

IMPLEMENTING COOPERATIVE LEARNING STRATEGIES WITH AN  
EMPHASIS ON TEAMBUILDING IN A HIGH SCHOOL PHYSICS CLASSROOM

by

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A professional paper submitted in partial fulfillment  
of the requirements for the degree

of

Masters of Science

in

Science Education

MONTANA STATE UNIVERSITY  
Bozeman, Montana

July 2014

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July 2014

## ACKNOWLEDGEMENTS

This project greatly benefited from the insight and guidance provided through Montana State University's MSSE program and the professors and advisors involved. Eric Brunsell and Marta Toran worked diligently to provide constructive and timely feedback. Also, thank you to Gregory Francis and Diana Paterson for your insight and suggestions. Thank you to the numerous students in the MSSE program who helped through their feedback and suggestions. Deepest thanks go to Clay McCormick for all of the love, support, editing, and encouragement along the way. Lastly, thank you to Jenna O'Dell for the encouragement and study sessions throughout the entire MSSE program.

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## ABSTRACT

The purpose of this research project was to determine the impact cooperative learning and teambuilding would have on high school physics students both academically and socially. Students were divided into two groups for the unit taught on light. Four classes, 122 students, were taught using cooperative learning strategies this was compared to two classes, 65 students, who were taught the same information without the use of cooperative learning strategies. Due to the short duration of the intervention most of the results were not significant, although the students' willingness to work together did show improvement in the group of students who were taught with cooperative learning strategies compared to the students who were not taught this way.

## INTRODUCTION AND BACKGROUND

I teach at Harrison High School, a division one school just outside of Cincinnati, Ohio. This school, as well as the entire district, has adopted a mission that states, “Academic and social growth for all students, every day!” (Southwest, n.d.). I use this mission to guide my teaching practices and feel that the best way to encourage both academic and social growth is through the use of cooperative learning. I teach physics as an advanced science course where students work to master in-depth curriculum as well as complete projects that apply concepts covered throughout the year.

### School Demographics

The course consists of students from several different grade levels: tenth (23%), eleventh (59%) and twelfth (18%). Through my years of teaching I have observed that students are hesitant to work with others they see as being different from themselves. Grade level is only one of the differences; students’ gender, social economic status, learning ability, ethnicity and social networks all vary. Kagan and Kagan (2009) state that, “If there are racial or other tensions among students, teambuilding is a must” (p.10.1). Because of this, I believe that the use of teambuilding activities will be essential for students to become more accepting of each other. To encourage academic advancements through positive social interactions amongst heterogeneously mixed students, I will be using many of the techniques and resources specifically from Kagan Cooperative Learning.

### Focus Question

The primary question I will be trying to answer is, how will cooperative learning, with a focus on teambuilding, impact students’ academic achievement? I will then try

and answer two secondary questions: how will the implementation of these strategies impact students' willingness to work together, and how will the implementation of these strategies impact students' attitudes toward projects and lab activities in science? These questions will clarify the impact of cooperative learning and teambuilding on students both socially and academically.

### CONCEPTUAL FRAMEWORK

Several studies have been conducted to determine the impact of cooperative learning on students. When students participated in cooperative learning, teambuilding, and classbuilding activities, it was found that they had better attitudes towards their classmates as well as more positive cross-ethnic and cross-gender relationships (Farivar, 1991). Another study showed that socially isolated students, through cooperative learning, increased their positive social interactions with their peers, which resulted in better relationships (Mesch, Lew, Johnson, & Johnson, 1986). Better attitudes toward science in general were also found through the implementation of cooperative learning (Köse, Şahin, Ergün, & Gezer, 2010). Several studies have determined that cooperative learning results in higher student achievement (Johnson & Johnson, 1999; Johnson, Johnson, & Taylor, 1993; Köse, et al., 2010; Mesch, et al., 1986; Oickle & Slavin, 1981; Topping et al., 2011). Dialog between students who were working together cooperatively was much greater than with students who were not using this strategy (Topping et al., 2011). The interactions between students in cooperative learning groups have been found to be more positive if specific guidelines are established for the group (Kuester & Zentall, 2012). Several studies have shown that cooperative learning has a positive impact on

students' attitudes and interactions with peers (Farivar, 1991; Köse et al., 2010; Kuester & Zentall, 2012; Mesch et al., 1986; Topping et al., 2011).

Cooperative learning has provided an avenue for increasing student interactions. These interactions lead students to a deeper understanding of their group members which increases their tolerance, acceptance, and empathy towards them (Kagan & Kagan, 2009). A study conducted by Erath, Flanagan, and Bierman (2007) looked at the social effects of having anxiety during early adolescence. It was found that students who were identified as having social anxiety were less accepted by their peers, the target of more peer ridicule, and were more socially withdrawn (Erath et al., 2007). Johnson and Johnson (1999) stated, "Students who are isolated or alienated from their peers and who do not have friends are more likely to be at risk for violent and destructive behavior than students who experience social support and a sense of belonging" (p. 73). Cooperative learning has been found to create positive interactions and relationships between peers which results in decreased anxiety and less isolation (Johnson & Johnson, 1999).

Not only are positive interactions encouraged through the use of cooperative learning, but this process has been found to increase students' achievement. Johnson and Johnson (1999) stated that students who learn through cooperative learning are more likely to put effort into learning and develop positive relationships with their peers. Köse, Şahin, Ergün, and Gezer (2010) stated that students who learn cooperatively outperform those who learn individually because they are actively engaged in learning, their peers hold them accountable, and interactions among classmates are more common. It would be a misconception to assume that only low performing students would benefit from cooperative learning. A study found that high-ability students also benefit

academically because of the interactions achieved through cooperative learning (Johnson, et al., 1993). Oickle and Slavin (1981) conducted a study comparing white majority students to black minority students to determine how cooperative learning impacted their academic achievement. Their findings indicated that cooperative learning resulted in achievement gains for both black and white students but the gains were much greater for the black students. Overall, studies have found that cooperative learning is academically beneficial for all student groups, including students with high-ability, race minority, and the socially isolated (Johnson, et al., 1993; Oickle & Slavin, 1981; Mesch, et al., 1986).

In order to implement cooperative learning it is necessary to understand how it varies from traditional group. Group work is considered cooperative if group members are working to accomplish a common goal, and individual contributions are necessary for group success (Johnson & Johnson, 1999; Kagan & Kagan, 2009). According to *Kagan Cooperative Learning*, there are seven keys for success: structures, teams, management, classbuilding, teambuilding, social skills, and basic principles (Kagan & Kagan, 2009). Structures are used to organize the interactions of students while they work towards a goal; they are considered “content free” meaning that structures can be used with any content in a variety of methods. *Kagan Cooperative Learning* provides an extensive list of structures and instructions for their implementation (Kagan & Kagan, 2009). Structures were designed to be relatively easy to master so that teachers would not be overwhelmed with how to use them (Kagan, 1990). Heterogeneous teams are ideal because they provide the greatest opportunity for positive interactions between students of different grade level, ethnicity, ability levels, and sex. Class building activities will be used to build a community among the students where they feel that they belong. In order

to develop trust and connections between the students, who will be working together in cooperative groups, it is important to use teambuilding activities. Kagan and Kagan (2009) express that teambuilding is the best strategy to implement if students do not want to work together. The last key to cooperative learning uses four basic principles: positive interdependence (students' success is linked together), individual accountability (each group member is accountable for their own work), equal participation (students are equally engaged), and simultaneous interaction (several students participate at the same time) (Kagan & Kagan, 2009).

In conclusion, cooperative learning has been found to create positive attitudes towards peers and science in general (Farivar, 1991; Johnson & Johnson, 1999; Köse et al., 2010; Mesch et al., 1986). The method that has been found most useful for creating acceptance, trust, and positive attitudes is teambuilding (Kagan & Kagan, 2009; Farivar, 1991). Cooperative learning and teambuilding allow for positive social interactions which can reduce social anxiety and improve students' attitudes (Erath, et al., 2007; Johnson & Johnson, 1999; Kagan & Kagan, 2009; Kuester & Zentall, 2012; Topping, et al., 2011). Cooperative learning results in higher student academic achievement (Johnson & Johnson, 1999; Johnson, et al., 1993; Köse, et al., 2010; Mesch, et al., 1986; Oickle & Slavin, 1981; Topping et al., 2011). Based on previous research findings, cooperative learning will encourage students to work with peers who are different from themselves and will lead to an increase in student achievement.

## METHODOLOGY

Montana State University's Institutional Review Board granted this research methodology an exemption due to its compliance with the standards for working with

human subjects. Research strongly supports the use of cooperative learning with a foundation of teambuilding to increase student achievement as well as build positive social interactions. Implementation of these strategies provided insight into the research questions: how will these strategies impact students' academic achievement, willingness to work together and attitudes toward projects and lab activities in science?

### Participants

The participants in this study came from four of the six physics courses. Three were classes that occurred before lunch and one occurred after lunch. The four participating classes had a total of 122 students, 57% female and 43% male. There were students in tenth (29%), eleventh (55%) and twelfth (16%) grade in these classes. Some of the other areas of diversity included students with low social economic status (16%), students receiving special services (6%) and some are identified as gifted and talented (20%). ("Southwest," 2013).

The non-treatment group consisted of the 3<sup>rd</sup> and 7<sup>th</sup> period classes, one occurring before lunch and one occurring after lunch, so that the time of the day class occurs would have minimal impact on the results. The two classes made up a total of 65 students where 51% are boys and 49% are girls. The students were from different grade levels with 14% tenth graders, 65% eleventh graders and 22% twelfth graders. There were students in the non-treatment group with low social economic status (22%), some who receive special services (6%) and some who are identified as gifted and talented (17%). ("Southwest," 2013).

The diversity at Harrison High School was limited, with one Asian student (0.09%), one Black or African American student (0.09%), fourteen Hispanic or Latino

students (1.25%), two American Indian students (0.18%), two Pacific Islander students (0.18%) and eight multi-racial students (0.72%). Almost all students are White (97.5%). (“Southwest,” 2013). This diversity was reflective of all the physics classes, including both the treatment and non-treatment groups.

### Intervention

The intervention lasted approximately six weeks and took place during the unit on light which covers shadows, mirrors, refraction, lenses and color. At the beginning of the unit students were assigned to teams. Ideally, the teams consisted of four students divided into groups where no clear majority exists. In order to implement this, most groups had two girls and two boys as well as a mix of social economic statuses, ability levels and grade levels. Once teams had been determined students participated in several teambuilding activities. The first week focused on teambuilding, and the following five weeks focused on the implementation of cooperative learning strategies. In the non-treatment group the students received instruction using groups, determined the same way as the treatment group, but they did not include teambuilding or cooperative learning structures.

One full class period was spent on teambuilding where the students participated in “getting to know you” activities and cooperative games. For the remainder of the first week students did one team building activity per day. These teambuilding activities continued for the rest of the intervention typically occurring every Monday. This helped students stay connected and develop relationships with their teammates throughout the unit.

Cooperative learning was implemented in the teams using three of the structures from *Kagan Cooperative Learning*: Numbered Heads Together, RoundRobin, and Timed Pair Share. Each of these structures will be described briefly using the information provided by Kagan and Kagan (2009). When implementing Numbered Heads Together students answered a question individually then stood up and “put their heads together” with their teammates. They shared their responses and discuss the answers until everyone came to agreement on the best response. When everyone in the group had the answer they sat back down. The students in the team were numbered and a number was chosen at random, where that student shared the team’s answer with the class. RoundRobin was used for discussing questions that have more than one response, and each person in the team took turns sharing their thoughts. The last structure implemented was Timed Pair Share. A topic was announced and a certain amount of time for each person was provided for them to share with their partner. After one person shared while the other listened they switched roles. In order to maximize these structures and provide the students time to discuss relevant science topics a higher order thinking question was provided before each lab activity. For example, “How is what you see in curved mirrors different from what you see in ordinary flat mirrors?” (Eisenkraft, 2010, p. 548). These discussion questions along with the use of cooperative learning structures provided students a variety of ways to interact with their teammates.

Kagan & Kagan (2009) state that there are four basic principles that make group work “cooperative learning” and they refer to them as PIES. The P stands for positive interdependence, I for individual accountability, E for equal participation, and S for simultaneous interaction. The benefit of using the structures proposed by Kagan and

Kagan is that the principles are built into each structure. Therefore, through the use of the three structures described, cooperative learning was conducted during classroom instruction.

These strategies were beneficial for learning new material or participating in discussions, but as part of a science course team projects and lab activities were also used. Each week for the six week intervention students participated in a lab activity or project. These activities were structured so that each student was assigned a role. The different roles were defined during the introduction to the activity and students were either assigned a role at random or they were able to choose their own role. In the study conducted by Archer-Kath, Johnson, and Johnson (1993) it was stated that, “individual, as compared with group, feedback resulted in increased use of targeted social skills, greater day-to-day intrinsic motivation to achieve, higher achievement by all members, a narrower range of achievement within the group, more positive relationships among members, greater perceived interdependence within the group, and more positive attitudes toward learning within cooperative groups” (p. 693). Because these benefits far outweigh the outcomes of only providing group feedback, students were given individual feedback on all assignments that are submitted or presented. Table 2 shows the schedule for the duration of the intervention.

Table 1  
*Implementation Schedule*

Week	Day 1	Day 2	Day 3	Day 4	Day 5
1	Pre-Test on the light unit	Teambuilding	Teambuilding	Teambuilding	Teambuilding
	Pre-Survey	Cooperative Games	Shadow Discussion	Shadow Activity	Shadow Content and Questions
	Assign Teams		Introduction to Shadow Activity		Minute Paper
Week	Day 1	Day 2	Day 3	Day 4	Day 5
2	Teambuilding	Reflected Light Activity	Notes on Flat Mirrors	Flat Mirror Questions	Review Activity and Discussion
	Flat Mirror Discussion		Vocabulary		Minute Paper
	Introduction to Reflected Light Activity				
Week	Day 1	Day 2	Day 3	Day 4	Day 5
3	Teambuilding	Curved Mirror Activity	Curved Mirror Notes	Practice Problems B and C	Curved Mirror Questions
	Curved Mirror Discussion	Curved Mirror Quick Lab	Vocabulary		Review Activity and Discussion
					Minute Paper
Week	Day 1	Day 2	Day 3	Day 4	Day 5
4	Teambuilding	Refraction Activity	Snell's Law Notes	Snell's Law Practice Problems	Review Activity and Discussion
	Refraction Discussion		Vocabulary	Refraction Questions	Minute Paper
	Introduction to Refraction Activity				
Week	Day 1	Day 2	Day 3	Day 4	Day 5

5	Teambuilding  Lenses Discussion Introduction to Lenses Activity	Lenses Activity	Ray Diagrams  Lenses Practice B	Lenses Questions	Review Activity and Discussion Minute Paper
Week 6	Day 1 Teambuilding  Color Discussion	Day 2 Color Activity	Day 3 Color Notes and Questions	Day 4 Review Activities	Day 5 Post-test  Post-Survey  Begin Interview Process

### Data Collection

Students in all six classes took a pre-test that covered the topics taught in the light unit (Appendix A). They also completed a survey (Appendix B) where they answered questions about their attitudes toward working with other students in class as well as projects and lab activities. Throughout the intervention observational data was used. This was collected in the form of a checklist (Appendix C), where it was document if students were actively participating, interacting with each other, following directions, working in defined roles, etc. This checklist was used in both the treatment and non-treatment groups. The minute paper, an informal classroom assessment technique described by Angelo and Cross, was also used throughout the intervention for gauging student learning (1993). Upon completion of a cooperative learning activity students were given questionnaires (Appendix D). The questionnaire was created using another classroom assessment technique suggested by Angelo and Cross called Group-Work

Evaluations (1993). Upon completion of the intervention and unit, a post-test, post-survey and student interviews were conducted. The interview questions (Appendix E) were asked of students from both the treatment and non-treatment group, and were conducted within one week of completion of the intervention. The students used for the interviews were randomly selected but students were chosen from different groups, so if two students were selected from the same group another name was chosen at random. Two students from each class were interviewed providing eight students from the treatment group and four from the non-treatment group. Table 1 shows the data collection techniques for each of the questions answered during the action research process.

Table 2  
*Triangulation Matrix*

Focus Question: How will cooperative learning with a focus on teambuilding impact students both academically and socially?			
Subquestions	Data Source		
Subquestion 1: How will the implementation of these strategies impact student's academic achievement?	Pre- and Post-Test for the unit	Informal Assessment: Minute Paper	Student Questionnaire: Group-Work Evaluations
Subquestion 2: What will be the impact on students' willingness to work together?	Student Surveys: Pre- and Post-Treatment	Student Interviews: Post-Treatment	Teacher Observation Data
Subquestion 3: How will these strategies impact students' attitudes toward projects and lab activities in physics?	Student Surveys: Pre- and Post-Treatment	Student Interviews: Post-Treatment	

## DATA AND ANALYSIS

The goal of this research was to determine how cooperative learning with a focus on teambuilding would impact students both socially and academically.

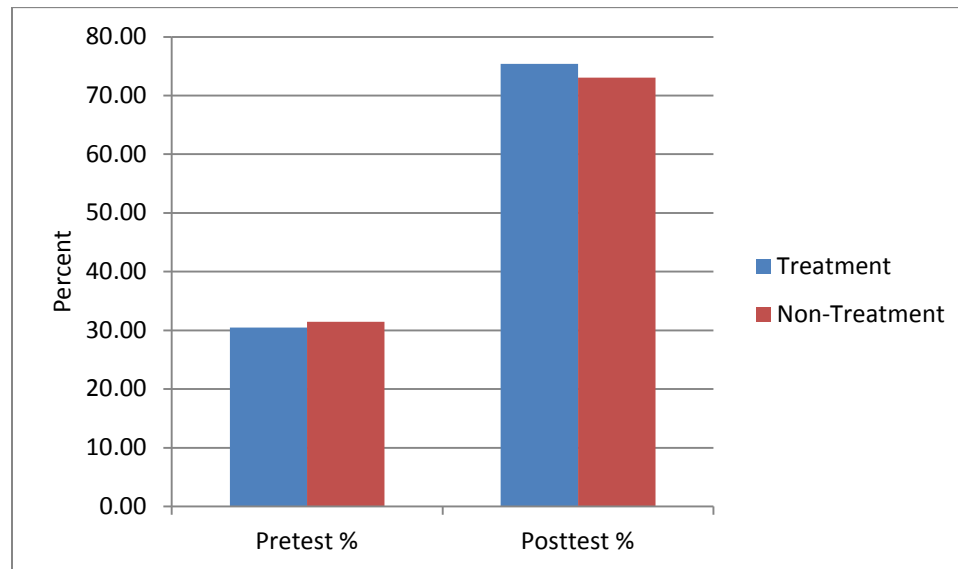
There were three areas investigated through this research. The impact of cooperative learning on academic achievement during one unit of curriculum was determined. For the social impact, there were two areas analyzed. The first was how cooperative learning with an emphasis on teambuilding changed students' willingness to work together. The second was how cooperative learning would impact students' attitudes toward projects and lab activities where students work with their classmates to complete an assignment.

#### Impact of cooperative learning on academic achievement

To determine cooperative learning and teambuilding's impact on students' academic achievement several data sources were used. The data provided through the pre-test and post-test as well as the questionnaire was insignificant and although the one minute papers did show an improvement in the treatment group that was significant the overall impact of cooperative learning on students academics was inconclusive.

The first form of evidence was the pre- and post-test data. In the treatment group 120 students completed the pre- and post-test and the non-treatment group had 64 students. For these students, their average scores were calculated. In the treatment group their average pre-test score was 30.49% (SD = 9.01) and their post-test score was 75.37% (SD = 17.20). For the non-treatment group their average pretest score was 31.47% (SD = 9.10) and their post-test average was 73.05% (SD = 17.70), see *Figure 1*. The normalized gain was also calculated for each group. For the treatment group, the normalized gain was 64.77% while the non-treatment group was 60.36%, see *Figure 2*. Although both methods of analyzing the test data showed a slightly larger improvement in the treatment group than in the non-treatment group, it was not significantly greater. An unpaired *t* test

was calculated using the normalized gain data for the treatment and non-treatment groups. For the treatment group the mean (average) was 64.77, the standard deviation was 24.69, and the number of participants was 120. For the non-treatment group the mean (average) was 60.36, the standard deviation was 26.34, and the number of participants was 64. The results of the  $t$  test showed that there was not a significant difference,  $t(182)=1.1273$ ,  $p=0.261$ . Because of this insignificance and the fact that both groups showed improvement the actual impact of cooperative learning on academic achievement demonstrated through the pre- and post-test data was inconclusive.



*Figure 1.* Pre- and post-test data for treatment and non-treatment groups, ( $N_T=120$ ,  $N_N=64$ ).

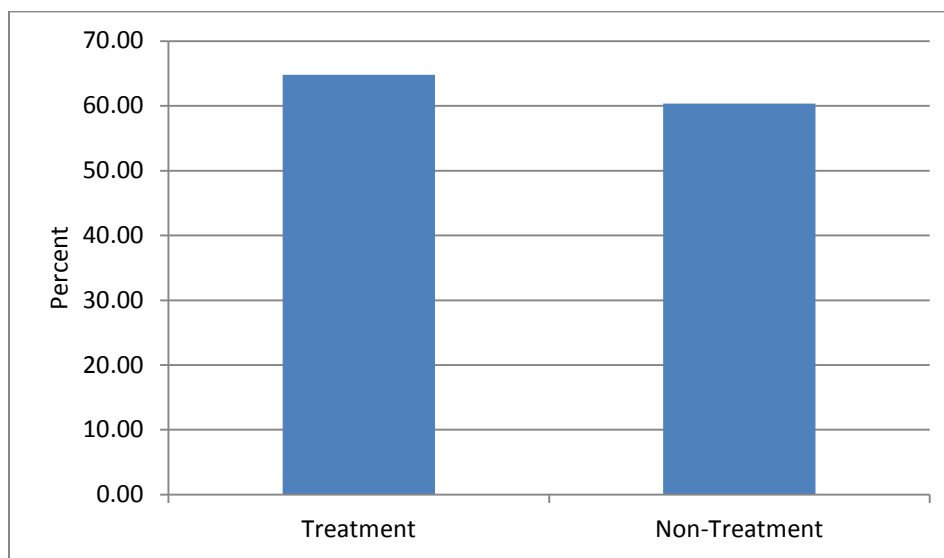
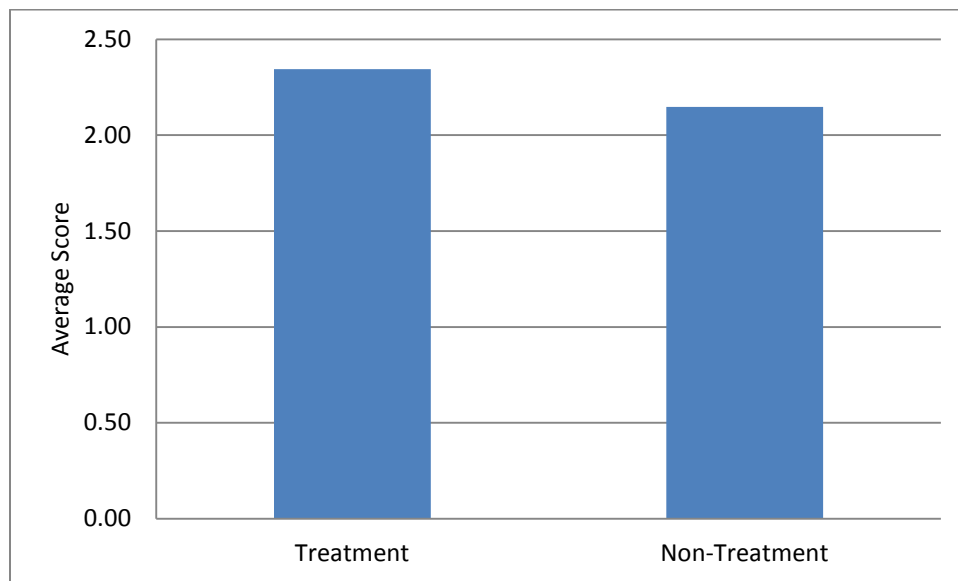


Figure 2. Normalized gain for the pre- and post-test scores, ( $N_T=120$ ,  $N_N=64$ ).

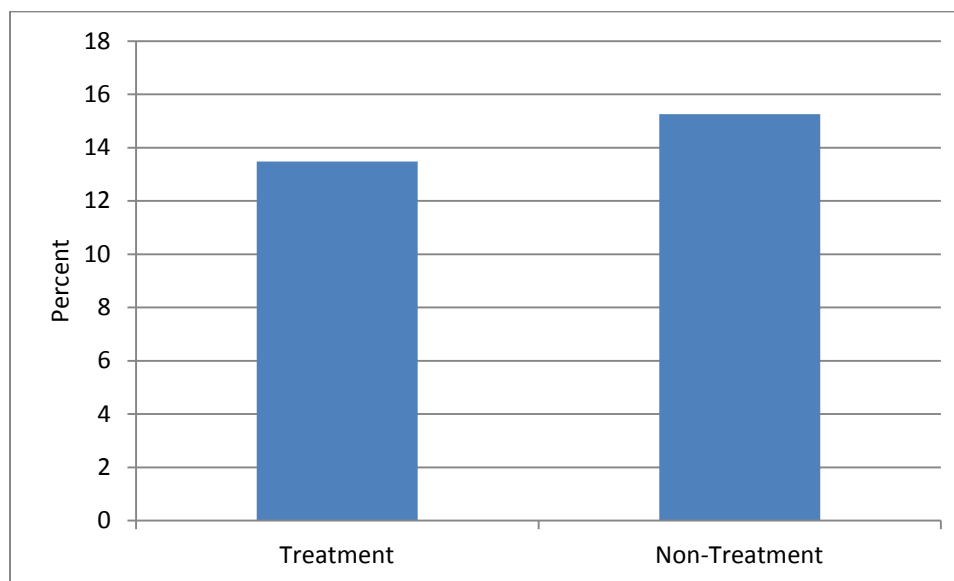
When looking at the students' responses to their one minute papers, where students write about the main idea for the lab activity, the data shows that the treatment group demonstrated a slightly higher level of understanding with an average score of 2.34 than the non-treatment group with an average score of 2.15, see *Figure 3*. This average was based on a point system where a score of a one represents that the student did not get the main idea, a two indicates that the student demonstrates somewhat of an understanding of the main idea and a three represents a good level of understanding of the main idea. Half points were given if a student fell between two levels. An example of a student response with a score of a one is, "A laser can't go through a light bulb while it is lit." A score half way between one and two would be given if the student demonstrated somewhat understanding of the main idea but did not use content specific vocabulary and did not provide enough detail. An example of this would be, "lasers do some pretty crazy things when you shine it through glass." A score of a two would have been given for a response such as, "light can reflect in many directions." When giving a

score between a two and a three, students would respond without including enough detail or for being on the right track but not quite getting to the appropriate conclusion, “Angle of incidence and angle of reflection is always similar and angle of refraction is always less than.” In order to get a score of a three the student would have to include specific information related to the main idea, for example, “The angle of refraction changes based on the angle of incidence. Also the angle of incidence and refraction are equal.” One minute papers were collected more than once during the unit giving the treatment group a total of 185 papers and then non-treatment group 85 papers. The standard deviation for the average scores on the papers was 0.54 for the treatment group and 0.41 for the non-treatment group. This information was used to calculate a *t*-test and the results showed that the difference between the treatment and non-treatment groups was significant,  $t(268)=2.8834$ ,  $p=0.0043$ .



*Figure 3.* One minute paper data for treatment and non-treatment groups, ( $N_T=185$ ,  $N_N=85$ ).

A third form of evidence was used to provide insight on students' academic achievement as a result of the use of cooperative learning and that was a student questionnaire. On the questionnaire, one of the questions stated, "Give one example of something your group members probably learned from you that they might not have learned if they were working alone." The diversity of their answers varied greatly. For example one student said, "Other observations that I might not have picked up, coming from different angles." Another student said, "I don't think I would have learned about the umbra and penumbra if I was working alone." Due to the variety of responses, the number of students who felt that they did not learn anything from their group members was analyzed, see *Figure 4*. The questionnaire was administered twice in the duration of the unit; the results from both were combined together giving the treatment group a total of 230 student responses and the non-treatment group 118 student responses. The treatment group had a lower percent (13.48%) of students who felt they did not learn anything from their group members than the non-treatment group (15.25%). The results from the questionnaire show that students in the treatment group said that they were learning from their groups more often than the students in the non-treatment group, but they were not significantly different.



*Figure 4.* Student questionnaire data, percent of students who did not learn from their groups, ( $N_T=230$ ,  $N_N=118$ ).

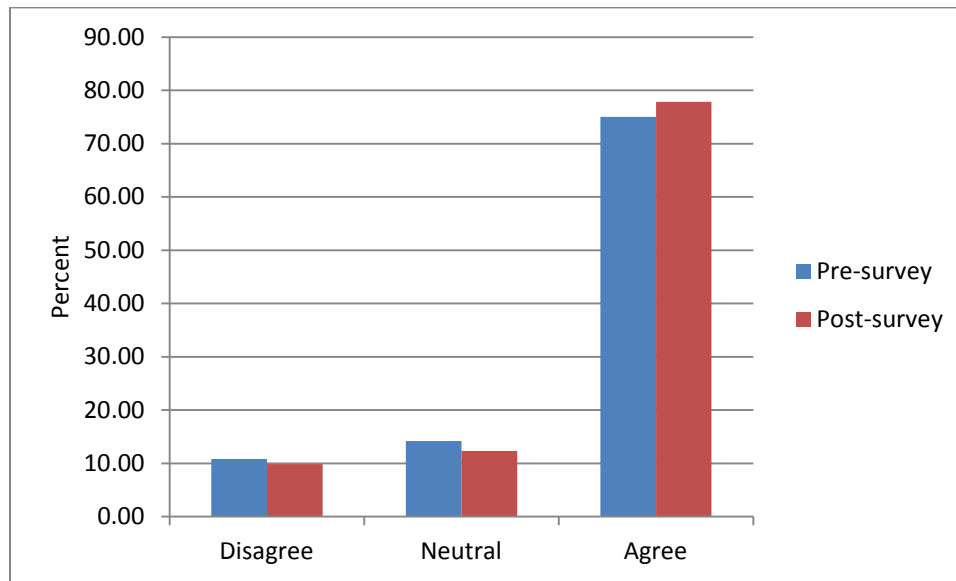
Overall, the evidence between the treatment and non-treatment groups' academic achievement was inconclusive because the data did not show a significant difference between the two groups. This is not surprising because the study was only conducted over a short period of time.

#### Impact of cooperative learning on students' willingness to work together

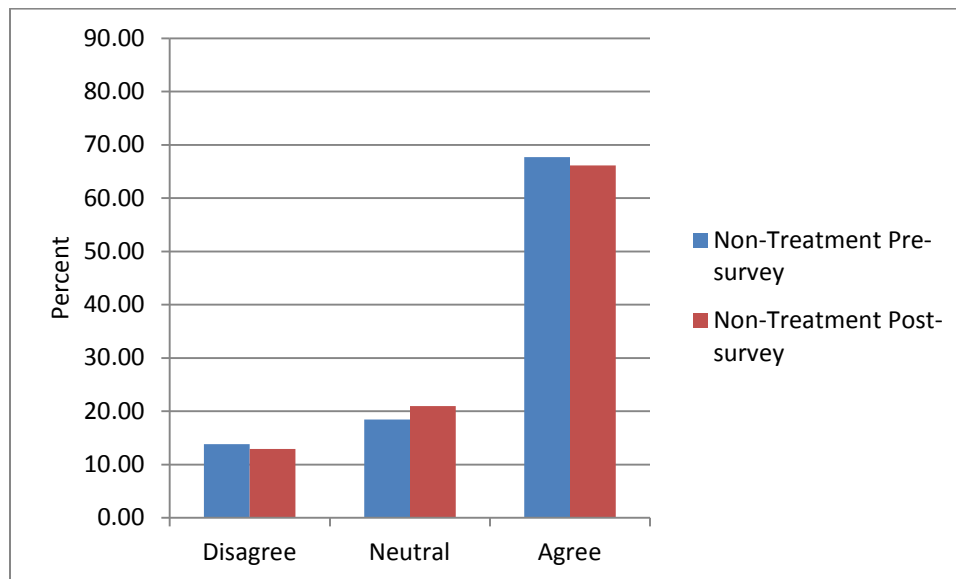
The use of cooperative learning with an emphasis on teambuilding was likely to impact students socially. To determine this impact data was collected through a question on the pre- and post-survey, through some of the interview questions, as well as teacher observation. This data indicated that students were more willing to work together upon completion of a unit taught using cooperative learning and teambuilding strategies.

The first question on the survey asked students to respond to the statement, "I would rather learn science through group activities than alone." A response of a one indicated that the student strongly disagreed with that statement, three was neutral and a

five indicated that they strongly agreed. The students answered this question in the pre-survey before the beginning of the unit and then again in the post-survey when the students had been working in their groups for several weeks. To simplify the results they were categorized into disagree, neutral, and agree. The responses showed in the treatment group that more of them agreed (2.87%) with this statement after participating in cooperative learning and teambuilding activities. This value was based on the percentage agreeing post-survey (77.87%) minus the percent that agreed pre-survey (75%), see *Figure 5*. The number of students who participated in the pre-survey for the treatment group was 120 and post-survey was 122. The non-treatment group had less students agreeing (1.56%) with this statement after completing the unit. This value was determined by taking the difference between the students' pre-survey (67.69%) and post-survey (66.13%) results that agreed with the statement see *Figure 6*. The number of students who participated in the non-treatment group pre-survey was 65 and post-survey was 62.



*Figure 5.* The treatment group's responses to the statement, I would rather learn science through group activities than alone, ( $N=120$ ).



*Figure 6.* Non-treatment group's responses to the statement, I would rather learn science through group activities than alone, ( $N=62$ ).

The student interviews had two questions that were focused on student willingness to work together. The first was, "Do you feel more comfortable working with the classmates in your group now than you did at the beginning of the unit?" This

question was asked of the treatment and non-treatment students interviewed. In the treatment group six of the eight students said that they were more comfortable because they know them better now, one student said they already knew the students in their group so they were already comfortable with them, and one student said “It made no difference, I don’t like groups.” In the non-treatment group half (two of the four) students interviewed said that they were more comfortable because they know their group better now. The other two said they are not more comfortable with their group, one student said, “I didn’t have a lot in common with my group so I didn’t work with them.” Students were also asked in the interview, “Are you more likely to choose to work with someone from your group now than you would have been before this unit?” In the treatment group six of the eight said yes and the other two said maybe, one because she likes working with a friend that was not in her group for this unit and the other because they would prefer to work alone. In the non-treatment group two of the students said yes while the other two said no. Based on the interviews conducted, students in the treatment group were more willing to work with classmates from their group after completing teambuilding activities and using cooperative learning strategies. One student during the interview said, “with all of the teambuilding we really go to know each other and use our strong points.” The students in the non-treatment group showed that about half of them were more willing to work with classmates from their group, but the other half did not want to work with their assigned group. One student said, “the group I was assigned inhibited my learning so I moved to a different group where we were able to get labs done and work effectively.”

Many students in my non-treatment group decided that they did not want to work with their assigned group. So after a few days of sitting in their assigned groups students began switching seats. Observational data was taken on January 30, approximately two weeks into the research and found that all of the treatment students worked with their assigned groups, but the non-treatment groups showed signs of dysfunctional teamwork. In third period, a non-treatment class, one student switched groups as soon as attendance was taken and another student asked if he could switch groups because his group does not talk to him. This class asked a lot of questions about the materials and required a lot more teacher input to get started than the treatment classes. In seventh period, the other non-treatment class, four students were not sitting with their assigned groups and were hesitant to go to their assigned groups when asked. In several of the groups more than one student retrieved materials for the group, as a result other groups had to go searching for extra materials. Students asked for teacher instruction for getting started instead of working through the directions in the packet with their group.

Two weeks later observational data was taken again and this time the difference between treatment and non-treatment was even more extreme. For the treatment classes, first period did not have any students move from their assigned seats, second period had one student move to another seat to get a better view during notes, fourth period had one student turn in his chair to face the front of the room, and in fifth period one student frequently visited another group with friends in it, but all other students sat in assigned groups. In the non-treatment classes many more students moved to work with other groups. Third period had four students sitting with a group other than the one assigned

and one student moved to a different group part way through the class period. In seventh period eight students had switched seats and remained that way the entire class.

The last set of observational data was taken at the end of the treatment. This again showed that the treatment students stayed in their assigned groups, all 122 of them, while the non-treatment students switched seats, 17 out of 60, to work with classmates of their choice. The data showed that the students were more willing to work together through the completion of the cooperative learning strategies with an emphasis on teambuilding. Many of the non-treatment group students decided to work in groups that they were not assigned, demonstrating their unwillingness to work together with their group.

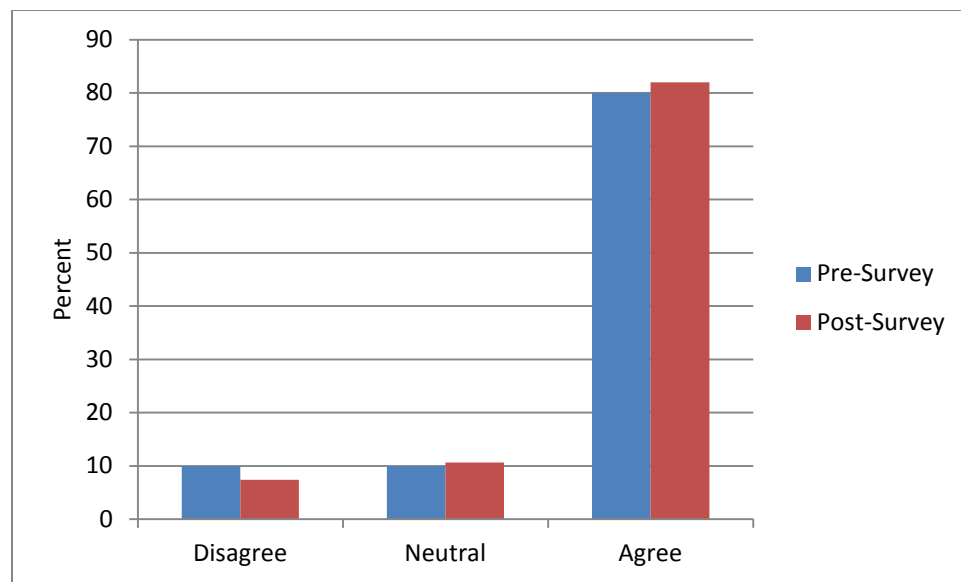
Overall, the data from the survey, student interviews, and teacher observations all indicated that students were more willing to work together in a group when the class was given instruction using cooperative learning with an emphasis on teambuilding.

#### Impact of cooperative learning on students' attitudes toward projects and lab activities

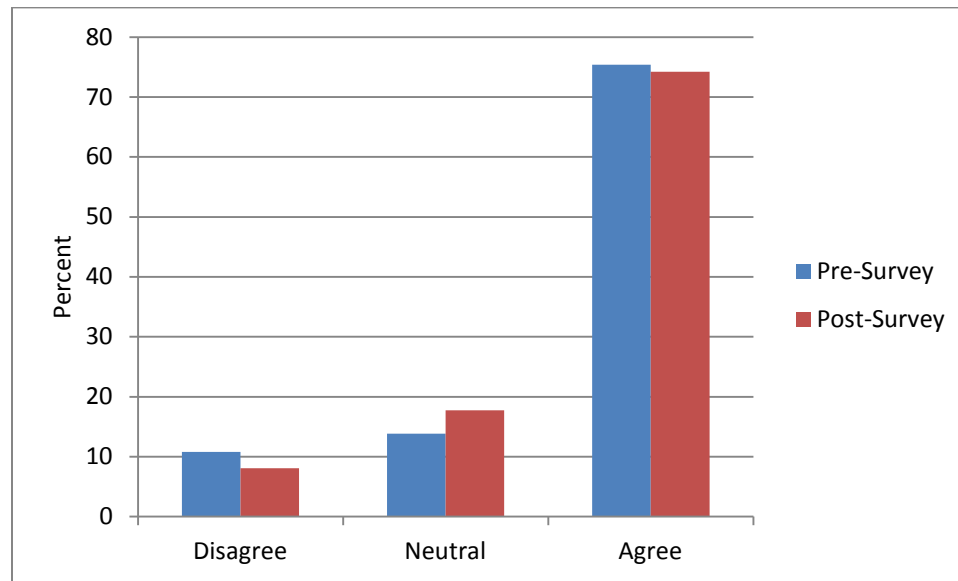
Data was gathered to determine how these strategies would impact students' attitudes toward projects and lab activities in science. Two questions on the student survey addressed student attitude toward projects and lab activities and both showed a slightly better attitude in the treatment group. A question from the student interviews asked how working in groups is different than learning in other ways; group work was done in the unit during lab activities. But the interviews did not produce enough data in this area to draw any conclusions. The answer to this question was inconclusive.

The students were asked to respond to the statement, "I like doing group activities such as labs and projects in physics." Between the pre- and post-survey the treatment

group showed an increase of 1.97% in the number of students who agreed, while the non-treatment group showed a decrease of 1.19%, see *Figure 7* and 8. The treatment group also showed a higher percent overall agreeing (81.97%) post-survey than the non-treatment group (74.19%). There were 120 students who completed the pre-survey and 122 who completed the post-survey in the treatment group. For the non-treatment group 65 completed the pre-survey and 62 completed the post-survey.

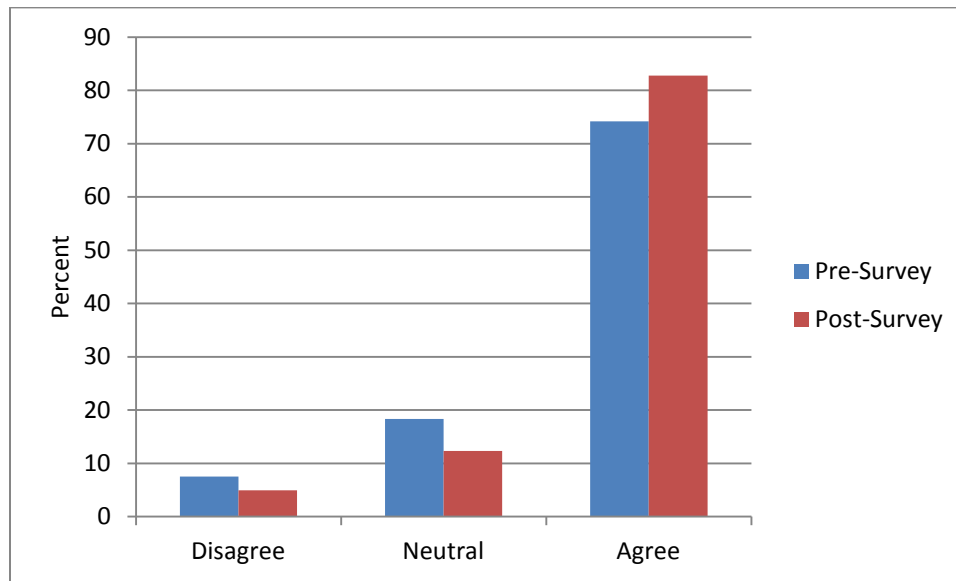


*Figure 7.* Treatment results for the survey statement, I like doing group activities such as labs and projects in physics, ( $N=120$ ).

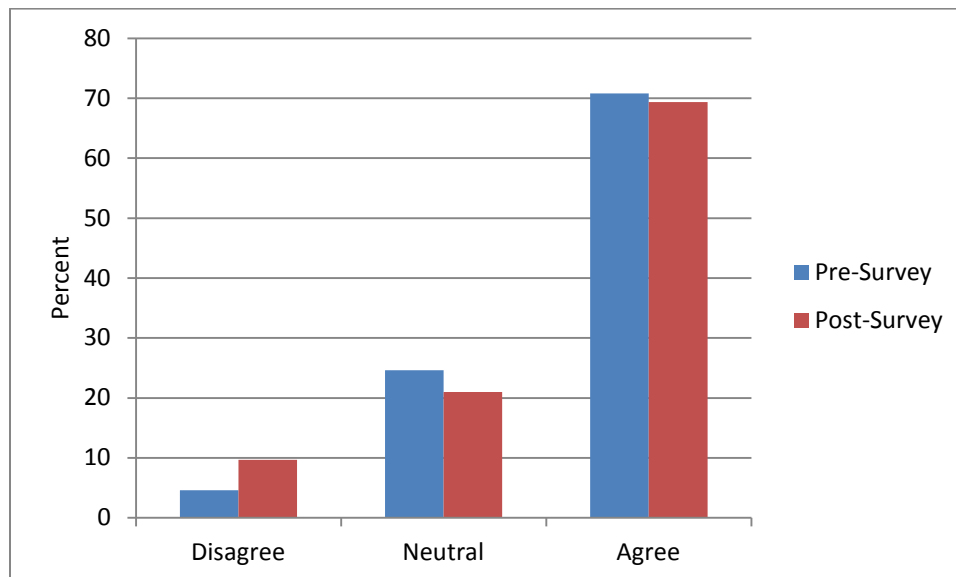


*Figure 8.* Non-treatment results for the survey statement, I like doing group activities such as labs and projects in physics, ( $N=62$ ).

Another survey question asked students to respond to the statement, “Group activities, such as labs and projects, help me learn the material covered in class.” The results show that the treatment group had more students respond to the statement in agreement on the post-survey (82.79%) as compared to their pre-survey(74.17%), see *Figure 9*. While students in the non-treatment group showed agreement statements in the post-survey (69.35%) as compared to their pre-survey (70.77), see *Figure 10*. This showed that the treatment group increased their agreement with the statement upon completion of the unit by 8.62%, while the non-treatment group decreased their agreement by 1.42%. There were 120 students who completed the pre-survey and 122 who completed the post-survey in the treatment group. For the non-treatment group 65 completed the pre-survey and 62 completed the post-survey.



*Figure 9.* Treatment results for the survey statement, group activities, such as labs and projects, help me learn the material covered in class, ( $N=120$ ).



*Figure 10.* Non-treatment results for the survey statement, group activities, such as labs and projects, help me learn the material covered in class, ( $N=62$ ).

During the student interviews students from the treatment group were asked to answer the question, “How is learning in cooperative learning groups different than learning in other ways?” Students from the treatment group all eight responded

positively and included reasoning to suggest that cooperative learning groups are actually more beneficial to learning than learning in other ways. For example, one student said, “cooperative learning is much easier with other brains to work with and tasks are simpler.” In the non-treatment group the students were asked, “How is learning in a group different than learning in other ways?” Three of the four students interviewed responded positively to this question. One student stated, “Learning in a group isn’t successful for me, but doing things alone is how I learn.” From the interviews it does show that the non-treatment group had a less positive attitude toward group work, such as projects and labs, but with the limited number of student responses it is not a significant result.

Overall, the impact on students’ attitudes toward projects and lab activities in physics was inconclusive. The treatment group did show a slightly more positive attitude toward projects and lab activities after being taught using the cooperative learning strategies with an emphasis on teambuilding. The interview question was not directly related to this sub-question so the data taken from the interview was not a good indicator of students’ attitudes. More data would need to be collected to be able to draw specific conclusions.

### INTERPRETATION AND CONCLUSIONS

Through the process of teaching using cooperative learning with an emphasis on teambuilding students seemed to be most impacted in their willingness to work together. The cause of this, as identified by most students, was that they knew each other better. Student interviews and teacher observations seemed to indicate that this was most likely caused by the teambuilding activities. Students in the non-treatment group were often

disappointed that they would not be doing the same teambuilding activities as the treatment classes. It was surprising to see how much the students enjoyed and gained from these activities. This really should not have been a surprise based on what research showed, increasing student interactions results in better attitudes towards classmates (Kagan & Kagan, 2009). This was apparent when the students who were assigned seats in the treatment group stayed where assigned even if it meant working with students they were originally unfamiliar with, while in the non-treatment group students switched from their assigned groups to their own self-assigned group.

Although the treatment group lost instructional time compared to the non-treatment group in order to complete the teambuilding activities, research supports that students increase their academic achievement through the use of cooperative learning (Johnson & Johnson, 1999; Johnson, Johnson, & Taylor, 1993; Köse, et al., 2010; Mesch, et al., 1986; Oickle & Slavin, 1981; Topping et al., 2011). The data collected from the one minute papers was considered statistically significant and it showed that the students in the treatment group had a deeper understanding of the content being taught. With a longer implementation a clearer picture of student achievement would likely be gained.

#### VALUE

Cooperative learning and the use of teambuilding activities are beneficial teaching strategies for students both academically and socially. Although in some areas of the research there was not enough data to answer the questions posed, the potential for benefit is still apparent and students really enjoyed participating in the teambuilding activities as well as the discussions and labs. There was not a lot of additional time required to implement these strategies for the teacher or the students. At the beginning of

the year these strategies will be implemented and anytime students are assigned new groups teambuilding activities will be used.

Through the process of this action research project it was beneficial to have data in support of the teaching strategies used. Without the data it would have been difficult to reflect accurately on the success of cooperative learning and teambuilding. Through this reflection process, the way that the school year will begin as well as the routines and structures used in all group activities will be quite different than it was previously. Instead of waiting until second semester to use cooperative learning structures and teambuilding activities, they will be used all year. Instead of basing teaching methods on personal preferences it seems much more logical to rely on what outside research says but also on data gained from the specific students and context in which the teaching is taking place.

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APPENDICES

APPENDIX A

PRE- AND POST-TEST QUESTIONS

Appendix A  
Pre-and Post-Test Questions

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Multiple Choice

Identify the letter of the choice that best completes the statement or answers the question.

- \_\_\_\_\_ 1. Which portion of the electromagnetic spectrum is used to identify fluorescent minerals?
- a. ultraviolet light
  - b. X rays
  - c. infrared waves
  - d. gamma rays
- \_\_\_\_\_ 2. What is the frequency of infrared light of  $1.0 \times 10^{-4}$  m wavelength?
- a.  $3.0 \times 10^{-13}$  Hz
  - b.  $3.0 \times 10^2$  Hz
  - c.  $3.0 \times 10^4$  Hz
  - d.  $3.0 \times 10^{12}$  Hz
- \_\_\_\_\_ 3. When red light is compared with violet light,
- a. both have the same frequency.
  - b. both have the same wavelength.
  - c. both travel at the same speed.
  - d. red light travels faster than violet light.
- \_\_\_\_\_ 4. The farther light is from a source,
- a. the more spread out light becomes.
  - b. the more condensed light becomes.
  - c. the more bright light becomes.
  - d. the more light is available per unit area.
- \_\_\_\_\_ 5. When incoming rays of light strike a flat mirror at an angle close to the surface of the mirror, the reflected rays are
- a. inclined high above the mirror's surface.
  - b. parallel to the mirror's surface.
  - c. perpendicular to the mirror's surface.
  - d. close to the mirror's surface.
- \_\_\_\_\_ 6. When a straight line is drawn perpendicular to a flat mirror at the point where an incoming ray strikes the mirror's surface, the angles of incidence and reflection are measured from the normal and
- a. the angles of incidence and reflection are equal.
  - b. the angle of incidence is greater than the angle of reflection.
  - c. the angle of incidence is less than the angle of reflection.
  - d. the angle of incidence can be greater than or less than the angle of reflection.
- \_\_\_\_\_ 7. If a light ray strikes a flat mirror at an angle of  $27^\circ$  from the normal, the reflected ray will be
- a.  $27^\circ$  from the mirror's surface.
  - b.  $27^\circ$  from the normal.
  - c.  $90^\circ$  from the mirror's surface.
  - d.  $63^\circ$  from the normal.

- \_\_\_\_\_8. If a light ray strikes a flat mirror at an angle of  $14^\circ$  from the normal, the reflected ray will be
- a.  $14^\circ$  from the mirror's surface.
  - b.  $76^\circ$  from the normal.
  - c.  $90^\circ$  from the mirror's surface.
  - d.  $14^\circ$  from the normal.
- \_\_\_\_\_9. If a light ray strikes a flat mirror at an angle of  $29^\circ$  from the normal, the reflected ray will be
- a.  $29^\circ$  from the normal.
  - b.  $27^\circ$  from the normal.
  - c.  $29^\circ$  from the mirror's surface.
  - d.  $61^\circ$  from the normal.
- \_\_\_\_\_10. The image of an object in a flat mirror is always
- a. larger than the object.
  - b. smaller than the object.
  - c. independent of the size of the object.
  - d. the same size as the object.
- \_\_\_\_\_11. Which of the following best describes the image produced by a flat mirror?
- a. virtual, inverted, and magnification greater than one
  - b. real, inverted, and magnification less than one
  - c. virtual, upright, and magnification equal to one
  - d. real, upright, and magnification equal to one
- \_\_\_\_\_12. What type of mirror is used whenever a magnified image of an object is needed?
- a. flat mirror
  - b. concave mirror
  - c. convex mirror
  - d. two-way mirror
- \_\_\_\_\_13. For a spherical mirror, the focal length is equal to \_\_\_\_\_ the radius of curvature of the mirror.
- a. one-fourth
  - b. one-third
  - c. one-half
  - d. the square of
- \_\_\_\_\_14. A concave mirror with a focal length of 10.0 cm creates a real image 30.0 cm away on its principal axis. How far from the mirror is the corresponding object?
- a. 20 cm
  - b. 15 cm
  - c. 7.5 cm
  - d. 5.0 cm
- \_\_\_\_\_15. A concave mirror forms a real image at 25.0 cm from the mirror surface along the principal axis. If the corresponding object is at a 10.0 cm distance, what is the mirror's focal length?
- a. 1.40 cm
  - b. 7.14 cm
  - c. 12.0 cm
  - d. 17.0 cm
- \_\_\_\_\_16. An object is 29 cm away from a concave mirror's surface along the principal axis. If the mirror's focal length is 9.50 cm, how far away is the corresponding image?
- a. 12 cm
  - c. 29 cm

b. 14 cm

d. 36 cm

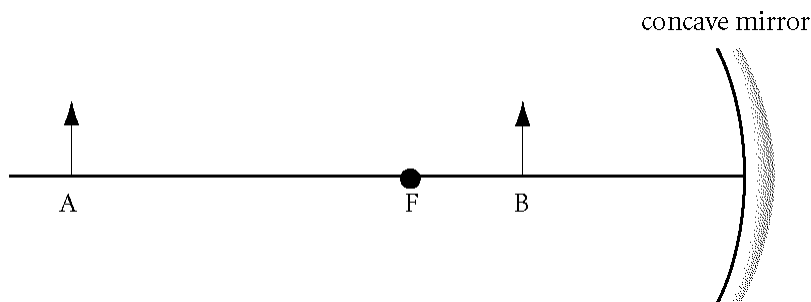
\_\_\_\_\_ 17. A mirror has an object located on its principal axis 40.0 cm from the mirror's surface. A virtual image is formed 15.0 cm behind the mirror. What is the mirror's focal length?

a. -24.0 cm

c. 2.38 cm

b. -10.9 cm

d. 13 cm



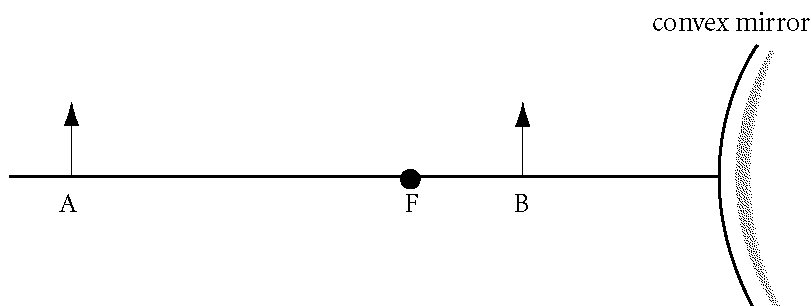
\_\_\_\_\_ 18. In the diagram shown above, the image of object *B* would be

a. virtual, enlarged, and inverted.

c. virtual, reduced, and upright.

b. real, enlarged, and upright.

d. virtual, enlarged, and upright.



\_\_\_\_\_ 19. In the diagram shown above, the image of object *B* would be

a. real, reduced, and upright.

c. virtual, reduced, and upright.

b. real, enlarged, and upright.

d. virtual, enlarged, and upright.

\_\_\_\_\_ 20. Which best describes the image of a concave mirror when the object is located somewhere between the focal point and twice the focal-point distance from the mirror?

a. virtual, upright, and magnification greater than one

b. real, inverted, and magnification less than one

c. virtual, upright, and magnification less than one

d. real, inverted, and magnification greater than one

\_\_\_\_\_ 21. Which best describes the image of a concave mirror when the object is at a distance greater than twice the focal-point distance from the mirror?

a. virtual, upright, and magnification greater than one

b. real, inverted, and magnification less than one

- c. virtual, upright, and magnification less than one
- d. real, inverted, and magnification greater than one

\_\_\_\_\_22. Which best describes the image of a concave mirror when the object's distance from the mirror is less than the focal-point distance?

- a. virtual, upright, and magnification greater than one
- b. real, inverted, and magnification less than one
- c. virtual, upright, and magnification less than one
- d. real, inverted, and magnification greater than one

\_\_\_\_\_23. When red light and green light shine on the same place on a piece of white paper, the spot appears to be

- a. yellow.
- b. brown.
- c. white.
- d. black.

\_\_\_\_\_24. Which of the following is *not* an additive primary color?

- a. yellow
- b. blue
- c. red
- d. green

\_\_\_\_\_25. Which of the following is *not* a primary subtractive color?

- a. yellow
- b. cyan
- c. magenta
- d. blue

\_\_\_\_\_26. Part of a pencil that is placed in a glass of water appears bent in relation to the part of the pencil that extends out of the water. What is this phenomenon called?

- a. interference
- b. refraction
- c. diffraction
- d. reflection

\_\_\_\_\_27. Refraction is the bending of a wave disturbance as it passes at an angle from one \_\_\_\_\_ into another.

- a. glass
- b. medium
- c. area
- d. boundary

\_\_\_\_\_28. Which is an example of refraction?

- a. A parabolic mirror in a headlight focuses light into a beam.
- b. A fish appears closer to the surface of the water than it really is when observed from a riverbank.
- c. In a mirror, when you lift your right arm, the left arm of your image is raised.
- d. Light is bent slightly around corners.

\_\_\_\_\_29. When a light ray moves from air into glass, which has a higher index of refraction, its path is

- a. bent toward the normal.
- b. bent away from the normal.
- c. parallel to the normal.
- d. not bent.

- \_\_\_\_\_30. When a light ray passes from zircon ( $n = 1.923$ ) into fluorite ( $n = 1.434$ ) at an angle of  $60^\circ$ , its path is
- a. bent toward the normal.
  - b. bent away from the normal.
  - c. parallel to the normal.
  - d. not bent.
- \_\_\_\_\_31. What type of image does a converging lens produce?
- a. real
  - b. virtual
  - c. real or virtual
  - d. none of the above
- \_\_\_\_\_32. In what direction does a focal ray from an object proceed after passing through a converging lens?
- a. The ray passes through the focal point,  $F$ .
  - b. The ray passes through the center of the lens.
  - c. The ray exits the lens parallel to the principal axis.
  - d. The ray intersects with the center of curvature,  $C$ .
- \_\_\_\_\_33. In what direction does a focal ray from an object proceed after passing through a diverging lens?
- a. The ray passes through the focal point,  $F$ .
  - b. The ray passes through the center of the lens.
  - c. The ray exits the lens parallel to the principal axis.
  - d. The ray intersects with the center of curvature,  $C$ .
- \_\_\_\_\_34. The focal length for a converging lens is
- a. always positive.
  - b. always negative.
  - c. dependent on the location of the object.
  - d. dependent on the location of the image.
- \_\_\_\_\_35. A virtual image has a \_\_\_\_\_ image distance ( $q$ ) and is located in \_\_\_\_\_ of the lens.
- a. positive, front
  - b. positive, back
  - c. negative, front
  - d. negative, back
- \_\_\_\_\_36. The focal length for a diverging lens is
- a. always positive.
  - b. always negative.
  - c. dependent on the location of the object.
  - d. dependent on the location of the image.

APPENDIX B  
STUDENT SURVEY

## Appendix B Student Survey

Your participation or non-participation in this survey will have no impact on your grade. Please answer questions honestly. Your class period number must be included, but you will remain anonymous.

Class Period: \_\_\_\_\_

1. I would rather learn science through group activities than alone.

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

2. I like doing group activities such as labs and projects in physics.

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

3. Rate your comfort level of communicating with your classmates.

1	2	3	4	5
Not comfortable	Somewhat uncomfortable	Neutral	Somewhat comfortable	Comfortable

4. Group activities, such as labs and projects, help me learn the material covered in class.

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

5. Group activities help me to work with others to find answers.

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

6. I like working in a group when each person in the group has their own job to do.

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

7. I like working in a group when each person is given their own grade based on individual effort.

1	2	3	4	5
Strongly	Somewhat	Neutral	Somewhat	Strongly

disagree

disagree

agree

agree

8. It is common for some of my group members to not do enough work.

1  
Strongly  
disagree

2  
Somewhat  
disagree

3  
Neutral

4  
Somewhat  
agree

5  
Strongly  
agree

9. I get frustrated when some of my group members do not do enough work.

1  
Strongly  
disagree

2  
Somewhat  
disagree

3  
Neutral

4  
Somewhat  
agree

5  
Strongly  
agree

APPENDIX C  
TEACHER OBSERVATION JOURNAL CHECKLIST



APPENDIX D  
STUDENT QUESTIONNAIRE

Appendix D  
Student Questionnaire: Group Work Evaluations

This questionnaire is adapted from the sample on page 350 of Classroom Assessment Techniques: A handbook for college teachers by Angelo and Cross (1993).

Your participation or non-participation in this questionnaire will have no impact on your grade. Please answer questions honestly. Your class period number must be included, but you will remain anonymous.

Class Period: \_\_\_\_\_

1. Overall, how effectively did your group work together?

1	2	3	4	5
Poorly	Adequately	Somewhat well	Well	Extremely well

2. Out of your group members, how many participated actively most of the time?

All of them    All but one    All but two    All but three    All but four    All but five

3. Give one example of something you learned while working in your group that you might not have learned if you were working alone.

4. Give one example of something your group members probably learned from you that they might not have learned if they were working alone.

5. Suggest a change that the group could make to improve its performance.

APPENDIX E  
STUDENT INTERVIEW QUESTIONS

Appendix E  
Student Interview Questions

Students from both treatment and non-treatment groups will be interviewed. Students will be told that their participation or non-participation in the interview will have no impact on their grade and to please answer honestly. Any interview data that is shared beyond me personally will be coded and student names or identifying information will not be included in the data.

1. (Both) How do you prefer to learn science, working in a group or alone?

2a. (Treatment) How did working in a cooperative learning group over the last unit affect your learning?

b. (Non-treatment) How did working in a group over the last unit affect your learning?

3. (Treatment) How is learning in cooperative learning groups different than learning in other ways?

b. (Non-treatment) How is learning in a group different than learning in other ways?

4. (Treatment) Would you prefer working in a cooperative learning group or an unstructured group?

Why?

5a. (Treatment) How could I make cooperative learning work better?

b. (Non-treatment) How could I make group work better?

6. (Both) Do you feel more comfortable working with the classmates in your group now than you did at the beginning of the unit?

Why?

7. (Both) Are you more likely to choose to work with someone from your group now than you would have been before this unit?

Why?