, I lectured, assigned worksheets, and completed a digital microscope lab. The students were placed in rows according to a seating chart and worked independently. To help me evaluate how much the students had learned during the unit, the students were given a preassessment, an assessment and a postassessment, as well as surveys questions and participated in student interviews.

Two treatment units were used to compare with the nontreatment unit. At the beginning of the first treatment unit, the student's desks were placed into small groups of three and the students were assigned to their seats based on a heterogeneous mixture of gender and ability. The first treatment unit covered meiosis and sex cell formation and division. The second treatment unit covered basic Mendelian genetics and inheritance.

During the treatment units a variety of collaborative learning techniques were used. The collaborative learning techniques ranged from simple things like reviewing notes with your group or taking turns defining vocabulary to more complex group project based learning activities. For example, prior to asking for an answer to a teacher-posed, class directed question, the students were given time to discuss the answer as a group before offering their ideas for the rest of the class. The students were also asked to compare homework answers throughout the class period and prior to submitting their

homework, allowing the students to discuss questions that they did not have consensus on.

Other examples of cooperative learning strategies used during the treatment units included Kagan Cooperative Learning Strategies such as Round Table, Stand Up, Hand Up, Pair Up, Timed Pair Share and Quiz, Quiz, Trade (Kagan, 2009). As a beginning of class review and in using the Round Table strategy, I asked each group to use a single sheet of butcher paper and title it: Steps in Meiosis. The first member of the group then wrote out and drew a picture of the first step of meiosis. That student then passed the paper to the second member of the group and they wrote out and drew a picture of the second step of meiosis. The paper was then passed to the third member of the group where they wrote out and drew the third step in meiosis. This continued until all of the steps meiosis had been written and drawn. Each group member was required to give help or advice as the process proceeded so at the end of the assignment they had consensually created their group diagrams with explanations. The students were allowed to use their book and notes as a reference while they completed this assignment.

Another collaborative learning activity that we used was to use the iPads to make a Claymation movie modeling and explaining Meiosis as described in Appendix A. These movies were then shared with other groups, where each group was asked to provide a critique of the details of their movie and the steps to meiosis. At the completion of the critique, the students were asked to return to their assigned seats and were given the Meiosis Mix Up worksheet, as seen in Appendix B, and were asked to complete that worksheet but to help their group members throughout the process. Once the students

had completed the worksheet, they were asked to stand up and find someone who was not in their group to compare their answers, I then projected the correct answers to the worksheet on the active board and the students corrected their assignments.

During the second treatment unit covering basic Mendelian genetics and inheritance, the students were asked to work with their groups to complete different assignments where the students could divided the work up and share answers or were expected to work in sync without moving ahead of their group members. During this time, the students were also asked to not only compare answers with their group members but were also asked to double check their work with other groups.

I believe that completing a nontreatment and two treatment units like this helped me address my focus questions by allowing me to compare a traditional, teacher-centered classroom with that of a more student-centered classroom where peer collaboration was used. By having the student work independently in rows where there was little student to student interaction and then having them work in a small group setting where the students were asked to rely on each other, I was able to see if peer collaboration does increase student learning, student motivation and knowledge retention and if it helped me to enjoy my job more as a teacher.

Data Collection Instrument

All students in the class were given a preunit assessment and a unit assessment to evaluate prior knowledge and current knowledge over the course of the nontreatment and treatment units, as seen in Appendix C. The students were also given the same postassessment fourteen days after the completion of each treatment unit to assess student

knowledge retention. In addition to this, the students participated in a postunit survey that was used to help me evaluate student motivation, as can be found in Appendix D.

At the end of the two treatment units, I conducted interviews with ten students as seen in Appendix E. In selecting these students, I intentionally chose low, medium and high-performing students and then randomly selected the other seven students based on their willingness to participate. Interviews were meant to be short and casual but informative. By having the students participate in interviews, I was able to get a good representation of the students at all levels and was also able to include outliers.

I collected data from the three distinct sources and was able to collect and analyze both qualitative and quantitative data. Table 1 is the triangulation matrix for my capstone project in collecting data concerning a student-centered classroom and peer collaboration.

Table 1
Data Triangulation Matrix
Focus Questions

Project Questions	Source 1	Source 2	Source 3
What are the effects of using peer collaboration on student understanding of high school biology concepts?	Pre and postunit assessments	Postunit student concept interviews	Posttreatment survey
What are the effects of using peer collaboration on student's long-term memory?	Postunit and delayed unit assessments	Postunit and student concept interviews	Postunit surveys

What are the effects of using peer collaboration on student motivation?	Instructor field observations	Posttreatment student nonconcept interviews	Posttreatment Student surveys
What are the effects of using peer collaboration on teacher motivation?	Teacher weekly reflection journal	Nontreatment and treatment observations by colleagues	Posttreatment teacher survey

The topic of my focus question and subquestions addressed creating a student-centered classroom that used peer collaboration to increase student understanding of content, long-term memory of content, student motivation and teacher motivation. The use of preassessments and unit assessments were meant to provide quantitative data concerning student understanding of concepts. The students were then given the same postunit assessment 14 days after the unit to quantify what the students remembered, thus, addressing the long-term memory of the content learned.

Student motivation was quantified by having the students complete surveys that included open-ended questions and helped me to evaluate student motivation and enjoyment of the teaching styles being used with peer collaboration. During the interview portion of the project, I was also able to understand what the students had learned and how they felt about being able to work with others.

The project was conducted over the course of eight weeks beginning on January 19th and ending on March 13th. The students took the postunit assessment 14 days after

the end of each unit to assess long-term memory of content. The timeline for the unit can be found in Appendix F.

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 and can be seen in Appendix G.

DATA AND ANALYSIS

The data from my action research project will be broken down and analyzed by looking at my capstone research question and then subquestions.

Impacts of peer collaboration on students' understanding

To begin my research, the students took all three preassessments, one for each of the nontreatment unit and the two treatment units. For the nontreatment unit, where students worked independently and were seated in rows, the students scored an average of 29.5% on their preassessment and 70.1% on their assessment. When comparing the improvement between the preassessment and assessment, the students showed an actual increase of 41.3% over the course of the nontreatment unit, a gain score of 58.6% and a standard deviation in gain of 26.0%.

During the first treatment unit, where the students were seated in small groups of three and were allowed to work together, the students scored an average of 14.2% on their preassessment and 61.8% on their assessment. In analyzing the increase in score between preassessment and assessment, the students showed an actual increase of 47.6% over the course of the unit, a gain score of 55.5% and a standard deviation in gain of 29.5%.

For the final treatment unit, the students scored on average 38.4% on their preassessment and 70.6% on their assessment, increasing their average testing score by 32.1% over the course of the unit. This increase in score yielded a gain score of 52.4% and a standard deviation in gain of 28.9%. A comparison of average scores gained between preassessment and assessment and average gain score can be seen in Figure 1.

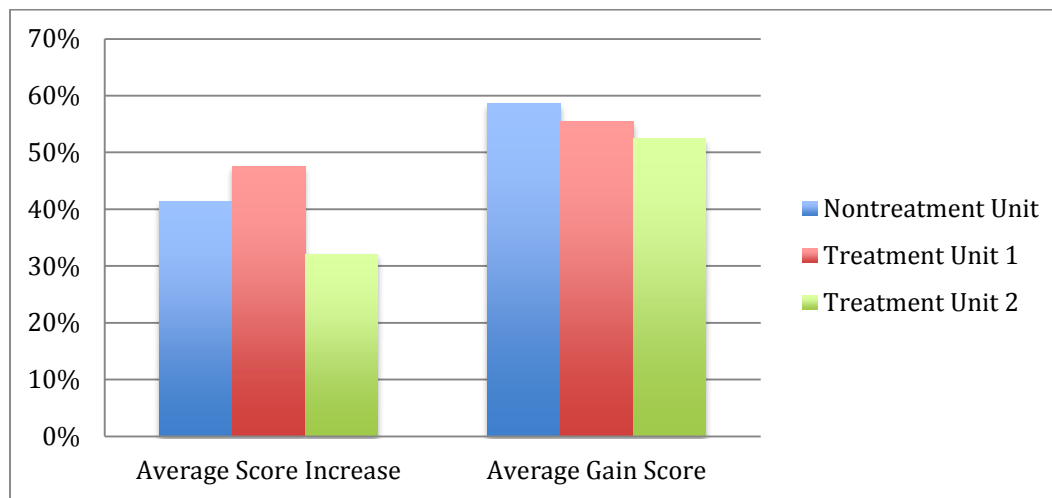


Figure 1. Entire class score increase, (N=72).

The data was also analyzed in terms of low, medium and high performing students. Ten students from each of the low, medium and high performing groups were chosen based on their current performance in class and their current overall grade. The student's scores were analyzed by group to help determine trends or patterns in the data.

When looking at the high performing group of students for the nontreatment unit, the students averaged 40% on the preassessment and 77.5% on the assessment. When comparing the change in scores between the preassessment and the assessment, this yielded an average increase in score of 37.5%, with a standard deviation in gain of 39.5% and a gain score of 59.6%. For the first treatment unit, this group of students averaged

7.5% on their preassessment and 75% on their assessment. This yielded an average increase in score of 72.5%, with a standard deviation in gain of 27.5% and a gain score of 31.3%. The data for the second treatment unit showed that the students averaged 53.4% on their preassessment and 81.5% on their assessment, showing an average increase in score of 29.1%. This change in score yielded a standard deviation in gain of 25.2% and a gain score of 39.9%.

The students that represented the medium performing group averaged 35.0% on the nontreatment unit preassessment and 67.5% on the assessment improving by 32.5% overall. The change in score between the two assessments yielded a standard deviation in gain of 39.2% and a gain score of 51.7%. When looking at the first treatment unit, this group of students averaged 5.0% on their preassessment, 62.5% on their assessment thus showing an increase of 57.5%, yielding a standard deviation in gain of 39.2% and a gain score of 43.8%. For the second treatment unit, the students averaged 43.3% on their preassessment, 69.9% on their assessment and improved their scores by 26.6%. In looking at the change in score, this yielded a standard deviation in gain of 25.2% and a gain score of 34.2%.

The students representing the low performing group, scored an average of 32.5% on their preassessment for the nontreatment unit, 77.5% on the assessment and improved by 45.0% between the two assessments. In looking at the change in score, this yielded a standard deviation in gain of 16.85% and gain score of 66.7%. For the first treatment unit the students averaged 5.0% on their preassessment, 47.5% on their assessment and showed an average increase in score of 45.0%. Again in looking at the change in score

between assessments, this yielded a standard deviation in gain of 28.0% and a gain score of 31.1%. For the second treatment unit, the students averaged a 34.9% on their preassessment, 66.5% on their assessment and improved between the two tests by 31.6%. This yielded a standard deviation in gain of 31.5% and a gain score of 41.4% between the two assessments.

When comparing the three different groups in terms of average percent gained between the preassessments and the assessments and average gain score, all three groups showed higher gains in the nontreatment unit where students were working individually. Figure 2 shows a comparison between the three groups and their percent increase in preassessment and assessment. Figure 3 shows a comparison between the three groups and their gain scores.

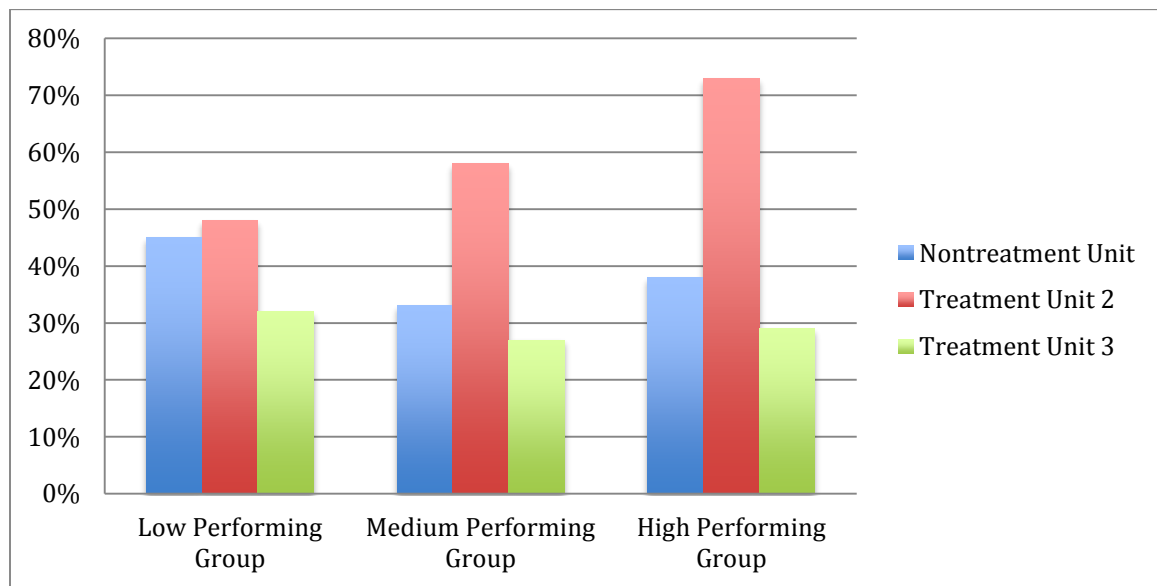


Figure 2. Increase in score for each performance group, ($N=72$).

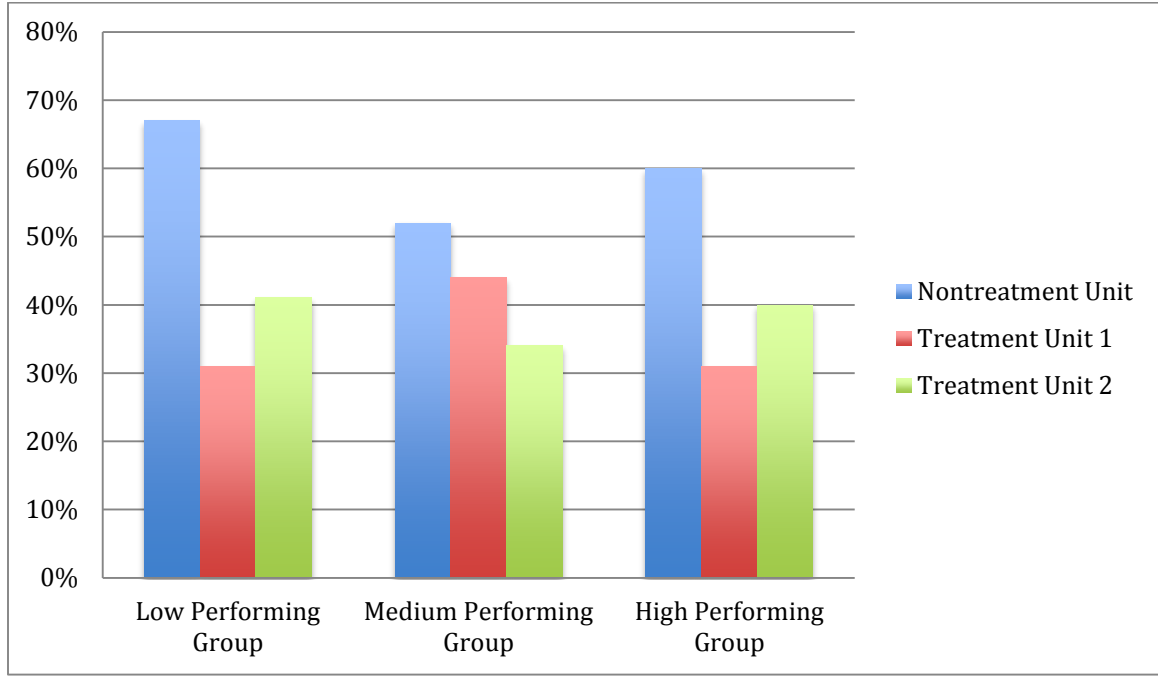


Figure 3. Gain scores per performance groups, (N=72).

Effects of Peer Collaboration on Students' Long-Term Memory

Fourteen days after each unit assessment a delayed postassessment was given to determine the amount of content knowledge that had been retained. For the nontreatment unit, the student's scores dropped by 3.4% showing a loss in content knowledge. During the first treatment unit, the student's average scores did not change from the assessment to the postassessment. During the final treatment unit, the students showed a small increase of 0.75% on average as can be seen in Figure 4.

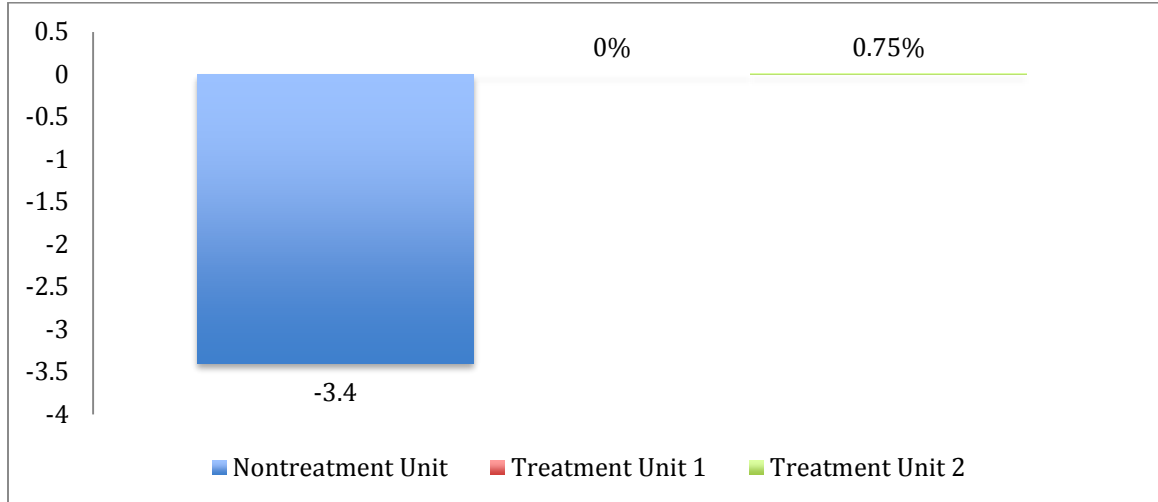


Figure 4. Average point change in scores between assessment and post assessment, (N=72).

When analyzing the knowledge retention of the high performing students the data showed that this group gained 17.5% between their assessment and their postassessment for the nontreatment unit. On the first and second treatment units, the students also improved their scores by 15% on the first treatment unit and 5% on the second treatment unit.

In analyzing the data from the medium performing group in terms of content knowledge retained, this group scored 5% lower on the postassessment than on the assessment for the nontreatment unit. For the first treatment unit, the student's scores also dropped by 5% and on the second treatment unit, the student's scores dropped by 3.3%.

The data for the low performing group showed that for the nontreatment unit, the student's scores dropped by 17.5%. For the first treatment unit the student's scores dropped by 5% and for the second treatment unit, the student's scores actually went up by 3.3%. The knowledge retention between the assessment and postassessment for each group is illustrated in Figure 5.

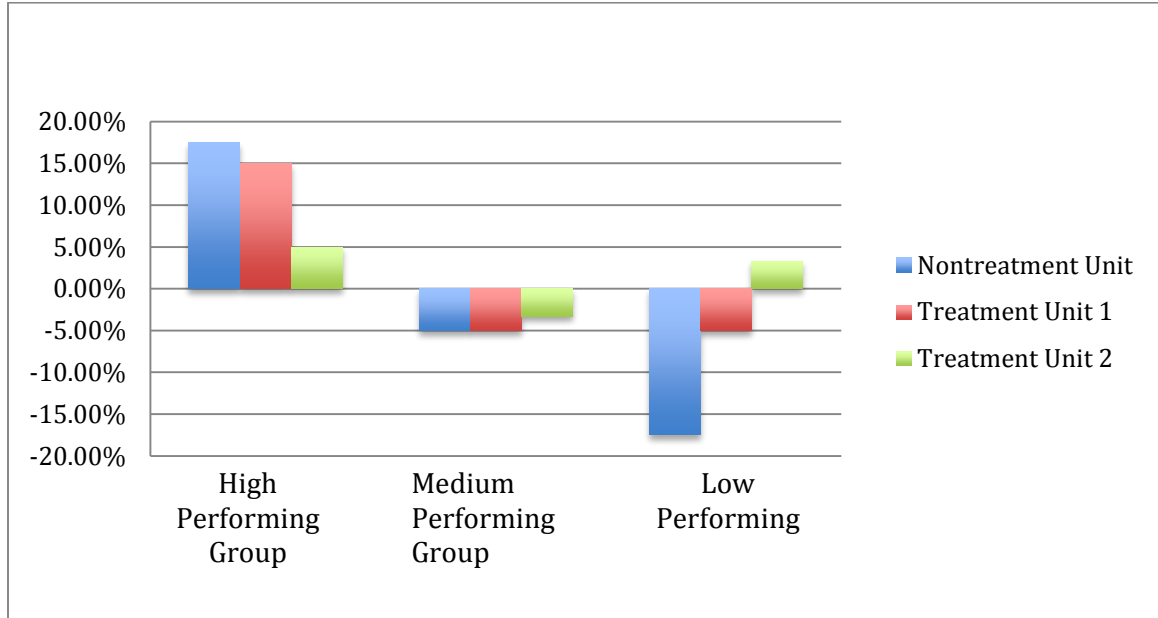


Figure 5. Average change in score between assessment and post assessment, ($N=72$).

As part of the data collection, interviews were conducted at the end of the three units. Ten students were chosen to participate in the interviews, three students were selected based on their performance in class to represent the low, medium and high performing students and the other seven students were selected on their willingness to participate but also represent each of the groups. Parts of the interviews focused on how students felt about their own learning and how working individually or with collaborative groups helped them retain content knowledge. Four of the ten students interviewed said that they learn best and retained the information for longer when they complete projects but when those projects are completed on their own and without partners. One student commented, “Creating projects like the Meiosis Claymation helped but it would have been better if I could have done it on my own like the Genetics Graffiti assignment.” This statement captures the results of my research showing that students do learn better when they are forced to work on their own. Six of the students interviewed said that they learn

best and retain the information longer when they work in groups and complete group activities and projects. Another student who represented the high performing students said that “Working in groups helps me remember the information because I usually need to explain it to other members in the group and teaching it helps me to remember it longer.” Another student who was specifically chosen to represent the low performing group said “Working in groups helps me by having someone else in the group explain what the big words mean.”

Effects of Peer Collaboration on Student Interest and Motivation

A survey was given to all students participating in my action research project and of those students 63% said that they prefer to work in small groups as can be seen in Figure 6. One idea that came up two different times in the interviews was that students liked to work in collaborative groups but that they do not like to complete projects, especially creative projects, with collaborative groups. One student stated “Working in groups is nice because you can share and talk through the answers to questions but I don’t like having to organize others when working on creative projects, I always end up doing the majority of the work on my own.”

Seven of the ten students interviewed noted that they prefer to work in groups because it helps them when they hear the information in a different way or need to explain the content to another student thus helping them to solidify the idea for themselves. One student stated that “I prefer to work in groups because it helps me to participate more and it seems more interactive. I especially like to review information in groups.”

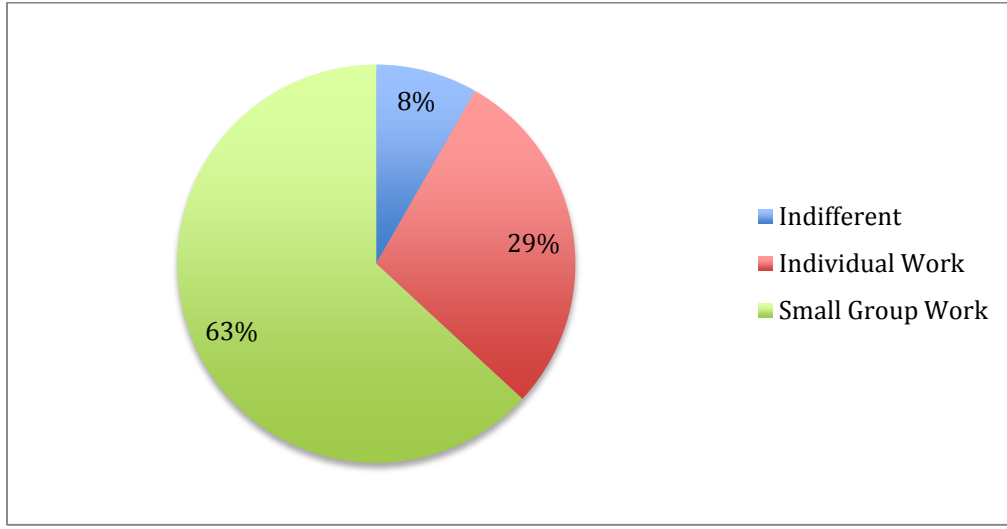


Figure 6. Students preference on individual vs. group work, ($N=10$).

Part of the survey asked the students to describe the way that they learn best and 54% of the students said that learn best when they are doing something with the content like group activities or labs as can be seen in Figure 7.

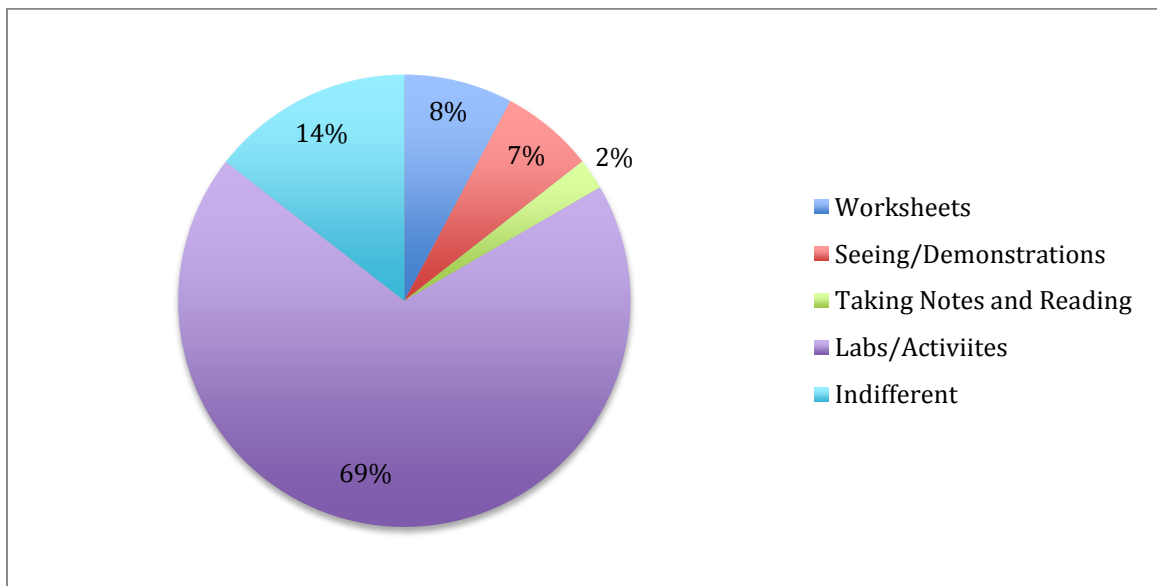


Figure 7. Students preferred learning styles, ($N=72$).

Effects of Peer Collaboration on Teacher Interest and Motivation

In determining my interest and motivation when teaching students in an individual setting verses a collaborative group setting, I kept a journal of how classes went and how I felt about teaching that day. I also asked a coworker to watch my mood and attitude towards my job and towards my students. In going back and reading my journal entries while working on the nontreatment unit, I noticed that I used the word “awkward” six times. Almost every journal entry that I logged during that nontreatment unit, I wrote about the class being “awkwardly quiet” or “students were not interacting at all and it was awkward” and “I didn’t have to redirect the students once because they just sat and worked – weird!” On one occasion, I had a substitute and she left a note that stated that “These were the three quietest classes I have ever substituted for”. I even recorded on one occasion that “I am so bored and I don’t feel a connection to my students and what they are learning”. My coworker noted that “Because the students worked independently and did not need as much monitoring and redirection, you interacted with them less and you sat at your desk and worked during class time.”

On the first day of the first treatment unit, I had the class work in their groups and complete a dice lab to help them understand the concept of probability, the dice lab can be seen in Appendix H. On that day, I noticed that I was way more excited about what the students were doing and I was more engaged with the students. On the second day of the first treatment unit, I assigned the Meiosis Claymation movie and I wrote that I was so excited about the types of student discussions I heard and the amount of interaction between students and between myself with students. On that particular day I journaled

that “This really is what I wanted in terms of students discussing/arguing and interacting with each other and with the content.”

When working on the second treatment unit, which focused on Mendelian Genetics, my journal entries continued to have a more positive tone. Some of the benefits that I saw from using collaborative groups for this unit included having students talk through the punnett squares and then check each other’s work. On one occasion, I wrote that;

“Today I had the students complete a dihybrid punnett square worksheet. It was so nice because I didn’t have to spend any time correcting the assignment. The students worked together in their groups and when they were finished, they double-checked that they all had the same answers to the problems. I then had the students use the Kagan strategy of Stand Up, Hand Up and find someone from another group to check their answers with. It was awesome!”

I spoke with my coworker many times throughout my action research project and he said that he felt I had a better attitude and was much less bored during my treatment units. He also commented that I was much more engaged with the students throughout the treatment units.

INTERPRETATION AND CONCLUSION

When analyzing the data in terms of average gain scores and knowledge gained, all groups including the whole group, high performing group, medium performing group and low performing groups, gained more knowledge during the nontreatment unit, where the students were seated in rows and worked individually then in the two treatment units.

However if the data is analyzed in terms of content knowledge retained, definite patterns appear to support the use of individual work in certain circumstances and collaborative group work in other circumstances.

The data shows that the higher performing students tend to do well in both individual work settings and in collaborative group settings. This group consistently improved their scores between the assessment and the postassessment. During the interviews, these students said that although they can work faster on their own, they benefit from working in groups because they are expected to help teach the others in the groups and this in turn helps them to remember the content better. This statement is consistent with the research of Summers and Volet (2010) who stated that students learn at a greater rate when interacting with other students. On the survey portion of the data collection one of the high performing students said that “I prefer to work alone on projects so that I can do it the way I like it but working in groups is more fun.”

The data from the medium performing group indicates that these students learn best and gain more content knowledge when working individually but retain the knowledge learned the same or better when working in collaborative groups. One of the students stated that “I really like to work in groups better because I like talking about the information and it helps me to remember it better.”

The data from the low performing group of students suggests that these students gain more knowledge when they work individually. However, they retain that knowledge better when they work in collaborative groups. One of the students interviewed that represented this group said that “Working in groups is way better then working alone, I get more done because I don’t have to do it all on my own.” This statement matches up with what Lin (2006) wrote concerning students learning more information when they are allowed to discuss the information with classmates and use prior knowledge to build new

knowledge. In contrast, another student representing this group mentioned that “Working alone is better for me because I don’t get distracted and I don’t ever get left out or left behind.” The data and the student’s responses allude to the fact that these students tend to get easily distracted and more interested in socializing and just finishing the work then they are with completing the work to learn the material.

VALUE

In designing my action research project I thought that I would find a magic bullet that would increase student learning, increase student motivation and help motivate me as a teacher. I was a little surprised when the data showed that students actually learned the content better when they were working individually and when I was enjoying my job the least. Although the data was not what I was expecting, there were a few factors that I believe skewed my overall data. For example, all my students have had previous experience with mitosis, the cell cycle and basic Mendelian genetics when they were in 7th grade. In contrast, this was the first time that my students have been taught about meiosis. This means that during the nontreatment unit, Mitosis and the Cell Cycle and the second treatment unit, Basic Mendelian Genetics, the students preassessment scores were higher than the first treatment unit covering Meiosis. During the first treatment unit covering Meiosis, the students scored much lower on their preassessment and showed much higher gains on their assessment which was a factor affecting the large gain score growth for the Meiosis unit. Although the initial data was not what I was expecting it did show me that I cannot go off of what I think is happening and that I need to look at the data before I form a conclusion in terms of how my classroom is going at the moment.

When the students worked in collaborative groups, they retained the information that they learned better than when they worked individually. One of the techniques that I used with collaborative groups was to have the student compare answers to Punnett square problems throughout the class with their group members, this way they were checking each other's work throughout the process and were able to correct errors before they repeated those errors. At the end of the class time, I used a Kagan Learning Strategy called Stand Up, Hand Up, where the students found another student from another group to compare answers with, again reviewing their own work and checking it with someone else. The students repeated this one more time with another student from another group. I saw throughout this lesson that students were actively engaged with the learning and that they were enjoying the opportunity to work and talk throughout the lesson. I also enjoyed this activity and it allowed me to circulate throughout the classroom and identify common errors that were being made and address those errors on the spot. This lesson also gave me the opportunity to interact with the students on a more personal basis, which helped to build the classroom community and trust that is so important for me as a teacher.

I think that using a variety of teaching techniques throughout the semester is a vital part of the learning experience. By mixing things up with individual work and collaborative work and collaborative projects, the students are more likely to stay engaged and interact more with the content, with each other and with me. As I mentioned above, I thought at the beginning of this project that I would be able to use the data to show that I had the magic bullet in terms of teaching and learning but what I actually

found was that the success of students and myself comes from using a variety of teaching and learning techniques. The magic bullet is actually the variety of ways in which we interact with the content and with each other. This is where the art of teaching comes in, there is no one thing that helps all students learn or remember what they have learned, rather, knowing my students and creating a classroom community where everyone feels safe is the magic bullet and this provides the opportunity for students to be successful. When my students are learning the content, interacting with each other and with me, this is when I am most motivated as a teacher and perform my art of teaching at its best.

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APPENDICES

APPENDIX A

CLAYMATION OF MEIOSIS

MEIOSIS CLAYMATION

WORKING WITH YOUR GROUP AND USING YOUR IPADS, CREATE A CLAYMATION MOVIE WITH YOUR CAMERA AND IMOVIE. USE THE GUIDELINES BELOW TO MAKE SURE THAT YOU RECEIVE FULL CREDIT ON THE ASSIGNMENT.

1. MOVIE SHOULD BE BETWEEN 2 AND 3 MINUTES LONG.
 - A. INTERPHASE – 1 PICTURE
 - A. PROPHASE I WITH CROSSING OVER – 3 PICTURE
 - B. METAPHASE I – 2 PICTURES
 - C. ANAPHASE I – 2 PICTURES
 - D. TELOPHASE I – 2 PICTURES
 - E. CYTOKINESIS – 2 PICTURES
 - F. PROPHASE II – 2 PICTURES
 - G. METAPHASE II – 2 PICTURES
 - H. ANAPHASE II – 2 PICTURES
 - I. TELOPHASE II – 2 PICTURES
 - J. CYTOKINESIS – 2 PICTURES
2. YOUR MOVIE NEEDS TO INCLUDE TYPED TITLES AT THE BEGINNING OF EACH PHASE.
3. YOU NEED TO INCLUDE VOICEOVER EXPLAINING THE PROCESS THROUGHOUT THE MOVIE.
4. CREATIVITY AND QUALITY COUNT!

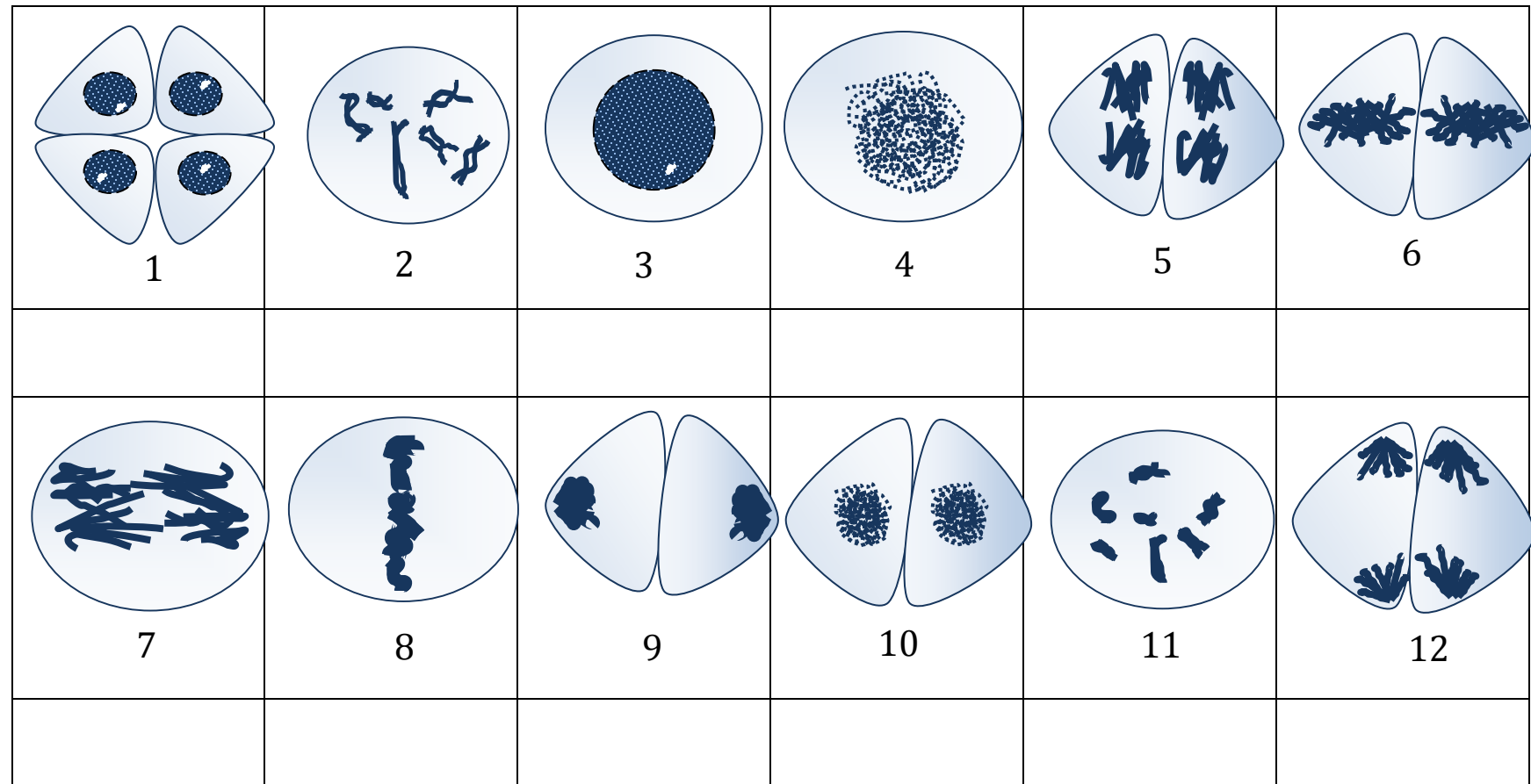
STUDENT FEEDBACK: _____

APPENDIX B
MEIOSIS MIX-UP WORKSHEET

NAME: **MIXED-UP MEIOSIS**

Drag the images to put them in the correct order – then drag the phase labels to the correct positions

Get your answer checked → add your name → print out for your notes



ANAPHASE 1

PROPHASE 1

TELOPHASE 2

TELOPHASE 1

PROPHASE 2

ANAPHASE 2

METAPHASE 2

PROPHASE 1

INTERPHASE

METAPHASE 1

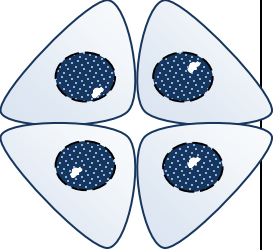
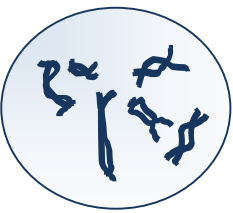
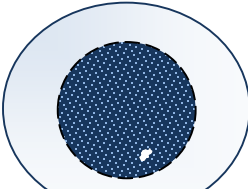
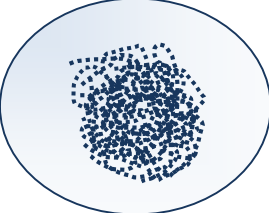
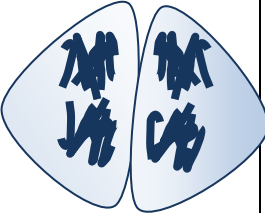
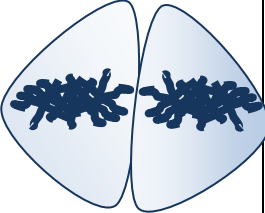
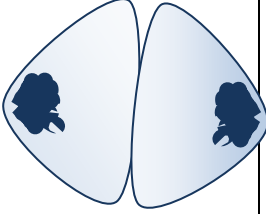
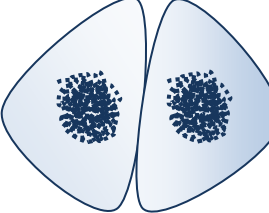
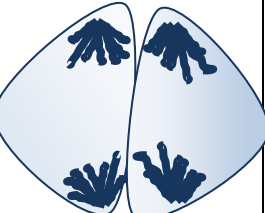
TELOPHASE 2

PROPHASE 1

NAME: *ANSWERS***MIXED-UP MEIOSIS**

Drag the images to put them in the correct order – then drag the phase labels to the correct positions

Get your answer checked → add your name → print out for your notes

 1	 2	 3	 4	 5	 6
TELOPHASE 2	PROPHASE 1	INTERPHASE	PROPHASE 1	ANAPHASE 2	METAPHASE 2
 7	 8	 9	 10	 11	 12
ANAPHASE 1	METAPHASE 1	TELOPHASE 1	PROPHASE 2	PROPHASE 1	TELOPHASE 2

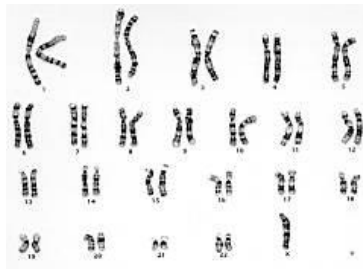
APPENDIX C

PRE AND POST ASSESSMENT

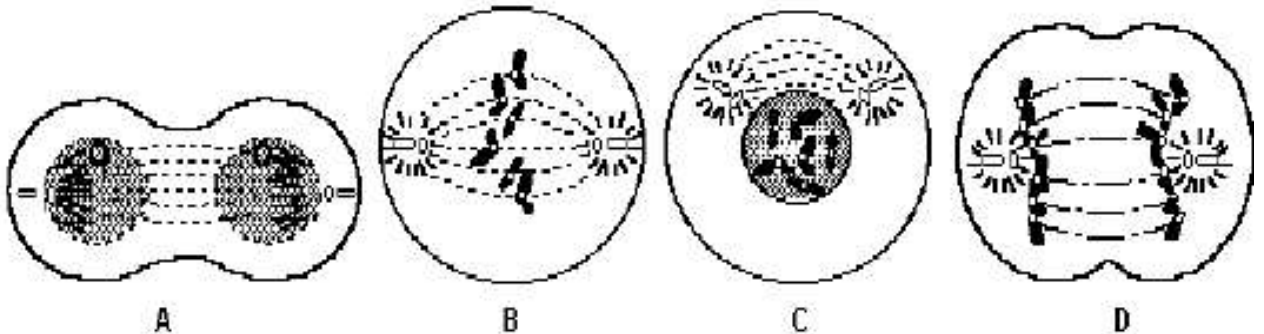
MITOSIS AND MEIOSIS AND INHERITANCE PATTERNS

Pre/Post Assessment – Cell Cycle and Mitosis

1. A scientist can study a karyotype to learn about the
 - a. structure of a chromosome
 - b. genes that are present in a strand of DNA
 - c. medical history of an individual
 - d. gender and some chromosome abnormalities of an individual
2. Choose the answer that best describes the individual using the karyotype below.



- a. Normal Female
 - b. Female with Turner's Syndrome
 - c. Male with Klinefelter's Syndrome
 - d. Normal Male
 - e. Male with Turner's Syndrome
 - f. Female with Triple X Syndrome
 - g. Female with Down's Syndrome
3. Which cell is the figure in metaphase?

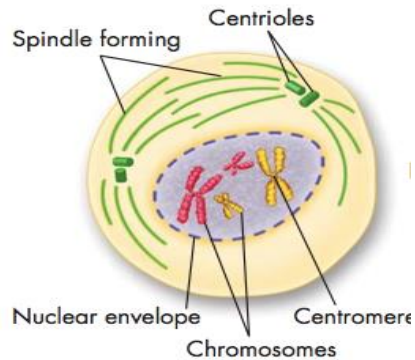


- a. A
- b. B
- c. C
- d. D

4. How does cell division differ between animal and plant cells?

- a. Animal cells do not have centrioles and furrow.
- b. Plant cells do not have centrioles and form a cell plate.
- c. Animal cells form a cell plate.
- d. Plant cells are always haploid.

5. Refer to the illustration below. The cell is in



- a. telophase
- b. anaphase
- c. prophase
- d. interphase
- e. metaphase

6. The longest phase of the cell cycle is

- a. mitosis
- b. metaphase
- c. interphase
- d. prophase

Pre/Post Assessment – Meiosis

1. An illustration of Metaphase I would show chromosomes
 - a. crossing over
 - b. chromatin condenses into chromosomes
 - c. lining up single file
 - d. chromosomes separating
 - e. chromosomes move into homologous pairs
2. When crossing-over takes place, chromosomes
 - a. exchange genes found in the same location
 - b. decrease in number
 - c. produce new genes
 - d. mutate in the first division
 - e. exchange chromatid pairs
3. The diploid number of chromosomes in a human skin cell is 46. The number of chromosomes found in a human gamete is
 - a. 92
 - b. 12
 - c. 5
 - d. 22
 - e. 46
 - f. 23
4. In meiosis, tetrads form during
 - a. Telophase II
 - b. Metaphase II
 - c. Telophase I
 - d. Anaphase I
 - e. Prophase I
5. Using TWO examples, explain how mitosis is different from meiosis.

Pre/Post Test – Inheritance Patterns

1. Tall plants (T) are dominant over short plants (t). If a heterozygous plant (Tt) is crossed with another heterozygous plant (Tt), what percentage of the offspring will be tall?
 - a. 0%
 - b. 25%
 - c. 50%
 - d. 75%
 - e. 100%
2. Normal color vision (N) is dominant over color blindness (n). A female who is a heterozygous carrier for color blindness (XNXn) marries a man with normal vision (XNY). What are the chances of a male child being colorblind?
 - a. 0%
 - b. 25%
 - c. 50%
 - d. 75%
 - e. 100%
3. A “pattern of bands” like a bar code, made from small DNA molecules are a person’s
 - a. karyotype
 - b. chorionic villi
 - c. DNA Fingerprint
 - d. Amnion
4. Scientists have shown, that although controversial, _____ show promise for regrowing damaged tissue.
 - a. body cells
 - b. blood cells
 - c. stem cells
 - d. germ cells
5. If a couple decides to have a child but they are concerned about the possibility of a chromosome abnormality, they may want to consider:
 - a. karyotyping
 - b. a test-cross
 - c. genetic counseling
 - d. contacting Gregor Mendel
6. Explain how two parents, neither of whom expresses a genetic trait, can have a child who does express that genetic trait.

APPENDIX D
STUDENT SURVEYS

Student Survey

Participation in this research is voluntary and participation or non-participation will not affect your grades or class standing in any way.

Please complete this survey about Mendelian genetics and the use of peer collaboration in class. Answer each question, and provide as much information as you can on the open-ended questions. It is important to be honest in your answers because I will use the information you provide to help me plan future lessons. You do not have to put your name on this survey. Thanks for helping me with this important project.

1. What have you learned about Mendelian genetics and inheritance patterns?

2. Choose from the options below identifying which way you feel you learn best.
 a. Listening b. Seeing c. Doing d. Talking

3. Do you prefer to work in small groups or by yourself? Please explain your answer.

4. What types of activities help you learn best? Please explain your answer.

5. What type of learning activities help you the least? Please explain your answer.

6. Is there anything else I should know or you would like to share with me about the content or working in small groups?

7. I look forward to science class. (Use a scale of 1 -5 where 1 means that you do not look forward to science class and a 5 means that you do look forward to science class.)

1	2	3	4	5
---	---	---	---	---

8. Do you agree or disagreed with the following statement: I am naturally good at science. Circle One.

Agree

Disagree

APPENDIX E
STUDENT INTERVIEW QUESTIONS

Teacher Prompt: In trying to find out if working in small groups is beneficial to students and student success, I have six questions that I would like to ask you. Participation in this research is voluntary and participation or non-participation will not affect your grades or class standing in any way.

1. Do you prefer to work on your own or in small groups? Why?
2. How does working alone or in groups help you learn?
3. Tell me about what have you learned?
4. If I asked you the same question as above in one month, do you think you will remember it as well as you do now? Why?
5. What could we do to help you remember it better?
6. What else would you like to share with me about either the content or how we have been working in groups?

APPENDIX F
TIMELINE FOR CAPSTONE PROJECT

Timeline For Capstone Project

Nontreatment Unit (Mitosis)– January 19th – January 30th. (Two weeks)

Treatment Unit #1 (Meiosis) – February 2nd - February 13th. (Two weeks)

Treatment Unit #2 (Basic Mendelian Genetics) – February 16th – February 27th. (Two weeks)

Post Assessment – March 13th

APPENDIX G
EXEMPTION BY MONTANA STATE UNIVERSITY'S INSTITUTIONAL REVIEW
BOARD

Administrator Approval

I, HOMER BENNETT, Principal of STAR VALLEY School,
 verify that I approve of the classroom research conducted by KELLIE CLINGER

Homer Bennett STAR VALLEY H.S. PRINCIPAL
 (Signed Name, Title of Position)

HOMER BENNETT
 (Printed Name)

10/27/14
 (Date)

Administrator Exemption regarding Informed Consent

I, HOMER BENNETT, Principal of STAR VALLEY HIGH
 School, verify that the classroom research conducted by KELLIE CLINGER
 is in accordance with established or commonly accepted education settings
 involving normal educational practices and that I approve the project. To maintain
 the established culture of our school and not cause disruption to our school climate,
 I have granted an exemption to KELLIE CLINGER regarding informed
 consent.

Homer Bennett - STAR VALLEY H.S. PRINCIPAL
 (Signed Name, Title of Position)

HOMER BENNETT
 (Printed Name)

10/27/14
 (Date)

APPENDIX H
DICE AND PROBABILITY LAB

Probability and Genetics

What can dice teach us about genetics and probability?



Introduction. In order to understand genetics you need to have some basic concepts concerning probability. The notion of probability and chance is used in every area of genetics from basic considerations of the outcome of meiosis and Mendel's so called laws of inheritance to gene sequencing problems and data based searches. The goal of this exercise is to introduce the important probability concepts and illustrate their use with some elementary examples from genetics.

In this activity, you will examine the probability distribution of an experiment in which two dice are rolled. The activity is in two parts: an experiment in which you will actually be rolling dice, and a mathematical activity in which you deduce some characteristics of the distribution by purely analytic means.

PART 1: EXPERIMENT

1. Roll a pair of dice 24 times and make a tally mark for the sum of the numbers of each roll in the **ROUND 1 COLUMN**.
2. Repeat step 1 three more times for a total of four rounds.

Sum of Roll	ROUND 1	ROUND 2	ROUND 3	ROUND 4
2				
3				
4				
5				
6				
7				

8				
9				
10				
11				
12				

GRAPH IT!

Use this page to create **FOUR** bar graphs that show your data for each of the rounds from the rolling experiment. **REMEMBER HULKS!!!**

1. What similarities and differences are there in the four graphs?

PART 2: Theoretical Application

In this part of the activity, you will determine the theoretical probability distribution of the experiment that you just performed.

To begin, you will need the table below to show all of the possible outcomes of rolling two dice. This table shows that if one dice is rolled a 1 and the other dice is rolled a 2 then the sum is 3.

	1	2	3	4	5	6
1						
2		4				
3						
4					9	
5						
6						

The table above shows that there are 36 possible outcomes.

2. What are the chances of rolling a 2? (Write a fraction)
3. What are the chances of rolling a 5?
4. What are the chances of rolling an 11?

Complete the following table to summarize the probability of each sum.
The sum of 2 is done for you.

Sum of Roll	Probability Distribution Fraction	Fraction Converted to a Decimal
2	$\frac{1}{36}$	0.027
3		
4		
5		
6		
7		
8		

9		
10		
11		
12		

GRAPH IT!

Construct a graph to show the Decimal Form of the Probability Distribution. **INCLUDE HULKS!**

5. How does this last graph compare to your first four graphs?
6. If there are differences between the first four graphs and this last one, why do they appear?
7. What are some important connections between probability and genetics?