EFFECTS OF COOPERATIVE PRE-ACTIVITIES ON STUDENT UNDERSTANDING OF HIGH SCHOOL BIOLOGY

by

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Dean Leon Brown

July 2014

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ABSTRACT

High school biology learner outcomes require students to understand some complex concepts about physiology, cell biology and ecology. Students in such classes are expected to learn these outcomes, as well as, participate in classroom assignments and activities. Cooperative pre-activities and cooperative learning structures were used to foster student curiosity, encourage dialogue and question asking between students. The pre-activities allowed students to gain some prior knowledge that would not only enhance cognitive development, but increase self-confidence and motivation to become more engaged in the learning environment. The additional cooperative learning structures improved cognitive development, as well as, social development in the classroom. In addition, teacher motivation and improved pedagogy also impacted the learning environment in a positive manner.

INTRODUCTION AND BACKGROUND

Project Background

I am in my 18th year of teaching and over that time period I have had the opportunity to explore and evaluate many different styles of teaching and learning. My school district has provided a variety of professional development opportunities, but over the last couple of years there has been a focus on cooperative learning. All teachers in the district have been trained in a program called Tribes (http://tribes.com) and over the summer of 2013 I was trained in a series of cooperative learning structures developed by Kagan (http://www.kaganonline.com). Since September, I have been experimenting with the implementation of these cooperative structures into my daily classroom routines. After some exploration and observation, cooperative learning appears to fit with the needs of many students that I teach in the science classroom.

This information is not only of interest to me, it is also of interest to my principal and his administrative team. They are very excited about cooperative learning at every level of education and encourage similar structures to be used at staff meetings and other staff activities. Outside of the school, the local school board is one of the driving forces behind the Tribes and Kagan initiative and as a result, any findings may be of interest to them as well.

While experimenting with cooperative learning, I found that some students would contribute to dialogue and activities, while others had very little to offer. It was hypothesized that these students wanted to contribute, but they did not have the prior knowledge to get involved or they were not confident in their level of understanding. As

a result, some students chose not to participate or contribute to their full potential in a variety of activities, both cooperative and individual.

In addition, biological concepts such as the nervous system, endocrine glands and hormones, DNA and protein synthesis, human reproduction, genetics, and population genetics are challenging areas of study for high school students. This has resulted in many students being immersed in an activity, assignment, or lecture on a topic that they know little or nothing about. Not only does this potentially decrease their conceptual understanding, it often results in students becoming disengaged in the learning process. It also has the potential to impact their self-confidence in learning activities in the classroom, as well as, their attitudes towards science in the future.

As a result of these observations, the idea of "pre-activities" came to the forefront. It was hypothesized that if students could gain even a minimal amount of prior knowledge about a concept, they may be more willing to become engaged in the classroom activities. As well, they may feel more confident in their learning and participation. This prior knowledge may also have the potential to improve their overall conceptual understanding of biological content.

A third observation involved looking at my own teaching. Throughout my career I have tried many different approaches to teaching and learning. I believe strongly in hands-on activities and technology in the classroom and have been using these strategies for a long time. The addition of cooperative learning in my teaching, combined with the implementation of pre-activities to develop some prior knowledge for students, has motivated and energized my teaching practice.

In summary, pre-activities and cooperative learning will be combined to investigate the impact on student understanding, engagement, and self-confidence, as well as, the impact on teacher motivation. Figure 1 provides an overview of the action research (AR) process.

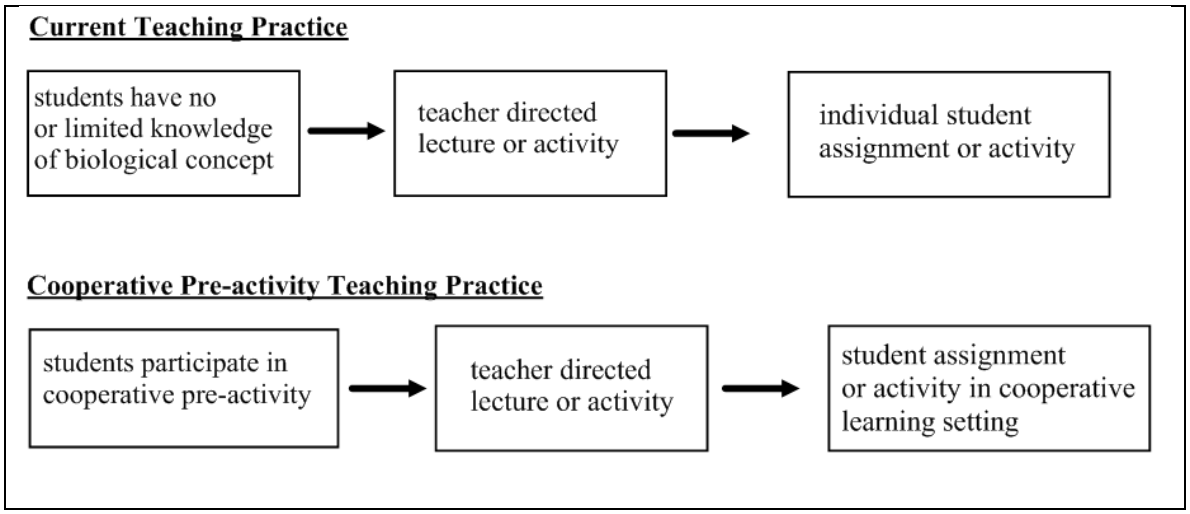


Figure 1. Summary of Current and Cooperative Pre-activity Teaching Practices.

Focus Questions

The focus questions that will be used in my AR include the primary focus question, "What are the effects of cooperative pre-activities on student understanding of high school biology concepts?" Sub-questions that will be researched included sub-question #1, "What are the effects of cooperative pre-activities on student assessment scores in high school biology?" Sub-question #2 asks, "What are the effects of cooperative learning structures on student self-confidence and motivation to become engaged in high school biology?" and sub-question #3 is stated as, "What are the effects of cooperative learning structures on teacher motivation and pedagogy in high school biology?"

CONCEPTUAL FRAMEWORK

Introduction

In order to better prepare students for both academic and social success in the biology classroom, some level of prior knowledge may be important. Julyan and Duckworth (2005) provide a reminder that many teachers and scientists have made connections that students have not yet made. Providing students with some background information should help them to better make connections.

In order to make these connections, two important components may be necessary. The first is the idea that students need to be engaged in a pre-activity to develop some of the basic information required to learn the more complex concepts. Piaget suggested that students learn best if they are doing an activity. This will allow for the construction of their own understanding, instead of adults (teachers) providing them with explanations (Mooney, 2000).

The second requirement involves collaboration between students. Vygotsky believed that the social surroundings and social interactions between students were important for learning (Mooney, 2000). In addition, Mooney (2000) states that "Vygotsky has helped teachers to see that children learn not only by doing, but also by talking, working with friends, and persisting at a task until they get it" (p. 92). This will also give students the opportunity to develop their own thoughts, ideas, and answers before they receive them from the teacher.

Direction For AR

Gibbs and Ushijima (2008) add that the "industrial era factory model no longer fits" (p. xiii) the current education system in which students are surrounded by technology. They also suggest that students are no longer engaged by passive instruction or by working individually in desks.

Further research has illustrated that many students attend school because they have to, not because they enjoy the process. Students are often focused on just getting by or more concerned with a passing grade, rather than learning material (Gibbs and Ushijima, 2008). This is a huge concern, as one of the focal points of education is cognitive development. Gibbs and Ushijima (2008) argue that much of the research on cognitive development and the environmental factors that affect learning and development of students has been largely ignored in the education system. They suggest that the way to deal with this issue is to develop learning communities within schools. This will not only address the cognitive development, but it will also address the second important focus of schools. That focus is social development. Our current world requires people to work together and have effective communication skills.

The use of collaborative learning appears to address this issue and seems to be on the rise in science classrooms around the world. Research based in Scotland by Howe, Tolmie, Thurston, Topping, Christie, Livingstone, Jessiman, and Donaldson (2007) and Tolmie, Topping, Christie, Donaldson, Howe, Jessiman, Livingston and Thurston (2010) found that students involved in collaborative learning in science had substantial gains in

both the attainment of science concepts and the development of social connections (as cited in Topping, Thurston, Tomlie, Christie, Murray and Karagiannidou, 2011).

Tomlie et al. (2010) also observed that peer relationships improved both inside and outside of the classroom. In the study, 237 rural children and 302 urban children were followed. Although urban children normally played with each other less outside of school, were less likely to know the family of other students in the class, and had less chance of seeing their classmates in the local community, cooperative group work in the classroom improved the social skills of these students both inside and outside of the classroom. Even though the relationships between rural students were slightly advanced, social gains were also observed when students worked in groups.

Topping et al. (2011) hypothesized that low attainment and motivation could be improved by collaborative learning, rather than "teacher-directed instruction." They also suggested that collaborative groups needed to be heterozygous, with defined roles for each member of the group. Gender mixing was also considered. Ding and Harskamp (2006) found that female students in a single-gender condition solved physics problems more effectively than those in mixed gender conditions. There were 26 females and 24 males (mean age 16) in the study. One specific area of interest in the study was on-task interactions between students in different group settings. Of the total 1014 on-task interactions recorded, 229 occurred between females in mixed gender groups, while 364 occurred in female only groups. For males, 285 occurred when males were in mixed gender groups, while only 136 occurred in male only groups. As a result of this research, it is evident that the gender make-up of collaborative groups needs to be a consideration.

Kagan (2009) adds that groups should be heterogeneous and contain members of mixed ability, mixed gender and mixed race. More importantly, Kagan (2009) suggests that these groups consist of one high achieving student, two middle achieving students, and one low achieving student. Some researchers are concerned that this will bring the high achievers down, but just the opposite occurs. Low achievers are brought up and the achievement gap begins to narrow when academic based heterogeneous groups are used (Kagan, 2009).

The development of social rules and characteristics such as trust within a collaborative group is one of the outcomes of the "Tribes" program. The formation of the group within the collaborative learning environment will be an ongoing challenge that needs to be considered in each collaborative pre-activity in the science classroom.

The second direction for AR stemmed from previous pre-activities assigned within the biology classroom. It was noted that students appeared to do better on complex biological outcomes if they were given an opportunity to gain some basic knowledge prior to learning the detailed materials. McNamara, Kintsch, Songer, and Kintsch (1996) demonstrated that "students with domain-specific prior knowledge are better equipped to understand challenging topics, especially science related topics presented in text books" (p. 271) (as cited in Moos and Azevedo, 2008). Moos and Azevedo (2008) stated that students with prior knowledge could more easily generate inferences when there were gaps in understanding. They also suggest these students can utilize more advanced learning strategies to enhance their understanding, while students

with limited knowledge on the topic are required to spend their time and energy developing the basic conceptual framework.

Furthermore, Moos and Azevedo (2008) reported that students with higher prior domain knowledge were involved in the planning of their learning. This involved the activation of current knowledge and the reviewing of learning goals at a greater frequency than those students with lower prior domain knowledge. Those same students also monitored their learning and evaluated content more frequently.

The focus of constructivism is based on the early research of Piaget and Vygotsky. The overriding emphasis is to immerse students in an environment where they can actively construct knowledge. This requires that students are given the opportunity to work together on a task that pushes their curiosity and desire to know more (Mooney, 2000). In addition, von Glasersfeld (2005) believes that "students perceive their environment in ways that may be very different from those intended by educators" (p. 7). This requires that the teacher not just deliver information, but give students the opportunity to investigate, talk and construct their own understanding.

Based on this research and the previous evidence presented, collaborative learning environments appear to promote a better understanding in the science classroom. Fosnot and Perry (2005) concluded that "dialogue within a community engenders further thinking" (p. 34). The primary purpose of the collaborative pre-activity is to provide some baseline information for the learner, but to also encourage some further thinking and learning through dialogue.

If the pre-activity can foster some thinking or cause what Piaget referred to as disequilibrium (Fosnot and Perry, 2005), students will be challenged to investigate or enquire more about a topic. In addition, students that gain a basic understanding and develop some prior knowledge should better understand the complex and challenging topics that follow (Moos and Azevedo, 2008).

Methodologies

Student assessment is one measure of the effect of any treatment used in AR. Prior knowledge and the potential change in student understanding are two important pieces to the AR project. Greene, Costa, Robertson and Deekens (2010) and Moos and Azevedo (2008) both used pre-tests and post-tests in their studies. Greene et al. (2010) concludes that these instruments were intended to measure participants' declarative knowledge of the content. It is this declarative knowledge or static knowledge that is stored in memory that needs to be identified in the pre-test and the post-test. Differences in scores should provide an indication of the change in declarative knowledge.

The pre-test and post-test were the same assessment in this study. Although Greene et al. (2010) were aware of the potential cues obtained by taking the same assessment twice, it was determined that this practice would be more effective than introducing a possibly less adequate measure.

Another potential tool for data collection is through student interviews, surveys, and questionnaires. In a study on collaborative groups by Ciani, Summers, Easter and Sheldon (2008), questionnaires were administered to gather valuable feedback about the

students' interest and enjoyment. Such questionnaires or surveys could be used to gather similar opinions of cooperative learning and pre-activities in the biology classroom. Ciani et al. (2008) included questions such as "I've had the opportunity to connect with diverse people in this class" and "I can relate to my fellow classmates" (p. 631). This type of questionnaire fits directly into the "Tribes" program outlined by Gibbs and Ushijima (2008) and would provide insight into how students view the collaborative process involved in the pre-activity.

In summary, the literature cited above provides some valuable strategies for data collection using the methods of pre-tests and post-tests, as well as, student surveys. These will be some of the methods used in the proposed AR project.

METHODOLOGY

Treatment

The use of cooperative pre-activities occurred in our textbook during chapter 17 (genetics) and chapter 18 (DNA and protein synthesis). The goal of the pre-activities was to foster student curiosity, encourage dialogue and question asking between students, and inspire students to enhance their understanding. During this process, students should become more prepared for the activities that follow, be more confident in their contributions and work, and become more motivated to engage in the overall learning process.

The first cooperative pre-activity was presented in chapter 17 on genetics. Students generally find this topic very challenging due to the wide variety of concepts and vocabulary that exists. This cooperative pre-activity included general genetics

principles and terms. The focal point of this activity was the use of "Crazy Traits" manipulatives, a product purchased from Cambridge Physics Outlet (CPO) science. A picture of the product can be seen in appendix A. This cooperative pre-activity focused on terminology and students were guided though an introductory activity supplied in the CPO teacher's guide. Each cooperative team worked through the activity and completed the data table as shown in appendix B. During the activity, students were exposed to terms such as gene, allele, dominant, recessive, homozygous and heterozygous. Students were also introduced to the concept of complete dominance, co-dominance, and incomplete dominance in the cooperative pre-activity.

Upon the completion of that activity, other Kagan based cooperative learning structures were used to enhance the understanding of X-linked recessive traits, X-linked dominant traits, and Y-linked traits. The cooperative learning setting may be a benefit for student understanding, self-confidence and motivation to become engaged in the classroom activities and assignments.

The second treatment took place during chapter 18 on DNA and protein synthesis. This concept requires knowledge of DNA, DNA replication, transcription, and translation. Cooperative pre-activities involving computer animations were used in this treatment. Internet sites such as YouTube, as well as, numerous biology related sites provided animations and video tutorials on DNA and protein synthesis. Students were directed to cooperatively analyze a video or animation on each topic. During the analysis of the prescribed animations, students were asked to write down thoughts or ideas on an index card or answer a series of questions in their cooperative teams (appendix C and

appendix D). This type of activity could encourage a great deal of cooperative dialogue and question asking. Furthermore, it may provide the prior knowledge required to be more successful in other classroom activities, labs, and lectures.

As previously summarized in Figure 1, these activities occur prior to any lecture or assignment that is directed by the teacher. Students must complete the cooperative pre-activities or be involved in a cooperative learning structure before any other activity on that topic. In both of the treatment chapters 17 and 18, the cooperative activities are not done for summative marks. In contrast, the ability to collaborate while completing the activity should allow students to gain some level of knowledge that can be used in future activities.

During the non-treatment chapter 16 on cell reproduction and chapter 19 on population genetics, cooperative learning will not be used. In contrast, students will receive information and perform activities on an individual basis, without any form of prior knowledge or learning occurring, other than what they had when they entered the classroom. This would model a lecture type situation in which the teacher delivers information and the students receive the information, while sitting in individual rows. There were still student labs and activities, but the cooperative teams and pre-activities did not take place during the non-treatment chapters.

It should be noted that the selected chapters are not of equal difficulty. The two treatment chapters 17 and 18 have a greater number of learning outcomes and generally take twice as many lessons to complete as the non-treatment chapters 16 and 19 (Figure

1). Although this was identified as a potential issue, it was felt that the impact of the treatment strategies would be better suited to the more difficult chapters.

Sample

Data collection occurred in one high school biology class. This was a 30 level (grade 12) class, but consisted of students in both grades 11 and 12. The class contained 20 females (13 in grade 11 and 7 in grade 12) and 15 males (2 in grade 11 and 13 in grade 12). Two of the grade 12 males had learner profiles and required individualized needs and accommodations. The remainder of the class was diverse, with past grades in biology ranging from below average to a few very high achievers. There are no Advanced Placement or International Baccalaureate programs at our school, so class diversity is the norm. All of the students in this class used English as their first language. The majority of the students in the class came from middle to upper class families in our city. In general, students in high school biology courses at our school are motivated to do well. In the majority of cases, students have selected this course as they want to achieve average or above average academic success.

In addition, it should be noted that these students could have entered our school as early as grade 7. Prior to that, they could have attended a variety of elementary schools within the city. The teaching practices within the classrooms both inside and outside of our current school setting would have included a wide range of styles and approaches to learning. At the time of this study, cooperative learning was not the norm of teaching in our city or school.

Timeline

The timeline for data collection is shown in Table 1.

Table 1
Timeline for Treatment and Non-Treatment Topics

Non-Treatment #1 – Cell Reproduction
Start Date: October 28, 2013 End Date: November 5, 2013 Number of Classes: 7

Treatment #1 – Genetics
Start Date: November 19, 2013 End Date: December 9, 2013 Number of Classes: 14

Treatment #2 – DNA and Protein Synthesis
Start Date: December 10, 2013 End Date: December 20, 2013 Number of Classes: 9

Non-Treatment #2 – DNA and Protein Synthesis
Start Date: January 6, 2014 End Date: January 13, 2014 Number of Classes: 6

Data Collection

Testing these questions required a great deal of data collection. Table 2 summarizes the data collection methodologies that were used for each study question.

The most important data collection tool was a pre-test and a post-test. A pre-test was administered prior to the treatment pre-activities. This provided some baseline quantitative data for comparison. At the completion of the collaborative pre-activity, but prior to additional teacher driven classroom activities, a post-test was given. This provided data on the actual knowledge gained by the pre-activity and measured

Table 2
Data Collection Matrix

	Methodologies						
Data Collection Matrix	Pre-survey	Post-survey	Pre-Test	Post-Test	Chapter Exam	Interview	Teacher Journal
Research Questions							
Primary Question	✓	✓	✓	✓	✓	✓	✓
Sub-question #1		✓	✓	✓	✓	✓	✓
Sub-question #2	✓	✓				✓	✓
Sub-question #3							✓

the change in student understanding. Upon completion of the additional cooperative learning activities, an end of chapter exam was completed by each student. End of chapter exams were also given at the end of each non-treatment chapter.

Qualitative data will also be collected in the form of a pre-survey and a post-survey. These will be administered in the same order as the pre-tests and post-tests. In addition, students will be interviewed individually and in small randomly selected groups at the end of the data collection timeline. This data will be used to gather feedback on the treatment activities, as well as, students' perception of self-confidence, motivation, and level of understanding in biology. Appendix E contains a copy of the pre-survey and the questions contained in the post-survey can be seen in appendix F.

Finally, the teacher journal will provide a record of how students respond to the treatment activities, as well as, the perceived effect on student understanding. This would be based on the combined analysis of the qualitative and quantitative data.

Within the seven different forms of data collection utilized, reliability and validity will be established to identity themes across the research questions asked. The research methodology for this project received an exemption by Montana State University's Institutional Review Board (IRB) and compliance for working with human subjects was maintained (appendix G).

DATA and ANALYSIS

A large amount of data was gathered during all phases of the AR project. The multiple instruments used supplied information for all four of the research questions. Some overall themes emerged that helped to define the impacts of pre-activities and collaborative learning on both cognitive and social development, as well as, teaching pedagogy.

In the two treatment chapters (17 and 18), three major cooperative pre-activities were presented to students (appendix C and appendix D). The combined results of the pre-tests and the post-tests for all three cooperative pre-activities are shown in Figure 2. The questions for the chapter 17 pre-test and post-test appear in appendix H and the questions for the chapter 18 pre-tests and post-tests are illustrated in appendix I and appendix J.

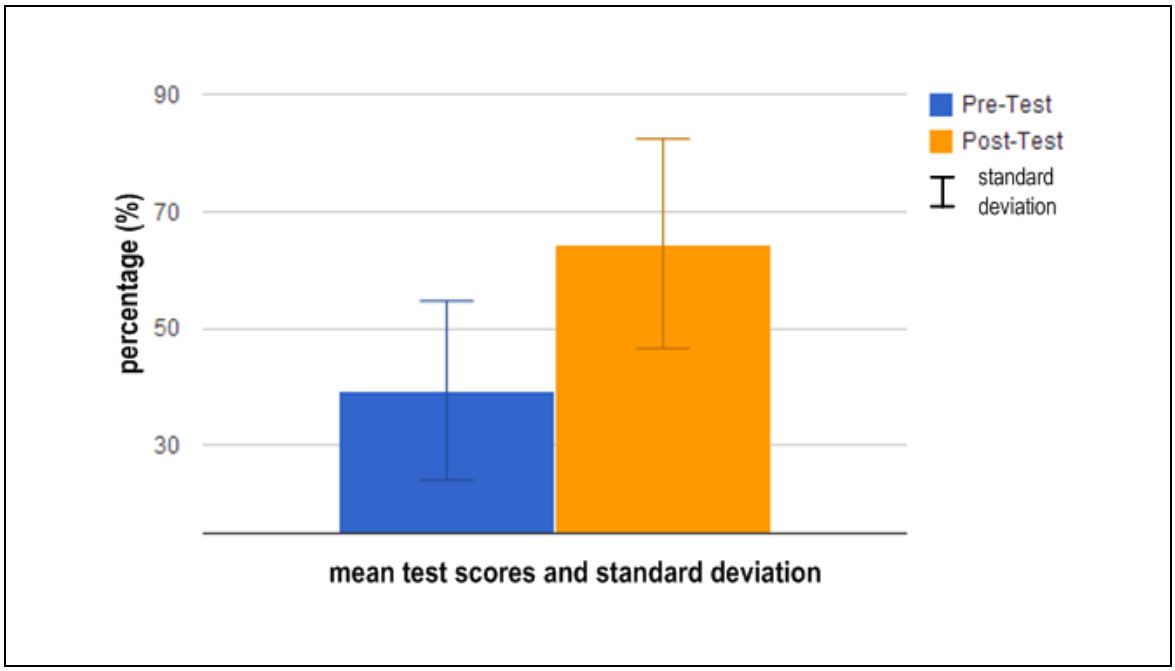


Figure 2. Treatment Pre-Test Results (*N*=96) and Treatment Post-Test Results, (*N*=102).

Examination of the test results illustrates a mean gain of 25.1% from the pre-test scores to the post-test scores. This gain is substantial considering that no teacher directed instruction occurred. Cooperative pre-activities were the only source available for any increase in student understanding.

Although the observed results in the mean test scores support an increased cognitive development, the change in standard deviation needs to be more closely examined. The standard deviation had an average rise of 2.6 in the post-tests. The chapter 17 post-test had one student score as low as 33.3% and one student as high as 83.1%, with six of the students scoring 41.7%. The chapter 18 post-test #1 found two students at 27.3%, four students at 36.4% and six students at 90.9%. One student scored 100% on the chapter 18 post-test #2, while seven scored 90.9%. One student scored a 27.3% and three received 36.4%.

The increase in standard deviation and high number of outliers cannot be overlooked. As previously stated, no teacher directed instruction was involved in any of the cooperative pre-activities so all gain in student understanding was due to information received from the material presented in the pre-activity or from discussion, dialogue, and question asking between cooperative team members. It appears that not all students had equal gains from such information and that some students remained at the low end of the spectrum, while others progressed rapidly. At the current time there does not appear to be any real explanation for such change.

Data was also collected at the end of both the non-treatment and the treatment chapters to help determine if the cooperative pre-activities and additional cooperative learning structures had an impact on the overall understanding of biological concepts. The results of the end of chapter assessments for both non-treatment and treatment chapters are presented in Figure 3.

The end of chapter assessments used during the AR project were the same assessments that were used in the second semester of 2012-13 school year. During that semester a variety of teaching strategies were used, but cooperative pre-activities and cooperative learning structures were not a direct part of the teaching and learning approach. It must be noted that the 2012-13 and 2013-14 data came from different groups of students, but the data does provide adequate grounds for comparison.

The focus group for the AR project was in the first semester of the 2013-14 school year. The graph illustrates that the focus group of the AR (2013-14) was slightly weaker than the previous students that wrote the non-treatment chapter 16 and 19 exams

in 2012-13. Supported by other in-class assignments and assessments, this was a trend across the grade spreadsheet.

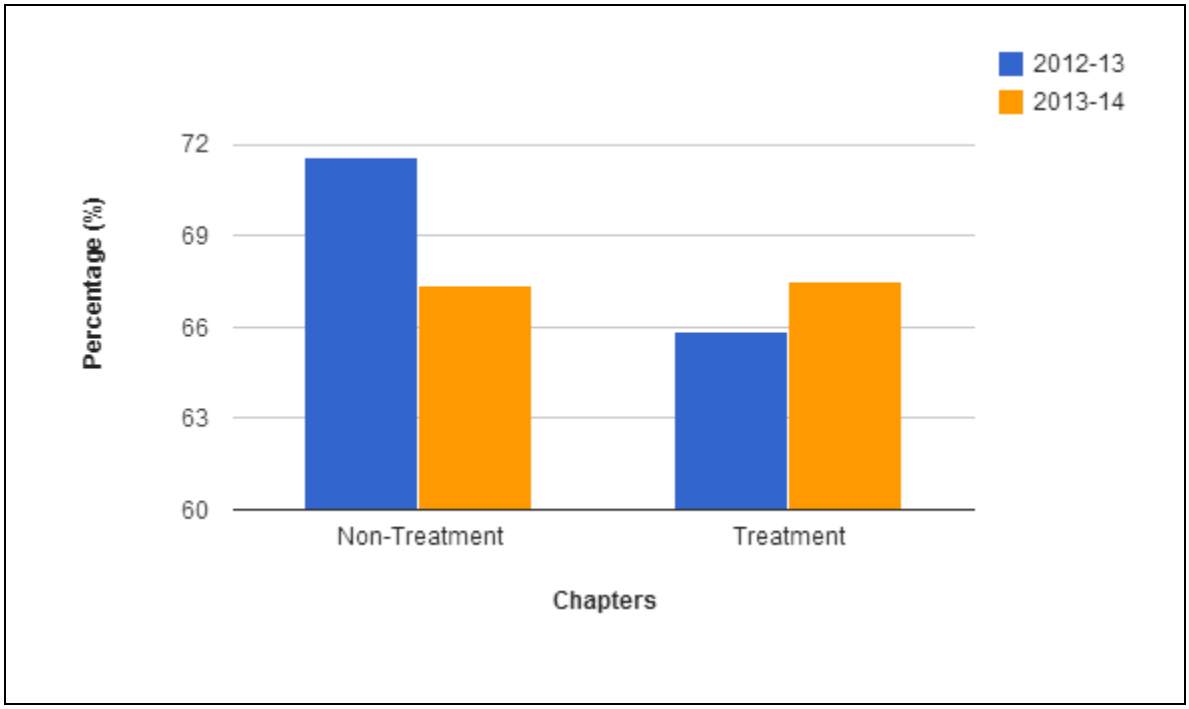


Figure 3. Non-Treatment and Treatment End of Chapter Assessment Results for Second Semester of 2012-13, (*N*=43) and Semester 1 of 2013-14, (*N*=35).

Figure 3 also shows that when exposed to cooperative pre-activities and other cooperative learning structures during the AR, this same group out performs the 2012-13 students in the treatment chapter 17 and 18 exams. This demonstrates that the knowledge gained during the treatment chapters may have had a positive impact on the cognitive development of students. These students, who appeared slightly weaker than the 2012-13 students were able to increase their exam scores in the treatment chapters.

One possible explanation for this increase is that these students were better prepared for the information contained in the next chapter due to their participation in cooperative pre-activities. Students were surveyed on the impact of such pre-activities

on their preparedness for the upcoming chapter. To help gather information on this topic, and to provide additional information, five separate surveys were conducted during the AR. These include the Chapter 16 Cell Reproduction AR Pre-Survey (appendix E), the Ch. 16 Cell Reproduction AR Post-Survey (appendix F), the Ch. 17 Genetics AR Pre-Survey (appendix K), the Ch. 17 Genetics AR Post-Survey #1 (appendix L), and the Ch. 17 Genetics AR Post-Survey #2 (appendix M).

In all survey information presented, a Likert scale was used to collect data. To aid in analysis, individuals selecting 3's were removed from the scale, while 1's and 2's were grouped and 4's and 5's were grouped. A value of 1 represents "not at all true" and value of 5 indicates "very true". Figure 4 illustrates the results of the Chapter 17 Genetics AR Post-Survey #2.

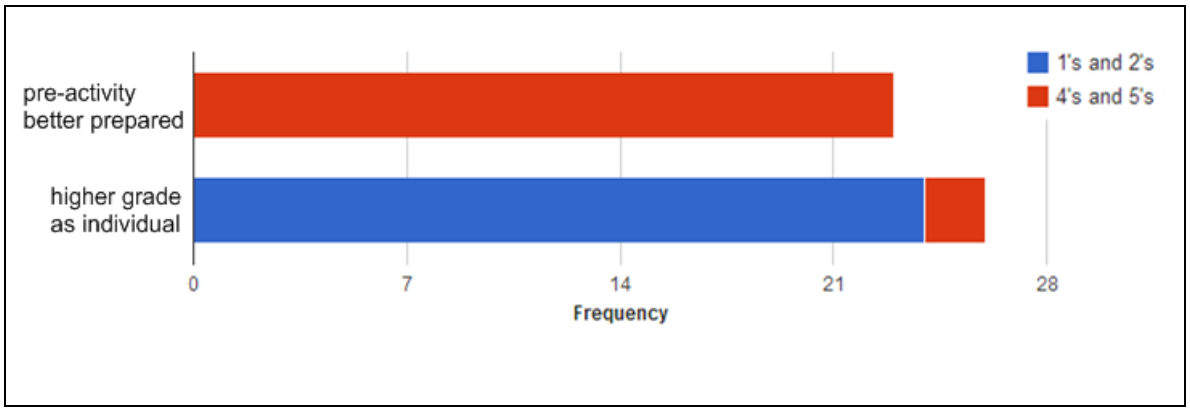


Figure 4. Ch. 17 Post-Survey #2 Results, (*N*=28). Likert Scale 1 (not at all true) to 5 (very true).

When asked if the "Crazy Traits" pre-activity better prepared students for the content of treatment chapter 17 on genetics, students overwhelmingly agreed. From the group, no students indicated a 1 or a 2 in the survey, while most all students selected 4's and 5's. During student interview questioning, which can be found in appendix N, one

student said, “I think (pre-activities) are really good because you get a basic understanding and you are introduced to it before you start learning…I think it makes it easier to learn.”, while another students said “You get to see certain words so when (the teacher) talks, you know a little bit about it.” Such comments provide a great deal of support for the learning that is possible from the cooperative pre-activities.

From the survey responses, one student said that “It was more fun than starting the chapter off with notes and (it) was more beneficial to people who learn by doing.” Another student stated that “It provided the basic knowledge so students (can) have some form of understanding before jumping right into a new chapter.” These student comments support the use of the cooperative pre-activities and were the norm in most survey and interview responses.

Although most students had similar feelings towards the cooperative pre-activities, it was evident that some students already had a strong knowledge base. One student communicated that “For how long it was, we didn’t really learn all that much that I didn’t already know.” This statement reemphasizes that all students have differing levels of prior knowledge. One of the goals of the cooperative pre-activities is to increase this prior knowledge in all students.

If prior knowledge is increased and students are allowed to continue learning while in cooperative teams, these students may perform better during the chapter and this could impact their overall grade. Figure 4 also illustrates the students’ perception of cooperative learning on their grades. When asked to respond to the statement, “My grade would be higher in genetics if I did not have to work in cooperative teams” in the Chapter

17 Genetics Post-Survey #2, a large majority of the group selected 1's and 2's. This indicates that they strongly feel that having the opportunity to work in cooperative teams will increase their grade. Additional support came from the interview when one student said "I think it definitely helps your grade out. You understand better (and) it makes tests and everything a lot easier."

It does appear that some students benefited academically from cooperative pre-activities and cooperative learning in general, but the impact on student self-confidence and motivation to engage in future classroom activities must also be considered.

In the surveys conducted in chapter 17, students were questioned on the impacts of cooperative pre-activities on their self-confidence and motivation to participate in future classroom activities. Figure 5 provides a summary of the survey results.

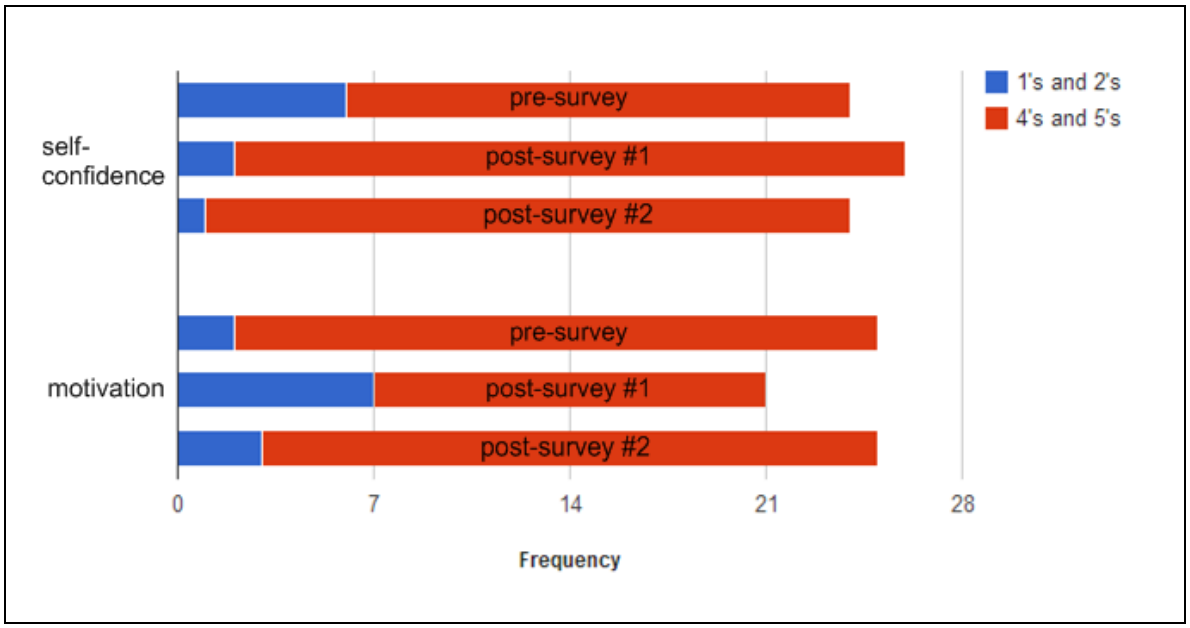


Figure 5. Ch. 17 Pre-Survey Results (N=33) and Post-Survey #1 Results, (*N*=31) and Post-Survey #2 Results, (*N*=28). Likert Scale 1 (not at all true) to 5 (very true).

The results of the survey depict a clear connection between cooperative learning and student self-confidence and motivation. In all instances of the survey results, the majority of students indicated that cooperative pre-activities and cooperative learning structures boosts their self-confidence in the classroom. This is shown by the number of students selecting 4's and 5's on all surveys and only a few students choosing 1's and 2's.

In the surveys, one student stated that, "When I can discuss my answers in my group, I feel more confident with the information I know and if I don't understand I can clarify with group members." Another student said, "Cooperative teams improve my self-confidence because it allows me to feel more involved in the classroom and it helps me to see that other students are at my level. It shows me how we all have strengths and weaknesses." Many other students communicated similar comments that support a gain in self-confidence when placed in cooperative teams.

In terms of motivation, one student indicated that "It motivates me because it helps me learn and understand new ideas.", while another said "It is more motivating to answer a question if four people agree with the answer we are about to give." As with self-confidence, most students describe a similar impact regarding motivation and Figure 5 clearly illustrates this point. The majority of students selected 4's and 5's, while only a limited number of students did not.

Although the comments strongly favored cooperative pre-activities, one student added that "Cooperative groups do not impact my self-confidence." In addition a different student stated that "(self-confidence and motivation) goes up unless they treat me like I'm stupid." Comments such as these stress the importance of the heterogeneous

structure of cooperative teams and highlight the importance of social skills development tools such as “Tribes”. If the team is not structured properly and positive social development is not emphasized, the gains in learning may not be positive for all members of that team. One student mentioned in her interview, “It is just like sitting individually, but with a bunch of strangers.” There appears to be power in cooperative learning, but the gains seem to be related, in large part, to the makeup of the team.

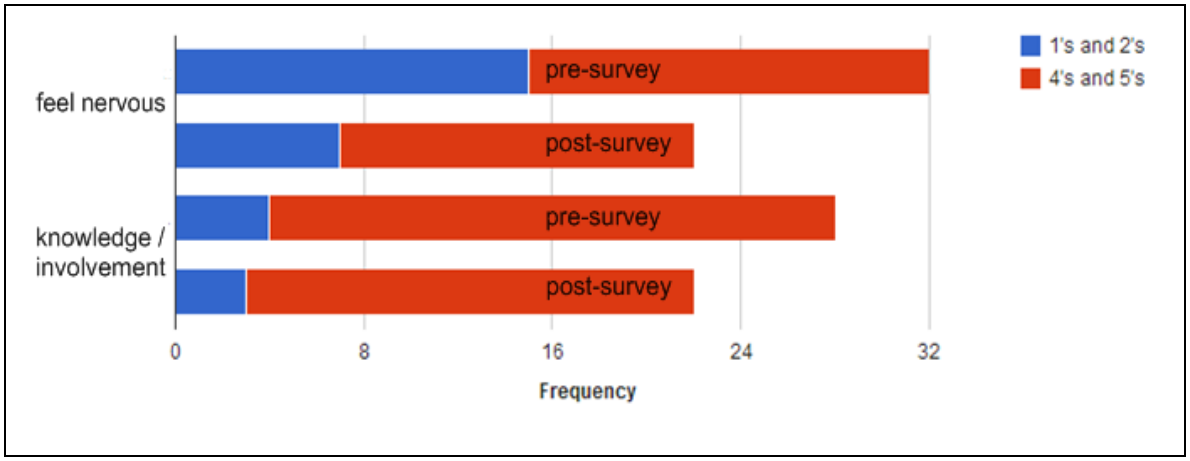


Figure 6. Ch. 16 Pre-Survey Results, (*N*=33) and Post-Survey Results, (*N*=28). Likert Scale 1 (not at all true) to 5 (very true).

Self-confidence and motivation are directly connected to how comfortable students are in class. Figure 6 displays the results when students were asked if they felt nervous answering teacher questions aloud in class. During the non-treatment chapter 16, just over half of the students agreed that they did feel nervous. After working individually in rows for the duration of the chapter, the number of students indicating that they did not feel nervous decreased. This shows that when students are in individual rows they may feel isolated and this can increase their level of nervousness.

Many of the student statements made in surveys reinforced these feelings. One student summed up her feelings regarding confidence when she said, “People always tell me I’m smart, but I don’t think I am that smart. I feel dumb when I’m wrong in front of everyone and I feel like a showoff when I’m right.” Another student shared, “Sometimes when I talk my words don’t come out right and I give a wrong answer although I know what the right answer is. (As a result) I get a lecture about the right answer and I already know it.” Lastly, a student explained lack of confidence in answering questions in class by saying, “If I know the subject fairly well it’s no problem, but if not then I don’t like answering.”

This statement leads to the next section of the survey results, student knowledge and involvement. Figure 6 illustrates that the majority of students agree that they tend to get more involved in classroom activities when they know more about a topic. This is clearly represented in the following two statements made by students: “If I don’t know the topic I’m not going to know what to do in the activity so I don’t participate as much as I should” and “If I have prior knowledge on the concept, or if it’s a concept we have been discussing for a while I’ll have more confidence in my answer and be more likely to participate”. The majority of students made comments in the survey similar to these two statements and thus supports the idea that the current knowledge of a student will greatly impact their involvement in classroom activities.

One of the key features of the AR project was to determine how students responded to individual rows in the non-treatment chapters 16 compared to cooperative

teams in the treatment chapter 17. Figure 7 summarizes student opinions on the preference for individual vs. cooperative work in the classroom.

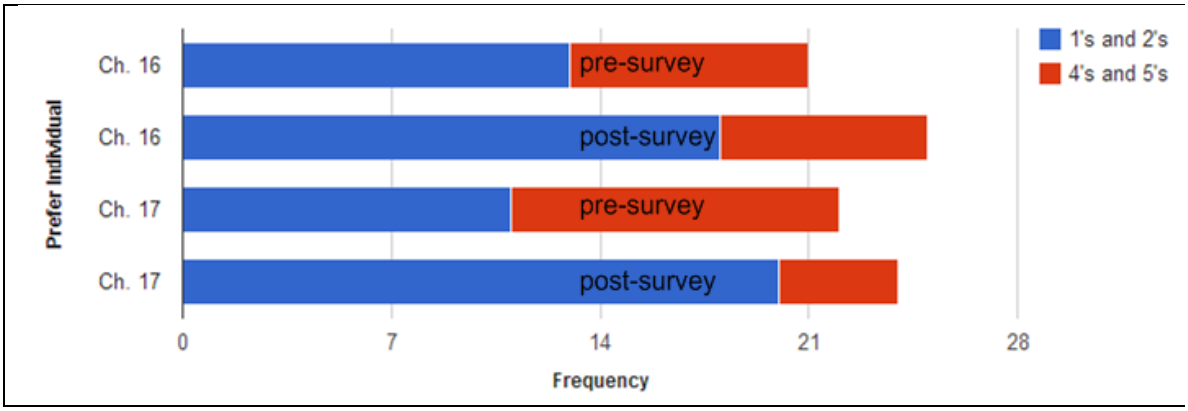


Figure 7. Ch. 16 Pre-Survey Results (N=33), Post-Survey Results, (*N*=28), Ch. 17 Pre-Survey Results, (*N*=33) and Ch 17 Post-Survey #2 Results, (*N*=28). Likert Scale 1 (not at all true) to 5 (very true).

By the end of the non-treatment instruction in chapter 16, the number of students who preferred individual work decreased. One students said that "I believe I work better as an individual because it helps me concentrate more and excel at my work", but the majority of the comments agreed with the two statements that follow; "It's boring" and "it's easier for me to work in groups because if I don't understand something (my team) can help me if I ask." Another comment that further supports the preference for cooperative group work is, "I like other students' feedback towards assignments and class discussion. I learn better with other students telling me in their words what is going on rather than a long explanation from someone higher up."

In the treatment chapter 17, the trend continued. The number of 1's and 2's once again illustrates the number of students disagreeing with the statement selected. Survey comments in this section provided additional opinions about cooperative learning. A few

students responded by stating that they “seem to get work done faster when alone”, while others like this student responded by saying “I like to do things my way, but I also like to hear other people’s opinions and views on how to do things.” Finally, some students responded by saying that they find it “easier to work with other people because more ideas are given, which makes it easier to understand the answer.”

The student interview provided additional information. One student said, “I felt that working with groups and the communication we had helped to put me in a better mood” and “if you talk a lot and laugh a little then you actually pay attention more.” This statement summarizes a common theme that students really enjoy cooperative learning where the setting encourages dialogue between team members. If structured properly and purposefully, there is great power in talking and communication between students.

A teacher journal (appendix O) was used throughout the two treatment and two non-treatment chapters. One theme that emerged was the lack of student interaction with each other in the non-treatment chapters. It was observed that students worked well in the assigned activities, but the work was very individualized. In addition it was noted that there was very little talking or engagement between the students and the teacher.

A second theme arose around asking students questions in class. When students were not in cooperative teams it was often difficult to get participation from a variety of students. This concern was reflected in the statement, “I tried to make adjustments from yesterday and I asked questions to rows of students and hoped someone in that row would answer.” In another lesson, a student was randomly selected to answer a question

about the ploidy of cells. When asked to select 1 of 3 cells to identify, the student had difficulty selecting a cell, and was unable to give an answer at all. After adequate wait time, "I had to move past him without an answer." As a possible solution to this problem, a random name generator may be a useful tool to help deal with student selection during questioning.

While in cooperative teams, it was found to be easier to question groups of students and have a selected student or a number of students answer the question. It was also observed that students were more willing to answer when they had time to discuss their thoughts within the cooperative teams.

In addition to answering questions, participation in classroom activities was also observed. This participation appeared to decrease when students were in individual rows. During one classroom activity, it was noted that "there was a group of students eager to come to the SmartBoard©, but about 1/3 of the class did not want to participate." Not only did participation decrease, content specific dialogue followed the same pattern. During a karyotype activity and a separate summary of cell division it was noted that students were working hard, but cross talk was very limited. Over the course of the non-treatment chapters 16 and 19, this form of observation was often observed.

In contrast, during the chapter 17 genetics "Crazy Traits" activity of the treatment chapter, it was recorded that "students were very engaged in the activity. All were on task and excited." A great deal of student dialogue occurred throughout the activity. In addition, although students were asked to "stop early on the second generation, they all wanted to finish right to the bell." In addition, it was noted in one of the treatment

classes that “this is a difficult concept, but student participation in groups and to the whole class (is) amazing.” Throughout the treatment chapters the amount of information sharing, question answering, and general dialogue between students increased and was supported by the teacher.

The final theme focused on teacher motivation. This component was rated on a 5 point scale (1 – low, 5 – high) throughout the 4 chapters in the study. The mean self-assessment of motivation increased from 3.7 in the non-treatment chapters to 4.2 in the treatment chapters. This does appear to be a somewhat significant increase and most likely stems from the amount of teacher / student interaction that occurred in the two different settings. During the non-treatment chapters the norm was more of a stand and deliver method with students being asked questions individually. As a teacher who prefers to be actively involved in the classroom, the non-treatment setting did not support this preference.

While in the setting of the treatment chapters, interaction with students in cooperative teams increased. The pedagogical approach of the cooperative learning structures appears to better suit the preferred teaching style. The cooperative setting provides an opportunity to interact with 8 groups of students as opposed to 30 or more individual students.

Efficiency within the classroom was also analyzed. To illustrate this, an observation was made during a non-treatment activity and it was stated that “I did a lot of running from desk to desk addressing small issues that students would normally ask their cooperative team.” There was a lot of one on one time with students, “but I seem to be

answering the same question over and over". In the treatment chapters it was noted that the teacher was more of a "facilitator, moving from group to group helping clarify student work." Many of the small issues that teachers face appear to be limited in the cooperative teams and more time can be spent solving more direct content based problems that students may encounter.

INTERPRETATION AND CONCLUSION

The first AR sub-question focused on the effects of cooperative pre-activities on student assessment scores of high school biology concepts. Based on the data collected there is evidence that cooperative pre-activities do have a positive impact on cognitive development and student understanding of some concepts in biology. Students demonstrated a 25.1% gain in the post-tests that followed the cooperative pre-activities. When compared to students from the previous year, the group of students in the AR went from being 4.2% lower on end of chapter exams in the non-treatment chapters to 1.7% higher on the end of chapter exams in the treatment chapters. Although that gain may appear small, students exposed to cooperative pre-activities did outperform the previous group of students. This data reinforces the impact of cooperative learning on cognitive development and provides the basis for future use of such strategies in the science classroom.

It must be recognized that the standard deviation actually increased following the pre-activities. This does indicate that not all students have the same gains from cooperative pre-activities, but supplemented with additional cooperative learning structures it does appear that these students still have gains on their end of chapter exams.

The cooperative pre-activities and additional cooperative learning structures presented in the treatment classes not only improves student understanding, these teaching methods also addressed the second sub-question of the AR. This question focused on student self-confidence and motivation to become engaged in high school biology. Based on the data, there was also a positive impact on both self-confidence and motivation to become engaged. In the three chapter 17 surveys, an average of 71% of the students selected 4's and 5's on the Likert-based survey question about cooperative pre-activities and an increase in self-confidence. Similarly, 55% of the students answered favorably on the question referring to increased motivation to be engaged in classroom activities. On those same surveys, a common theme emerged. Students communicated that having the ability to dialogue, ask questions, and communicate with cooperative teams was a positive experience. This evidence provides additional support for the use of cooperative learning in the science classroom.

The final sub-question looked at teacher motivation and the impact on pedagogy. Comments made in the teacher journal made it clear that the impact was positive. When the teacher is more of a facilitator and students are allowed to learn from each other the overall atmosphere of the classroom was inviting for all members of the learning community. Instead of having a few students involved in the questioning and answering that occurs during classroom activities, cooperative learning allows the teacher to involve all students most all of the time. In addition, the cooperative pre-activities and cooperative learning structures allow the teacher to actively engage more students in the

learning process. It creates an environment in which students want to know more, want to dialogue, want to ask questions, and most of all, want to learn.

Finally, the main focus question considered the effects of cooperative pre-activities son student understanding of high school biology concepts. Based on pre-tests and post-tests, end of chapter exams, student surveys and teacher journals, it can be concluded that cooperative pre-activities and additional cooperative learning structures have a positive impact on student understanding. Students appear to feel more confident in class, are more motivated to participate in the learning process and perform better on classroom assessments.

VALUE

As Gibbs and Ushijima (2008) summarized, many students attend school because they have to, not because they enjoy the process. Students are often focused on just getting by or more concerned with a passing grade, rather than learning material. There is some definite evidence provided by this AR project that cooperative pre-activities and cooperative learning helps with the social development that will encourage students to be in classes and have the self-confidence to be actively engaged in the learning process. As shown in Figure 5, the self-confidence of students increased from 55% selecting 4's and 5's in the pre-survey to 82% selecting those same values in post-survey #2. Student motivation varied in the first two surveys, but by the completion point of post-survey #2, 79% of the students felt they were more motivated to participate in classroom activities. Both self-confidence and motivation to participate are important factors in any classroom

and based on the values presented, it is recommended that teachers implement such activities into their classroom.

It is also evident that cooperative pre-activities and additional cooperative learning structures are important tools that could be used to increase student understanding and assessment scores. The 25.1% gain on the post-test scores and the additional gains on the end of chapter exams illustrate this point. Gains would most likely increase if cooperative learning was used as the main teaching style in the classroom, but any level of integration into pre-existing styles of teaching could be a benefit. Based on experiences and the gains reported in the AR, it is evident that these strategies will result in gains in cognitive development and overall student understanding of concepts in biology.

However, there needs to be closer examination of the outliers in the biology classroom. In future AR studies, individual students need to be carefully tracked to get a better idea of how cooperative learning directly impacts both the upper and, perhaps more importantly, the lower end students. A future AR question might be, "How can cooperative pre-activities be used to increase the understanding of students who normally perform below the average in high school biology?"

In addition, it is clear that in order for cooperative pre-activities or any type of cooperative learning to be effective, team development is essential. Kagan (2009) outlines many class-building and team-building activities that should be implemented in order for cooperative learning to be most effective. Further research on the impacts of such activities and the development of heterogeneous groups could be another area of

focus. An AR question to address this concern could be, “How does group formation impact academic success of cooperative teams in high school biology?”

Cooperative pre-activities and additional cooperative learning structures are very important strategies to improve student learning. Although many factors could impact the end result, there are definitely many benefits from the use of cooperative learning. Based on the data reported in the AR, cooperative pre-activities and cooperative learning structures will definitely be used in future science classes. In addition, it is encouraged that all teachers experiment with similar strategies to experience the benefits that cooperative learning can bring to their classroom, both socially and academically. Based on experience, it appears that these learning strategies have a positive impact in all content areas of biology and will most likely work in any subject area. In order increase success, classroom teachers should explore structured and tested programs such as Kagan (http://www.kaganonline.com).

In closing, it is highly recommended that teachers give some level of cooperative learning a try in the classroom. The social gains are evident very quickly if time is taken to structure the heterogeneous groups, taking care to consider both academic and gender differences. Although every class and every group of students is different, teacher persistence and a willingness to experiment with the groups until social success is occurring, will certainly lead to student academic success. Students in those groups will be motivated to talk, to share knowledge and to ask questions that will provide every learner with opportunity to gain knowledge and increase their understanding of any classroom topic. There are many options and variations to cooperative learning, so

explore, modify, and experience the difference that cooperative learning can make in any classroom.

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APPENDICES

APPENDIX A

CRAZY TRAITS – CLASSROOM PACKAGE



Image From: http://store.schoolspecialty.com

APPENDIX B

CRAZY TRAITS – STUDENT DATA SHEET

Table I: Genotypes and phenotypes of offspring

Trait	Allele from mother	Allele from father	Genotype	Phenotype
1. Gender				
2. Skin color				
3. Leg				
4. Foot				
5. Arms				
6. Hands				
7. Eye color				
8. Eyebrows				
9. Beak				
10. Ears				
11. Antenna				
12. Antenna shape				
13. Tail				
14. Wings				

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Table 2: Key to genotypes and phenotypes

Trait	Genotypes and phenotypes
1. Gender	**XX** – female **XY** – male
2. Skin color	**TT** - red **Tt** - purple **tt** - blue
3. Leg	**TT** – short **Tt** – short **tt** – long
4. Foot	**TT** – webbed **Tt** – webbed **tt** – talon
5. Arms	**TT** – long **Tt** – long **tt** – short
6. Hands	**TT** – paws **Tt** – paws **tt** – claws
7. Eye color	**TT** – red **Tt** – one red and one green **tt** - green
8. Eyebrows	**TT** – unibrow **Tt** – unibrow **tt** – separate
9. Beak	**TT** – trumpet **Tt** – trumpet **tt** – crusher
10. Ears	**TT** – elephant **Tt** – elephant **tt** – mouse
11. Antenna	**TT** – long **Tt** – long **tt** – short
12. Antenna shape	**TT** – knob **Tt** – knob **tt** – star
13. Tail	**TT** – long **Tt** – short **tt** – none
14. Wings	**TT** – no wings **Tt** – no wings **tt** – wings

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APPENDIX C

DNA INTRODUCTION – VIDEO ASSIGNMENT

DNA Introduction - Video

With cooperative group - watch the following videos.

http://www.youtube.com/watch?v=zwibgNGe4aY
http://www.youtube.com/watch?v=q6PP-C4udkA

While the videos are playing, please pause them every minute or so to reflect ideas/thoughts on an index card. Take turns writing and sharing ideas.

APPENDIX D

INDRODUCTION TO TRANSCRIPTION AND TRANSLATION

VIDEO ANALYSIS ASSIGNMENT

Introduction to Transcription and Translation

Video Animation Analysis Assignment

Transcription:

In your cooperative teams, watch the following video clips/animations on transcription:
http://www.youtube.com/watch?v=ztPkv7wc3yU
http://www.stolaf.edu/people/giannini/flashanimat/molgenetics/transcription.swf

Use the internet to gather additional information to complete the following. It is not necessary to write answers for each of the following, but please ensure that all team members are familiar with the answers to each.

1. What is transcription?

2. Where in the cell does transcription take place?

3. What is the function of RNA polymerase?

4. What does mRNA stand for?

5. How is mRNA different from DNA? (hint - two major differences - one based on structure and one based on nucleotides)

6. If a DNA strand was **AATCTGGATCCT**, what would be the order of nucleotides in the mRNA?

7. Where does the mRNA go once it is constructed?

Translation:

In your cooperative teams, watch the following video clips/animations on transcription:
http://www.youtube.com/watch?v=-zb6r1MMTkc
http://www.stolaf.edu/people/giannini/flashanimat/molgenetics/translation.swf

Use the internet to gather additional information to complete the following. It is not necessary to write answers for each of the following, but please ensure that all team members are familiar with the answers to each.

1. What is translation?

2. Where in the cell does translation take place?

3. What is the role of a ribosome?

4. What is the role of tRNA?

5. What is a codon?

6. What type of bonds hold amino acids together?

7. A chain of amino acids if referred to as a _____.

APPENDIX E

CH. 16 – CELL REPRODUCTION – PRE-SURVEY

Cell Reproduction AR Pre-Survey

Participation is voluntary, and you can choose to not answer any question that you do not want to answer, and you can stop at anytime.

Your participation or non-participation will not affect your grade or class standing.

* Required

1. **1. I prefer to work as an individual, rather than in a cooperative group. ***
   Mark only one oval.

	1	2	3	4	5	
not at all true	◯	◯	◯	◯	◯	very true

2. **2. Explain your preference for the above question ***

3. **3. I usually try hard during classroom activities. ***
   Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

4. **What factors influence or affect your effort and motivation in class? Please explain below. ***

5. **4. I sometimes feel nervous answering teacher questions aloud in class.** *
   Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

6. **5. Please explain why you do or do not feel nervous answering aloud.** *

7. **6. When I know very little about a concept, I tend not to get involved in classroom activities.** *
   Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

8. **7. Provide any additional information about how your knowledge of a concept can affect your participation in classroom activities.** *

9. **8. I would rate my current understanding of basic cell reproduction concepts as** *
   Mark only one oval.

	1	2	3	4	5	
know very little	◯	◯	◯	◯	◯	very knowledgeable

10. **9. Please provide other important information that you could not express in the questions above.**

_____

_____

_____

_____

_____

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APPENDIX F

CH. 16 – CELL REPRODUCTION – POST-SURVEY

Cell Reproduction AR Post-Survey

Participation is voluntary, and you can choose to not answer any question that you do not want to answer, and you can stop at any time.

Your participation or non-participation will not affect your grade or class standing.

* Required

1. **1. I prefer to work in individual desks/rows, rather than in cooperative groups. ***
   Mark only one oval.

	1	2	3	4	5	
not at all true	◯	◯	◯	◯	◯	very true

2. **2. Explain your preference for the above question ***

3. **3. I usually try hard during classroom activities. ***
   Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

4. **4. I sometimes feel nervous answering teacher questions aloud in class while sitting in individual desks/rows. ***
   Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

5. **5. Please explain why you feel nervous answering aloud.** *

6. **6. I was more willing and motivated to participate in classroom discussion while sitting in individual desks/rows.** *
Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

7. **7. Explain how your motivation to participate is impacted by being in individual rows.** *

8. **8. On a scale of 1-5, rate your participation in classroom activities over the last week.** *
Mark only one oval.

	1	2	3	4	5	
low	◯	◯	◯	◯	◯	high

9. **9. Mr. Brown asked me to answer a question aloud to the class during chapter 16.** *
Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

10. **10. I volunteered to answer a question aloud to the class during chapter 16.** *
Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

11. **11. When being asked to answer a question or volunteering to answer a question in class, what factors determine how you feel about answering that question?** *

_____

_____

_____

_____

_____

12. **12. When I know very little about a concept, I tend not to get involved in classroom activities.** *

Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

13. **13. Provide any additional information about how your knowledge of a concept can affect your participation in classroom activities.** *

_____

_____

_____

_____

_____

14. **14. I would rate my current understanding of basic cell reproduction concepts as** *

Mark only one oval.

	1	2	3	4	5	
know very little	◯	◯	◯	◯	◯	very knowledgeable

15. **15. Please provide other important information about factors that affect your motivation to get involved in classroom activities or your confidence level when getting involved in classroom activities.** *

_____

_____

_____

_____

_____

APPENDIX G

IRB EXEMPTION LETTER

INSTITUTIONAL REVIEW BOARD

For the Protection of Human Subjects
FWA 00000165

MONTANA STATE UNIVERSITY

960 Technology Blvd. Room 127
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Chair: Mark Quinn
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mquinn@montana.edu
Administrator:
Cheryl Johnson
406-994-6783
cherylj@montana.edu

MEMORANDUM

TO: Dean Brown and Walt Woolbaugh

FROM: Mark Quinn, Chair Mark Quinn cmj

DATE: October 28, 2013

RE: "*The Effects of Cooperative Pre-activities on Student Understanding of High School Biology Concepts* [DB102813-EX]

The above research, described in your submission of October 25, 2013, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

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

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

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

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

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

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

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

APPENDIX H

CH. 17 – GENETICS – PRE-TEST / POST-TEST

Ch 17 - Genetics - Pre-Test/Post-Test

Participation is voluntary, and you can choose to not answer any question that you do not want to answer, and you can stop at any time.

Your participation or non-participation will not affect your grade or class standing.

1. **A segment of DNA that provides the instructions or codes for a specific trait is referred to as a(an)**
   Mark only one oval.
   - ◯ gene
   - ◯ allele
   - ◯ nucleotide
   - ◯ codon

2. **The genotype of an organism is**
   Mark only one oval.
   - ◯ determined by the dominant genes
   - ◯ composed of only two alleles
   - ◯ the genetic makeup of an organism
   - ◯ the physical traits of an organism

3. **Red flower color best describes a plants**
   Mark only one oval.
   - ◯ genotype
   - ◯ phenotype

4. **RR best describes an organisms**
   Mark only one oval.
   - ◯ genotype
   - ◯ phenotype

5. **An individual plant is heterozygous for round seeds. This plant must have**
   Mark only one oval.
   - ◯ two identical genes for seed shape
   - ◯ two different genes for seed shape
   - ◯ two identical alleles for seed shape
   - ◯ two different alleles for seed shape

6. **A cow has the genetic makeup hh, which results in the lack of horns. We would say that this cow is**
Mark only one oval.

- ◯ heterozygous for the no horn condition
- ◯ homozygous dominant for the no horn condition
- ◯ homozygous recessive for the no horn condition
- ◯ heterozygous for the horned condition

7. **If green pod color (G) is dominant over yellow pod color (g), which of the following would illustrate a plant with yellow pods?**
Mark only one oval.

- ◯ GG
- ◯ Gg
- ◯ gg
- ◯ Yy

8. **Different forms of a gene are referred to as**
Mark only one oval.

- ◯ mutations
- ◯ gamates
- ◯ alleles
- ◯ karyotypes

9. **A tall plant (TT) is crossed with a short plant (tt). The predicted offspring of this cross are**
Mark only one oval.

- ◯ all short (Tt)
- ◯ all tall (Tt)
- ◯ 50% tall (TT) and 50% short (tt)
- ◯ 50% tall (TT) and 50% tall (Tt)

10. **A plant with red flowers is crossed with a plant that has white flowers. All of the offspring from this cross display pink flowers. This is an example of**
Mark only one oval.

- ◯ mutations
- ◯ segregation
- ◯ codominance
- ◯ incomplete dominance

11. **In horses, a white haired horse and a black haired horse produce a gray offspring. Upon closer inspection, the offspring contains both black and white hairs, but appears gray from a distance. This is an example of**

Mark only one oval.

- ◯ mutations
- ◯ segregation
- ◯ codominance
- ◯ incomplete dominance

12. **An individual has a free earlobe (unattached) and this trait is controlled by the genetic combination Ee. When this individual makes a gamete, which of the following is possible?**

Mark only one oval.

- ◯ E only
- ◯ e only
- ◯ E or e
- ◯ Ee

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APPENDIX I

CH. 18 – PRE-TEST/POST-TEST #1

Ch. 18 - Pre-Test/Post-Test #1

Participation is voluntary, and you can choose to not answer any question that you do not want to answer, and you can stop at any time.

Your participation or non-participation will not affect your grade or class standing.

* Required

1. **Chromosomes are mainly composed of**
   Mark only one oval.
   - ◯ RNA
   - ◯ DNA
   - ◯ proteins
   - ◯ amino acids

2. **DNA is composed of**
   Mark only one oval.
   - ◯ fatty acids
   - ◯ carbon molecules
   - ◯ sugar molecules
   - ◯ nucleotides

3. **DNA contains pairs of**
   Mark only one oval.
   - ◯ nitrogen bases
   - ◯ hydrogen bases
   - ◯ carbon bases
   - ◯ phosphate bases

4. **The most likely pairing is**
   Mark only one oval.
   - ◯ A-C
   - ◯ G-A
   - ◯ T-C
   - ◯ A-T

5. **Base pairs that make up DNA are held together by**
Mark only one oval.

- weak covalent bonds
- weak hydrogen bonds
- strong covalent bonds
- strong hydrogen bonds

6. **DNA is composed of two chains. These chains are said to be**
Mark only one oval.

- parallel
- antiparallel
- discontinuous
- semidiscontinuous

7. **If one strand of DNA contained ATCCGGA, the complementary strand would be**
Mark only one oval.

- TAGGCCT
- ATCCGGA
- CGAATTC
- GCTTAAG

8. **The three main molecules that make up DNA are** *
Mark only one oval.

- phosphate, ribose sugar, nitrogen base
- phosphate, deoxyribose sugar, nitrogen base
- nitrate, ribose sugar, hydrogen base
- nitrate, deoxyribose sugar, hydrogen base

9. **The main function of DNA is to code or provide a blueprint for**
Mark only one oval.

- nucleus development
- cell development
- protein structure
- lipid structure

10. **Each group of 3 letters on the DNA molecule code for a(n)**
Mark only one oval.

- ◯ protein
- ◯ amino acid
- ◯ lipid
- ◯ carbohydrate

11. **The "N" in DNA represents the nucleus of the cell**
Mark only one oval.

- ◯ True
- ◯ False

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APPENDIX J

CH. 18 – PRE-TEST/POST-TEST #2

Ch. 18 - Pre-Test/Post-Test #2

Participation is voluntary, and you can choose to not answer any question that you do not want to answer, and you can stop at any time.

Your participation or non-participation will not affect your grade or class standing.

1. **mRNA is synthesized on a DNA template in a process called**
   Mark only one oval.
   - ◯ translation
   - ◯ transcription
   - ◯ RNA synthesis
   - ◯ replication

2. **The process of mRNA synthesis on a DNA template takes place in the**
   Mark only one oval.
   - ◯ cytoplasm
   - ◯ ribosome
   - ◯ nucleus
   - ◯ nucleolus

3. **Two of the main differences between DNA and RNA is that RNA is**
   Mark only one oval.
   - ◯ double stranded and contains a thymine
   - ◯ double stranded and contains a uracil
   - ◯ single stranded and contains a thymine
   - ◯ single stranded and contains a uracil

4. **Given the following DNA strand - G G A C T G A T T, which of the following is its complementary mRNA?**
   Mark only one oval.
   - ◯ C C T G A C T A A
   - ◯ C C U G A C U A A
   - ◯ G G A C T G A T T
   - ◯ T T A G T C A G G

5. **The main enzyme required for the synthesis of mRNA is**
Mark only one oval.

- DNA polymerase
- RNA polymerase
- DNA ligase
- RNA ligase

6. **Once synthesized, mRNA leaves the**
(select the most specific answer)
Mark only one oval.

- cytoplasm and moves to the nuclues
- cytoplasm and moves to the ribosome
- nucleus and moves to the cytoplasm
- nucleus and moves to a ribosome

7. **Once mRNA is synthesized, the second process required in protein synthesis is**
Mark only one oval.

- translation
- transcription
- DNA synthesis
- replication

8. **Once mRNA is synthesized, which of the following is NOT necessary for protein synthesis to occur?**
Mark only one oval.

- tRNA
- ribosome
- mRNA
- DNA

9. **A group of three mRNA bases is referred to as a**
Mark only one oval.

- triplet
- codon
- recipe
- blueprint

10. **A group of three mRNA bases determines the corresponding**
Mark only one oval.

- ◯ protein
- ◯ base pair
- ◯ amino acid
- ◯ hydrogen bond

11. **The units that make up a protein are held together by**
Mark only one oval.

- ◯ hydrogen bonds
- ◯ nitrogen bonds
- ◯ peptide bonds
- ◯ amino bonds

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APPENDIX K

CH. 17 – GENETICS – PRE-SURVEY

Gentics - AR Pre-Survey

Collaborative Pre-Activities - Genetics

Participation is voluntary, and you can choose to not answer any question that you do not want to answer, and you can stop at any time.

Your participation or non-participation will not affect your grade or class standing.

* Required

1. **I prefer to work as an individual, rather than a cooperative team.** *
   Mark only one oval.

	1	2	3	4	5	
not at all true	◯	◯	◯	◯	◯	very true

2. **Explain your preference for the above question** *

3. **I sometimes feel uncomfortable working in a cooperative group.** *
   Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

4. **What aspects of a cooperative group make you feel uncomfortable?** *

5. **I sometimes feel nervous answering questions aloud in class.** *
Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

6. **Having an opportunity to discuss the answers to questions in my cooperative group boosts my self-confidence.** *
Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

7. **When being asked to answer a question or volunteering to answer a question in class, what factors determine how you feel about answering a question or volunteering to answer a question?** *

8. **I am more willing and motivated to participate in classroom discussions when part of a cooperative team.** *
Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

9. **Add any other additional information about how cooperative groups impact your self-confidence or motivation to participate in classroom activities.** *

10. **When I know very little about a concept, I tend not to get involved in classroom activities.** *
Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

11. **Provide any additional information about how your knowledge of a concept can affect your participation in classroom activities.** *

_____

_____

_____

_____

_____

12. **I would rate my current understanding of basic genetics concepts as** *
Mark only one oval.

	1	2	3	4	5	
know very little	◯	◯	◯	◯	◯	very knowledgeable

13. **Please provide other important information about factors that affect your motivation to get involved in classroom activities or your confidence level when getting involved in classroom activities.**

_____

_____

_____

_____

_____

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APPENDIX L

CH. 17 – GENETICS – POST-SURVEY #1

Genetics Post-Survey#1

Collaborative Pre-Activities - Genetics

Participation is voluntary, and you can choose to not answer any question that you do not want to answer, and you can stop at any time.

Your participation or non-participation will not affect your grade or class standing.

* Required

1. **The Crazy Traits activity was a good introduction to genetics. ***
   Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

2. **After completing the Crazy Traits activity, I feel that I will be better prepared for the content of this genetics chapter. ***
   Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

3. **After completing the Crazy Traits activity, I have gained some basic knowledge. This knowledge will increase my self-confidence and allow me to participate in future activities in genetics. ***
   Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

4. **After completing the Crazy Traits activity, I have gained some basic knowledge. This knowledge will increase my motivation to participate more in future activities. ***
   Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

5. **Describe how the knowledge gained from the Crazy Traits activity will impact your self-confidence and motivation in the genetics chapter.** *

_____

_____

_____

_____

_____

6. **Provide any additional information about the Crazy Traits activity.** *

_____

_____

_____

_____

_____

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APPENDIX M

CH. 17 – GENETICS – POST-SURVEY #2

Genetics Post-Survey #2

Collaborative Pre-Activities - Genetics

Participation is voluntary, and you can choose to not answer any question that you do not want to answer, and you can stop at any time.

Your participation or non-participation will not affect your grade or class standing.

* Required

1. **After completing the Crazy Traits activity, I feel that I was better prepared for the content of this genetics chapter.** *
   Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

2. **After completing the Crazy Traits activity, I gained some basic knowledge. This knowledge increased my self-confidence and allow me to participate in future activities in genetics.** *
   Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

3. **After completing the Crazy Traits activity, I gained some basic knowledge. This knowledge will increase my motivation to participate more in future activities.** *
   Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

4. **I enjoy doing the whiteboard activities (make examples of multiple alleles, drawing pedigrees,etc) in order to gain knowledge or practice what I know.** *
   Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

5. **Describe the benefits of working in cooperative teams – using shoulder partners and face partners to share and gain knowledge.** *

6. **Describe any negatives of working in cooperative teams – using shoulder partners and face partners to share and gain knowledge.** *

7. **Describe how working in cooperative teams affects your self-confidence and/or motivation to participate more in your team or in the classroom.** *

8. **Provide any additional information about cooperative learning.** *

9. **I would prefer to work in individual rows and not have to participate in cooperative teams.** *
Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

10. **My mark would be higher in genetics if I did not have to work in cooperative teams.** *
Mark only one oval.

	1	2	3	4	5	
not true at all	◯	◯	◯	◯	◯	very true

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APPENDIX N

STUDENT INTERVIEW QUESTIONS

Student Interview Questions

1. Describe how you feel about working individually in rows compared to working in cooperative teams.

2. Do you feel you are more willing to participate in classroom discussions and activities as an individual or in your cooperative team. (talking to a peer vs. whole class)

3. Do cooperative teams impact your motivation or self-confidence?

4. Which do you feel allows you to get a better grade -- individual or cooperative team?

5. Throughout the semester the class has been given some “pre-activities”. These are small introductory activities done prior to lectures or other classroom activities. Do you think it is an advantage to have an opportunity to learn a little bit about a topic prior to hearing a lecture or doing a more complex activity in the class?

6. Do you feel the knowledge gained from the pre-activities impacts your:
    a. motivation
    b. self-confidence
    c. participation
    d. grade

7. Other

APPENDIX O

TEACHER JOURNAL TEMPLATE

Date:

Description of Lesson

What went well? What needs attention?

Student Engagement / Self-Confidence

Teacher Motivation (1 low - 5 high)

Pedagogy

Best Reflection of the Day