TEACHER ASSIGNED LAB GROUPS:

HOW SPECIALIZED GROUPINGS AFFECT AN AP CHEMISTRY STUDENT'S SOCIAL CONFIDENCE AND COMMUNICATION HABITS

by

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TABLE OF CONTENTS

LIST OF TABLES

Figure Page

LIST OF FIGURES

Figure Page

.

ABSTRACT

Expecting students to work cooperatively in laboratory groups has become a challenging task for teachers as students continue to grow to be more socially isolated from one another. This research study sought to determine whether assigning students to specific laboratory groups in an AP Chemistry class and giving them specific roles to perform would affect their social confidence and their communication habits. Students were assigned one of three roles: facilitator, reflector, or presenter, while being assigned to randomized lab groups. Throughout the study, students completed post-lab analyses that asked them to reflect on their ability to perform in the lab. These post-lab analyses were compared to a pre- and post- survey to assess how students' social confidence and communication habits had changed after being assigned a specific laboratory role in an assigned laboratory group. The results of this study showed that students social confidence increased when they were assigned to a group of their peers. The research study showed that after treatment had been applied, 100% of participating students had confidence in contributing effectively to any group assignment that pertained to AP Chemistry.

CHAPTER ONE

BACKGROUND

Context of the Study

Manchester High School Central is the oldest public school in the state of New Hampshire. The school consists of four buildings sprawling across one full city block. One of the original buildings of the high school, the Classical Building, constructed in the late 1890s, is still used as classrooms to this day. The charm of Manchester High School Central does not stop in its historical appeal but also extends to its cultural appeal, as it services students from 60 different countries daily. The majority of students (54.4%) identify as a minority demographic (US News & World Report, 2022). At any given time throughout the day, 30 different languages are spoken between students and staff members. At its peak, Manchester High School Central held upwards of 2500 students but enrollment has dropped to 1200 students as surrounding towns withdrew their students from Manchester Public Schools in favor of schools not located in urban environments. This is my seventh year teaching high school chemistry, and my second year at Manchester High School Central. My first five years were spent teaching at a wealthy public school in southern New Hampshire where the student population was approximately 90% white (US News & World Report, 2022).

In the middle of my third-year teaching chemistry, the COVID-19 pandemic broke out and schools were sent scrambling to figure out how to pick up the pieces of teaching remotely. Three full years later, students are back in their classrooms, but their abilities are far behind where they should be academically. As a teacher, I do not see it feasible to try to address all the disadvantages and inconsistencies students have become accustomed to as they completed

crucial formative years of their adolescence in practical isolation. However, one tangible portion of my students' educational experience that could use additional support is their ability to work and communicate successfully in groups. I notice that my students often heavily rely on one person to complete a problem set and then copy what that one person has produced with little to no conversation about the problem at hand. Post-lab questions and homework assignments veer towards who has the answers and not who can explain why they got the answers. I recognize that I teach high school students and that this mentality has existed since the creation of homework, however, especially for my college bound students, I want to give them a basis of how to be a successful student in a group environment.

This capstone study was designed to observe how students' communication habits and social tendencies were connected to working in assigned lab groups. There has been a noticeable decline in students working cooperatively with one another since the return to school from months of remote learning. In Chemistry, students are expected to work cooperatively with a lab partner or a lab group to complete laboratory assignments. When students are not assigned a partner, they frequently work with the same one or two people throughout the year and do not practice working with other students. Students choose comfort by working with their friends instead of the discomfort of working with other students. By choosing partners that are comfortable, students tend to become complacent in their work, and codependent relationships can be formed. When completing the post-lab questions, poor-performing students rely on their well-performing friends to carry them through the analysis. This can create tension and an unwillingness to want to work with that partner in the future. The other unintended consequence of giving students the ability to choose their own lab partner is the social awkwardness when someone does not have a friend in class, or they do not know who to work with. There has been a

shift in students requiring that they work by themselves instead of working in a group. Since the 2020-2021 school year, it is much more likely that when students do not have a group to work in, they will all elect to work by themselves rather than form a group of remaining individuals.

In chemistry, working with a lab partner is inevitable and vital. Laboratory experiments performed by high school chemistry students require more than two hands and one brain. Chemistry is one of the first classes offered at the high school level where students are expected to collaborate efficiently to accomplish academic work. The relationships that are built between students as they learn a new subject are messy, confusing, and fascinating. If students are given the proper tools to build these relationships as they explore chemistry, I believe that they can learn not only the content of the class, but also foundational social-emotional skills that they can access for the rest of their lives.

There are four chemistry courses offered at Central. Three of the chemistry courses are considered introductory courses (Honors Chemistry, Chemistry, and Applied Chemistry). The final chemistry course offered is Advanced Placement (AP) Chemistry, a college level course that students can only enroll in after the successful completion of an introductory chemistry course. I currently teach both AP Chemistry and Applied Chemistry and will be working with my AP Chemistry course for this capstone study.

Focus Statement

The focus statement of my capstone study was to assess how assigning students to certain lab groups, while giving each student a designated role, affects their social confidence and communication habits.

CHAPTER TWO

CONCEPTUAL FRAMEWORK

Creating Student Groupings

Intentional group work in classrooms occurs when students are assigned to lab groups and expected to take ownership and control of their learning (Blatchford, 2004). When implemented correctly, student group work can create positive classroom dynamics and give students a sense of empowerment (Sullivan & King, 1999). Science classes, more than any other content course, utilize group work to conserve resources such as chemicals, glassware, and instruments (Baines et al., 2003; Howe, 2014). Students working in groups and discussing different views on the phenomena being studied make greater academic progress than if they could not hold such discussions (Howe, 2014).

Cooperative learning in group work needs certain elements to be successful. First, there needs to be two distinct roles: the individual and the group. Group work requires accountability, and it needs to be representative of the students placed in the group. Accountability in cooperative learning is motivated by group-based rewards that are dependent on individual performance. When groups are rewarded on the principle of individual student improvement, students are more inclined to help their group mates understand the learning objectives. Positive interdependence, an occurrence created when students recognize that every member of the group is responsible for the success of the group, maximizes the learning done between all group members (Johnson & Johnson, 1994; Slavin, 1999)

The second element that needs to be present in cooperative learning is permanence. Students need to create trust, rapport, and confidence in their group mates (Johnson & Johnson,

2018). In an academic setting, giving students time and space without the pressure of grades allows students to build rapport and trust naturally (Poort et al., 2020). The issue with permanence is how to create student groups. Should students be allowed to choose their partners, or should the teacher assign partners? Student-selected groups are often biased towards convenience whereas teacher-selected groups focus on fostering student growth. Students should be given the opportunity to experience both types of groupings so they can form opinions about how they work best (Mitchell et al., 2004).

The creation of student groups needs to be equitable. Assigning students of the same ability often leads to predictable, streamlined outcomes. Placing high achieving students in the same group leads to a high achieving group. Placing low achieving students in the same group leads to low achieving groups. Allowing students to create their own group allows students to create their own streamlined groups (Gibbs, 2009). Group size, task, and student friendliness all play a role in students' abilities to work together (Kerr & Bruun, 1983; Mamas, 2016). Students who are allowed to choose their groups are less engaged in the group work than students who are assigned to a group (Poort et al., 2020). There is an assumption that students know how to work productively in group work. However, unless explicitly told how to work together, students often complete group work and collaborative learning in ways they think best (Summers & Volet, 2010). Creating an equitable group typically means grouping students heterogeneously. One style of heterogeneous grouping focuses on creating constructive conflict, specifically in multicultural groups. Groups that are created to produce constructive conflict will be better than groups that lack constructive conflict (Kirchmeyer & Cohen, 1992).

After student groups have been established, students need to understand their expectations and their objectives for the group work (Burke, 2011). Students should understand

what the teacher is expecting from them academically and as a group member. Assigning roles to students in their groups gives purpose to each member of the group (Burke, 2011). There are four possible roles that students can take on during group work: the facilitator, the recorder, the reflector, and the presenter. The facilitator is responsible for managing their group and encouraging all members of the group to participate. The recorder acts as the notetaker for the group. The reflector interjects their group with questions and comments from observations about how the group is approaching the academic objective and relating it to their understanding of the concept at hand. The presenter acts as the spokesperson for the group and shares the group's progress with the class (The POGIL Project, 2023).

Group Work Motivation

A 2013 study published by the American Behavioral Scientist showed that students with more social capital in cross-class networks have significantly greater academic performance. The study showed that students who take classes with the same group of students tend to do better academically than students who do not. This suggests that students' social interactions with their peers paired with the number of classes they take with the same group of students impacts their academic performance in a course (Gasevic et al., 2013). Student perceptions of group work greatly influence their behavior and engagement in group work. A student who sees group work as a positive learning method will greatly contribute whereas a student who does not see the value in group work contributes little (Summers & Volet, 2010). It is evident that students prefer to work with their friends during group work rather than people whom they do not identify as friends. This becomes increasingly true as students continue to be in the same classes as their peers for years at a time. The more students work with one another, the more students become comfortable sharing their ideas and learning from one another. However, group work also

presents the challenges of having an unfair balance between group members (Mamas, 2016). Additional challenges are presented when student groups represent more than one culture. The challenges presented can be both positive and negative. Heterogeneous, culturally diverse groups, that are teacher-selected promote cognitive student engagement, leading to positive challenges subsequently leading to greater critical thinking and listening skills. Negative interactions within the group, however, can result in challenges which cause students to disengage and withdraw from the group. (Poort et al., 2020).

Student Communication

Small group communication occurs when people who share a common purpose and belong to the same group exert influence on one another. Communication is transactional and behavioral. When communication occurs, the person sending a message is receiving one at the same time. This is a result of body language and nonverbal messages from the person they are communicating with (Beebe & Masterson, 2016). Students bring their own beliefs and value to conversations and therefore can project their feelings into conversations (Wigfield & Eccles, 1992, as cited in Cline, 2021). During collaborative learning, students who participate the most and students who provide the most meaningful comments are high achieving students (Summers & Volet, 2010). These high achieving students are motivated and willing to engage deeper with their groups than students who are unmotivated (Poort et al., 2020).

CHAPTER THREE

METHODOLOGY

Treatment

Manchester High School Central (Central) is the second largest high school in Manchester, New Hampshire. The school population is 1,305 students, where 58.1% of the students identify as a minority and 41.9% of students identify as White. Minority groups represented at Central are Hispanic (26.7%), Black (16.5%), Two or More Races (11.4%), Asian (3.1%), and American Indian (0.3%) (US News & World Report, 2022). Thirty-seven percent of students come from households that fall below the national poverty line. There are 18 Advanced Placement (AP) Level Courses offered to Central students, one of them being AP Chemistry. AP Chemistry is a rigorous and expansive course aimed toward senior students who have already completed one year of introductory chemistry.

Since AP Chemistry is considered a second-year chemistry course, students enrolled in this course are typically college bound students highly interested in pursuing a science or medical college degree. In the 2023-2024 school year, there are 11 students enrolled in AP Chemistry. Of these students, three are juniors (27%) and eight are seniors (73%), five are male (45%) and six are female (54%). The course is representative of the school demographics since five students belong to a minority group and six students identify as white.

To test my focus statement, I began the AP Chemistry school year explaining to my students that they would always be assigned laboratory partners. Each unit, students would be randomly assigned a new lab partner. To communicate lab partner assignment to students, I designed a data table on my chalkboard with the lab bench number. This data was on the chalk

board on the first day of school. I wrote student names on popsicle sticks and placed magnets on the back of the popsicle sticks (Figure 1). At the beginning of each unit, students would check the chalkboard data table to see who their partners were for the unit. Since there was an odd number of students in the class, four lab groups were utilized: three lab groups had three student members and one lab group had two student members. In December, the letters F, R, and P were added to the chalk board to show the roles students were assigned. The letters designated the roles as facilitator, reflector, or presenter.

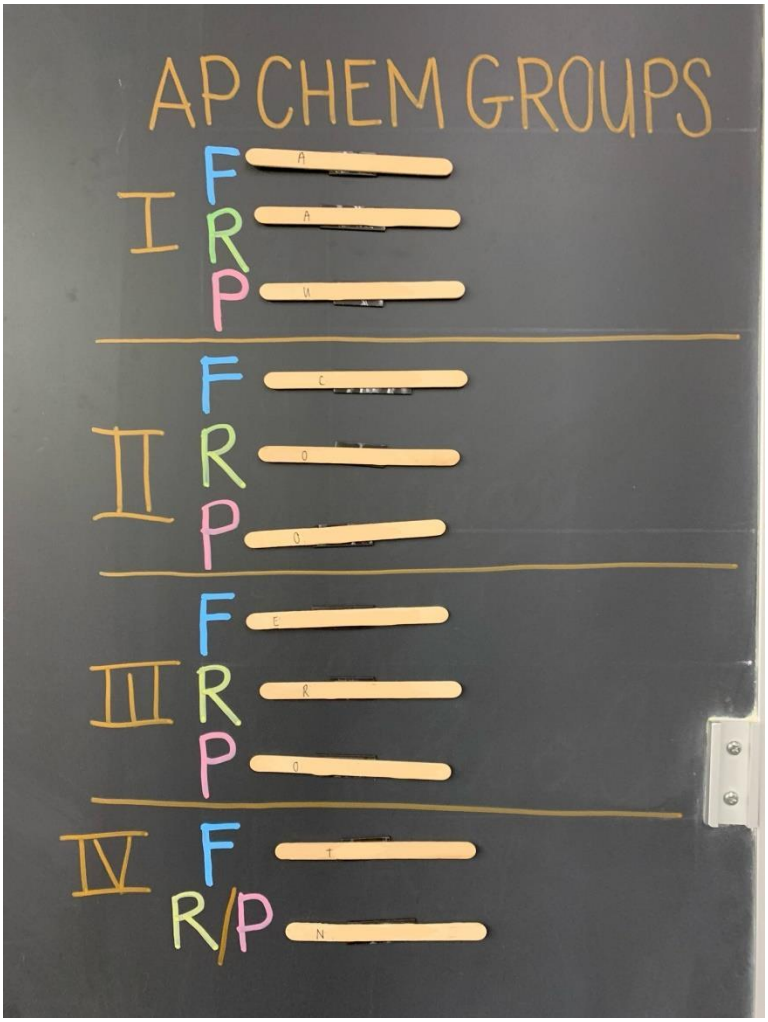

Figure 1. AP Chemistry lab group table

My study began in December 2023 and ended in March 2024. The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for work with human subjects was maintained (Appendix A). During this study, I continued to assign students to lab groups using the chalkboard data table, but I assigned each student a role in their lab group. Students were given one of three roles: the facilitator, the reflector, or the presenter. The student assigned to be the facilitator was the leader of their lab group. The facilitator was responsible for keeping the group on task and making sure their group worked effectively throughout class. The reflector was responsible for summarizing and verbally reflecting while completing the lab. The student who was assigned presenter was the lab group's spokesperson who oversaw asking for clarification or guidance from me or other lab groups. The presenter shared data with the class and within the group. Lab groups that consisted of two students instead of three had the role of presenter and reflector combined. Every student held each role at least once. It is important to remind the reader that students in AP Chemistry have always been assigned a lab partner since the beginning of the school year, however, students had not specifically been instructed to work with just those people. Before the study began, students were assigned specific lab partners but often elected to complete post-lab questions either independently or with people from different groups. Throughout the study, students were reminded that they should be completing their post-lab questions with their lab group specifically. The AP Chemistry students completed four labs throughout this study: two thermochemistry labs (Enthalpy of a Chemical Reaction and Design a Handwarmer), one kinetics lab (Kinetics of Crystal Violet Fading), and one equilibrium lab (Determination of K_{eq}).

Data Collection and Analysis Strategies

This study looked at two unique characteristics that occur when students work in a group: social confidence and communication habits. To begin the experiment, a baseline of students' social confidence and communication habits was measured using a 25-question four-point Likert survey, the Chemistry Group Work Aptitude Test. The four-point Likert scale was divided into strongly disagree, disagree, agree, or strongly agree. For most of the data analysis, the strongly disagree and disagree categories and agree and strongly agree categories were combined. This survey asked questions about students' interest in chemistry, their ability to learn chemistry while working in a group, and their communication skills and habits. The Chemistry Group Work Aptitude Test was given as a pre-survey and a post-survey and was analyzed using descriptive statistics and the Wilcoxon Signed Rank Test to test for significance (Appendix B).

To allow students to give more reflective feedback, they were given the Group Work Background Questions, which was a pre-study reflection that had them explain their feelings towards group work. The Group Work Background Questions asked students to explain what makes a group effective, how their social confidence plays a role in their ability to work with others, and how group dynamics play a role in their enjoyment of learning chemistry. It also gave them an opportunity to comment on their communication skills and habits before the study began. These questions were analyzed using emergent thematic analysis. The reflective nature of the Group Work Background Questions was intended to serve as qualitative information for the Chemistry Group Work Aptitude Test (Appendix C).

Throughout the study, students turned in a post-lab survey that asked them to reflect on their social confidence and communication throughout the lab. The post-lab survey had seven questions, the first six questions asked Likert style questions that asked about their confidence, comfort, and understanding of the lab while working within their group. Question one asked

students to rank their comfort while working with their group from not comfortable at all to comfortable. Question two asked students to rank their confidence in performing their role in their lab group from not confident at all to confident. Question three asked students to rank how well they understood the experiment because they worked with their assigned lab partner(s). Question four asked students to reflect on how successful they would have been if they had worked on the experiment independently. Question five asked students how many times they asked their lab partners questions during the lab. Question six asked students how many times they asked people outside their lab group questions during the lab. The last question asked if they had any muddiest points. The muddiest point is a part of the lesson or activity that the students were unsure about. By giving students an option to answer this question, they provided formative feedback to the teacher to make sure they received additional support before their graded summative assessment. The post-lab survey was stapled on the left side of their laboratory notebook before they started the lab to have students be mindful of the questions they would be asked and remind them to complete the survey before they turned in their notebook. The post-lab survey was analyzed using emerging themes and mean comparisons (Appendix D).

At the completion of the study, students were readministered the Chemistry Group Work Aptitude Test to see if their responses had changed. They were also administered a post-study reflection survey, the Chemistry Lab Partner Analysis, which contained ten reflective questions about their experiences while working in assigned lab groups. The ten questions were pointed and asked specifically about how their social confidence and their communication habits changed while working in these groups. The questions also asked what the benefits and detriments of working with assigned partners were versus the benefits and detriments of working with a partner of their choice. The Chemistry Lab Partner Analysis was compared using

emergent thematic analysis and anecdotal observations to provide commentary for the Chemistry Group Work Aptitude Test (Appendix E).

A data triangulation matrix was created to ensure that each instrument addressed both parts of the focus statement (Table 1). Upon creation of the instruments, each instrument was qualitatively coded to ensure that the questions asked pertained to either students' social confidence or communication habits. Questions included in instruments that did not pertain to social confidence or communication habits were rewritten or removed. Each instrument was found to answer both parts of the research statement.

Table 1. Data triangulation matrix.

Research Statements	Data Source 1	Data Source 2	Data Source 3	Data Source 4
Assigning students to specific lab groups affects their social confidence	Chemistry Group Work Aptitude Assessment	Group Work Background Questions	Post-Lab Survey	Chemistry Lab Partner Analysis
Assigning students to specific lab groups affects their communication habits	Chemistry Group Work Aptitude Assessment	Group Work Background Questions	Post-Lab Survey	Chemistry Lab Partner Analysis

CHAPTER FOUR

DATA ANALYSIS

Results

The results of the Chemistry Group Work Aptitude Test pre- and post-treatment shows that students have increased their social confidence after working in teacher assigned lab groups with certain roles. Before the research study, 77% of students indicated that they felt confident in their ability to effectively contribute to a group discussion relating to chemistry while after the research study, 100% of students indicated that they felt comfortable *(N*=10) (Figure 2). The results of the Wilcoxon Signed Rank Test showed no statistical significance for this result (p=0.080). Although all students indicated that they were confident in their ability to effectively contribute to group discussions, many students noted that some assigned laboratory groups worked better than others. In groups students felt comfortable in, they were able to freely share their opinions whereas they had reservations when they were not as comfortable in a lab group. Students' perception of their comfort working with their peers did not change greatly throughout the research study. Initially, 78% of students indicated they felt comfortable working with their peers (*N*=9) while after the study the percentage increased to 80% (*N*=10).

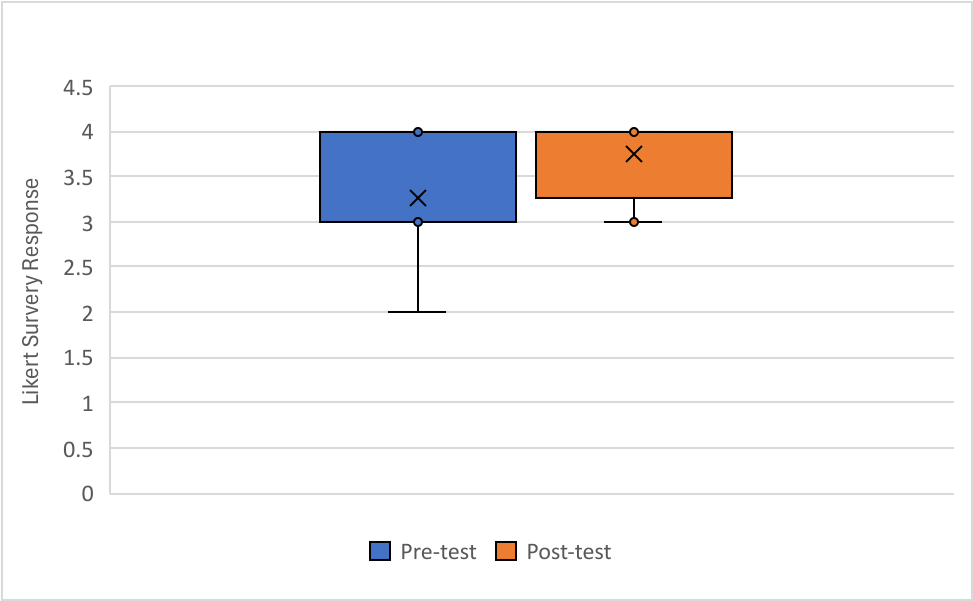

Figure 2. Student confidence in effectively contributing to any group chemistry discussion (N=10).

Social confidence increased when students worked with people they did not know well. Question 13 of the Chemistry Group Work Aptitude test asked students to gauge how confident they felt sharing ideas about chemistry when paired with people who they do not know well. Initially, 67% of students indicated they were confident, however, the post-survey results indicated that 80% of students felt comfortable (Figure 3). Students also changed their perception of what makes a chemistry group highly effective. In the Group Work Background survey, given before the study, AP Chemistry students wrote that a highly effective group was made up of equal work, good teamwork, and familiarity amongst partners. Only one student mentioned that it was important to have good communication skills (n=7). In the Lab Partner Analysis survey, given after the reach study was completed, five students explicitly mentioned that communication skills were one of the most important parts of having a highly effective chemistry group (*N*=10). Two students wrote that having peers that do not get distracted by other groups is important to having a highly effective chemistry group. One student wrote that a highly

effective chemistry group was made up of people who have equal levels of understanding and who can distribute work evenly between one another. A different student, who indicated that communication was the most important aspect of having a highly effective chemistry group, also wrote that it was important to cooperate so that no one in the group was left out.

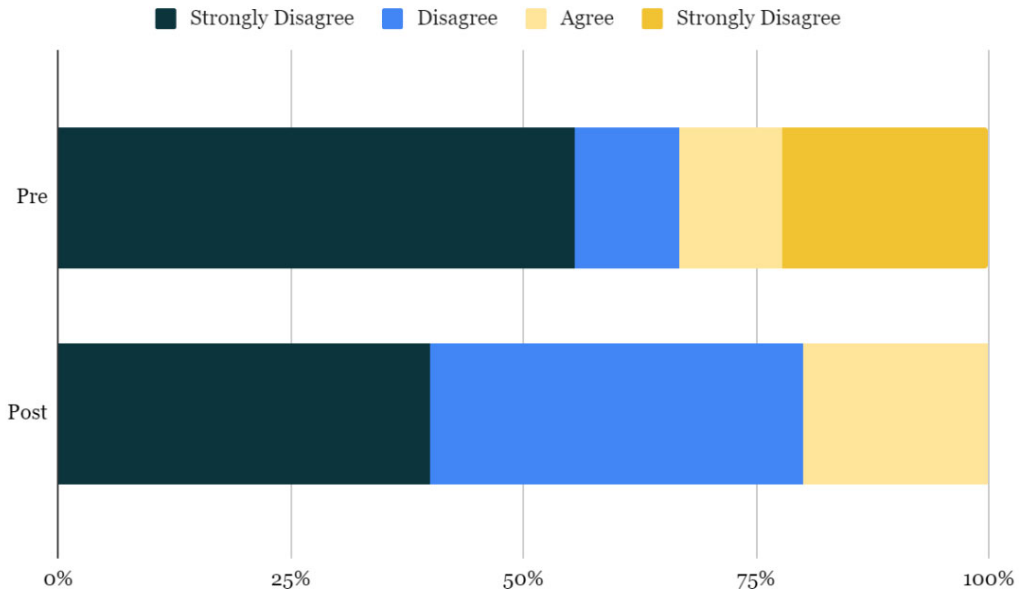

Figure 3. Student results of no confidence in sharing ideas about chemistry when paired with unfamiliar peers (*N*=10).

Throughout the research study, social confidence of students was measured using the Post-Lab Survey. Question one of the survey asked students how confident they were in their ability to perform their role. Throughout the research study, each student was assigned every role at least once. The non-treatment portion of the study was during unit six, Thermochemistry, when students were completing the Enthalpy of a Reaction Lab. No student held the role of facilitator, reflector, or presenter. The results of the Enthalpy of a Reaction lab indicated that 56% of students felt confident performing their role in the lab. Since students were not assigned a role, this role was defined by each student differently. Thirty-three percent of students indicated that

they were kinda confident performing their role, and 11% of students indicated that they were not very confident performing their role (*N*=9). The second lab in the thermochemistry unit was to design a handwarmer and was the first lab with assigned roles. Forty-three percent of students felt confident in their role and 43% felt kinda confident (n=7). The results of the third lab of the research study, Kinetics of Crystal Violet (CV) Fading, 43% of students felt confident, 43% of students felt kinda confident, and 14% of students felt not very confident (n=7). The results of the last lab, Determination of Keq, indicated that 43% of students felt confident, 29% of students felt kinda confident, and 29% of students did not feel very confident (n=7) (Figure 4).

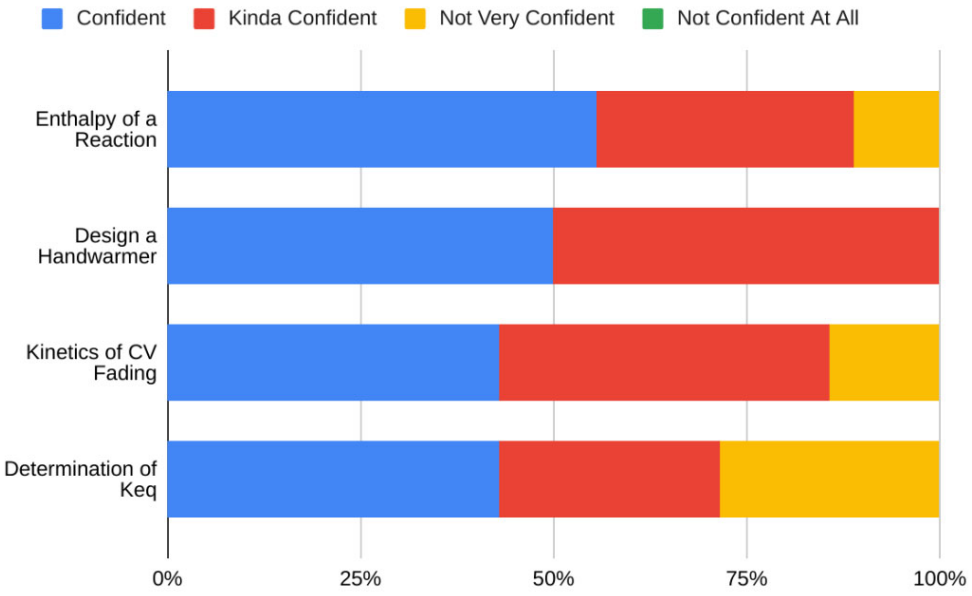

Figure 4. Students' ability to perform their assigned role during the laboratory experiment (N=9).

Throughout the research study, no student offered a written explanation as to why they scored their social confidence the way they did during the Post-Lab Survey. However, throughout the research study, students commented to their group members about their roles. Students in the facilitator role would mention they had a question, but they needed their presenter to ask it because it was not their turn to ask questions. The facilitator role was where students had

the lowest average confidence. On a Likert scale of one to four, students in the facilitator role averaged a 3.14 confidence, which indicates that they were barely more than kinda confident in performing their role (n=8). The role of presenter had the greatest average confidence of 3.40 on the four-point scale (n=5), and the role of reflector has an average confidence of 3.29 on the four-point scale (n=7).

The results of the Chemistry Group Work Aptitude Test pre- and post- treatment show that students have changed the way they communicate after working in teacher assigned lab groups with certain roles. Question 5, 6, 7, 10, 14, 17, and 25 of the Group Work Aptitude Test directly asked students to gauge their communication habits. Question 5 asked students to indicate if they preferred working in a group to tackle challenging chemistry questions. Initially, 55% of students agreed with this statement, but after the research study, 70% agreed with the statement. These do not match the results provided in the Group Work Background Survey and Lab Partner Analysis. Before the research study began, the Group Work Aptitude test was given on one day and then the following day the Group Work Background Survey was administered. In March, after the research study was completed, the Group Work Aptitude Test was readministered and the next day the Lab Partner Analysis survey was administered. The Group Work Background survey indicated that 30% of students would prefer to be in groups when tackling challenging chemistry problems. In the Lab Partner Analysis, 60% of students indicated that they would prefer to work in a group when tackling challenging chemistry problems.

The remaining results of the Chemistry Group Work Aptitude test did not have any mismatches from the qualitative data. Question 6 asked students to decide if developing communication skills was just as important as developing chemistry knowledge. Initially, 66% of students agreed with the statement, but after the research study, 80% of students agreed.

Question 7 had students rank their preference on completing experiments rather than reading about experiments. Before the research study, 66% of students indicated that they would prefer to do experiments, but after the research study, 80% of students indicated that they would prefer to do experiments. Question 10 asked if students would rather agree with other people than find an answer on their own. Before the research study, 89% of students disagreed with the statement, but after the research study, 100% of students disagreed. Question 14 asked if students found it hard to admit they had problems with their communication skills. Before the study, 11% of students strongly disagreed, 67% disagreed, and 22% agreed, whereas after the study, 40% of students strongly disagreed, 40% disagreed, and 20% agreed. Question 17 asked students if they thought asking the teacher for an answer was better than asking their group members. Initially, 56% of students disagreed, but after the research study, the answers were split 50% disagreed and 50% agreed. Question 25 asked students if they were less likely to contribute information to their group when one of its members disagreed with them. Initially, 66% of students disagreed, but after the research study, 70% of students agreed.

Before the research study began, every student that took the Group Work Background survey indicated that they were a good, or good enough, communicator (n=7). They attributed their communication skills to being able to get their point across or share their ideas and opinions with their groups. The results of the Lab Partner Analysis indicated that 30% of students did not change their communication habits from the beginning of the study, 10% of students had a decrease in their communication habits, and 60% had an overall increase in their communication habits (*N*=10). Students who wrote that their communication habits did not change wrote that they already felt they had strong communication habits or that they did not feel it necessary to change how they communicated in groups. The student who wrote that their communication

habits decreased explained that it was because they were not being listened to when they were speaking. The 60% of students who wrote that their communication habits changed for the better explained that it was because they had different roles to perform in the lab, or because they had more questions to ask their peers to gain clarification about the lab. One student noted that they were more comfortable sharing their incomplete thoughts on the material because they thought it would contribute to the group.

The results of question 1 from the Post-Lab Survey showed that students felt more comfortable sharing their ideas throughout the research study. In the non-treatment laboratory experiment, Enthalpy of a Reaction, 67% of students indicated they were comfortable sharing their ideas, 22% of students indicated they were kinda comfortable, and 11% of students were not really comfortable sharing their ideas during the lab (*N*=9). After the first treatment lab, Design a Handwarmer, 57% of students indicated that they were comfortable sharing ideas and 29% of students indicated that they were kinda comfortable (n=7). After the Kinetics of Crystal Violet lab, 57% of students indicated that they were comfortable, 29% of students indicated that they were kinda comfortable, and 14% of students indicated that they were not really comfortable sharing their ideas (n=7). After the last lab, Determination of Keq, 71% of students felt comfortable sharing their ideas and 29% of students felt kinda comfortable sharing their ideas (n=7) (Figure 5).

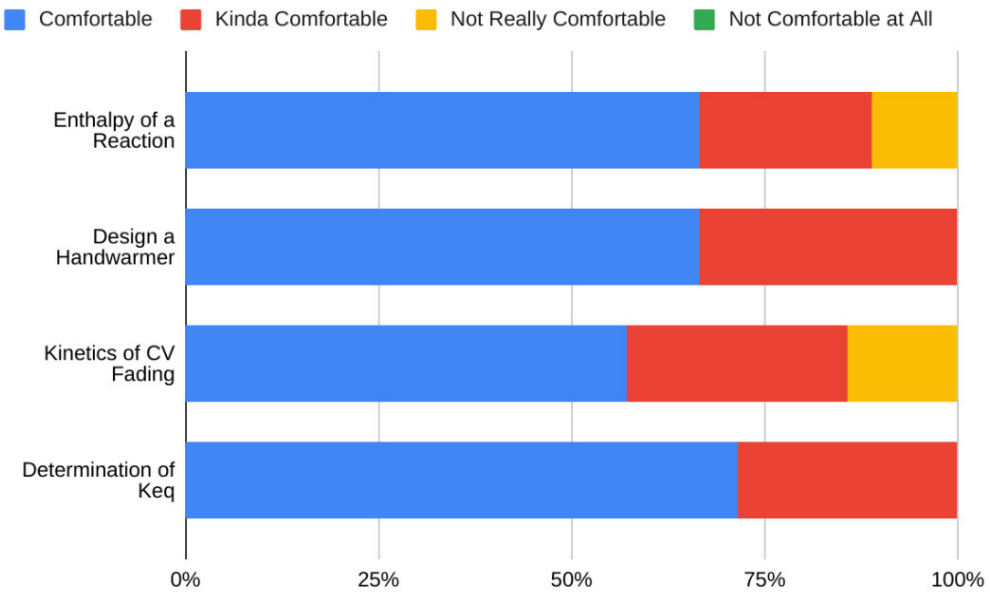

Figure 5. Results of how comfortable students felt sharing their ideas during the experiment (N=9).

Questions six and seven of the Post-Lab Survey asked students to rank the number of times they asked questions during the experiment. Question six asked how many times students asked questions to their group and question seven asked how many times students asked questions to people outside their group, including me. The classification of a question was never decided as a class, but the general consensus was that questions regarding where materials could be found were not considered recordable questions. The results of question six show that students asked the most questions to their groups during Enthalpy of a Reaction and the fewest number of questions to their group during Determination of Keq (Figure 6).

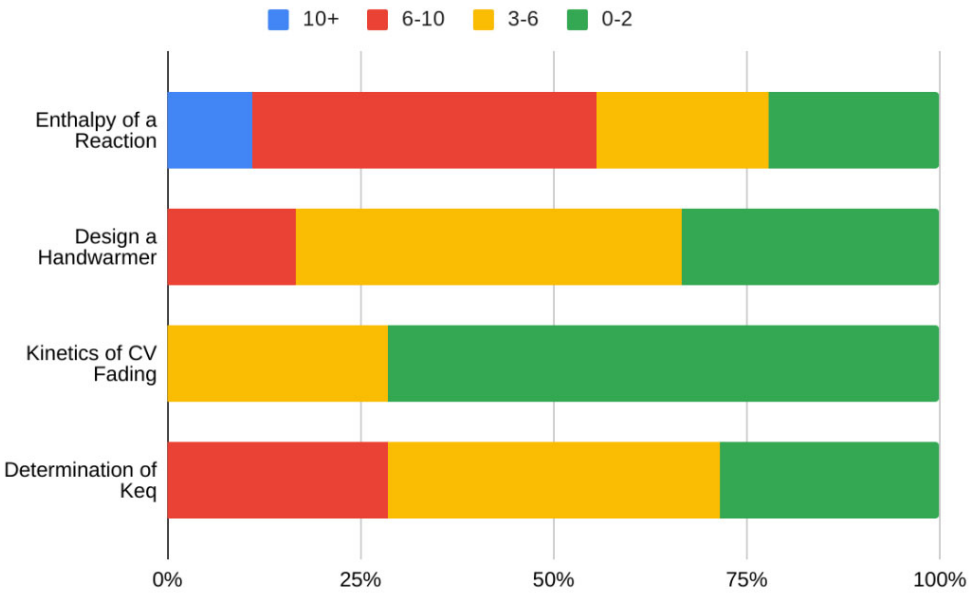

Figure 6. Number of times students asked their group questions while completing a lab (N=9).

The results of question seven show that students asked the most questions to people outside of their group during the Design a Handwarmer lab and Kinetics of Crystal Violet Fading lab and the least number of questions to people outside of their lab group during the Determination of Keq lab (Figure 7).

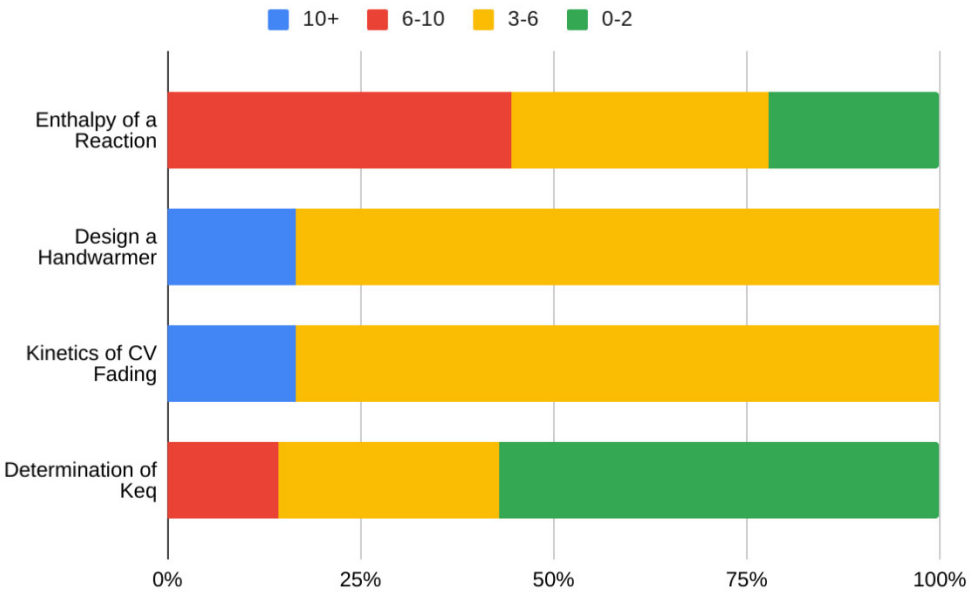

Figure 7. Number of times students asked questions to people outside their group during a lab (*N*=9).

AP Chemistry students found value in working in groups with assigned lab partners. In the Lab Partner Analysis, students wrote that their perception of assigned lab partners allowed them to work with new people during each lab and that each new person brought new problem-solving perspectives to the table. Two students (20%) indicated that working with assigned lab partners allowed them to delegate tasks, allowing them to work more effectively in the lab. One student wrote that it gave them room to try problems on their own and then regroup with their partner when they got stuck. Four AP Chemistry students (40%) noted that working with assigned lab partners meant that they got to work with people outside their social circle which gave them the opportunity to develop opinions for themselves about what kinds of students they work well with and what kinds of students they do not.

CHAPTER FIVE

CLAIM, EVIDENCE, AND REASONING

Claims From the Study

It is beneficial to assign lab groups in addition to giving each lab partner an assigned role because it positively increases students' communication habits. Before the research study started, 100% of students indicated in the Group Work Background questions that they were proficient communicators because they were able to get their points across during group work (n=7). After the research study ended, 60% of students indicated in the Lab Partner Analysis survey that their communication habits had generally improved (*N*=10). Their rationale for the change was not because they were able to get their ideas through to their groups better but because they were more aware of how their lab partners were doing during the lab and were able to better ask questions to their lab groups. Collaborative learning happens when students seek to share a common purpose in understanding what they are performing. Nonverbal communication and body language of peers greatly influences how students work with one another (Beebe & Masterson, 2016). The students who indicated that their communication habits changed (60%) were able to move past the idea that communication does not mean getting a point across, but rather, willingly cooperating with one another to achieve a common goal. The student who indicated that their communication habits decreased overall (10%) expressed that they wanted to communicate less because they did not feel like they were being listened to during the group work. When students experience continuous negative interactions within group environments, they disengage from group work (Poort et al., 2020). This student seemed to be an outlier of the overall class data, but their challenge of finding meaningful conversation to achieve a common

goal when completing a chemistry lab is of interest. In my initial hypothesis, I expected that students would, for the most part, put their differences aside to work effectively with their peers because all their laboratory assignments were graded. I did not expect that students would completely disengage from one another because it would not only decrease the group dynamic and slow down data collection, but also greatly affect the comradery of the class of only 11 students. This one student outlier did not find the value of working collaboratively with peers because it did not benefit their immediate needs or wants. This created dysfunction and uninterest within each lab group that this student was assigned to and caused the student to become more disengaged from their groups.

The roles assigned to students did not change the frequency of how students communicated within their groups or with students outside their group. I expected that students would decrease the number of questions asked to people outside their assigned lab group and increase the number of questions asked to people inside their lab group. The first lab of the study, where no treatment had been applied, showed that the average student asked 3-6 questions to their group mates and 3-6 questions to someone outside their group. The last lab of the research study indicated that the average student asked 3-6 questions to someone inside their group and 0-2 questions to someone outside their group. This data suggests that students stopped asking questions to people outside of their group. However, the variance of each lab needs to be considered when determining the appropriate trend of question asking. The first two labs of the study were completed within the same unit, Thermochemistry. Although the group and role assignments were changed between the two labs, students experienced the content and phenomena of thermochemistry for a longer time. From Enthalpy of a Reaction, the first lab measured, to Design a Handwarmer, student communication in the group decreased from a mode

of 6-10 questions asked to a mode of 3-6 questions asked. It might be assumed that students did not need to ask as many questions about content if they were already proficient in the study of thermochemistry. The other variables that needed to be accounted for were whether students fully understood what the laboratory experiment was asking of them (purpose, procedure, and analysis), whether I was in school to help them through the experiment, and the complexity of the unit topic. For example, during the Kinetics of Crystal Violet lab, a notoriously complicated AP Chemistry experiment, I was out sick for a week, which was when we were planning on completing the lab analysis as a class. It makes sense that students reported the highest mode of asking their group members 0-2 questions during the lab because no one knew how to properly complete the post-lab analysis. In this same example, the unit of chemical kinetics involves more mathematical analysis than the unit of thermochemistry. It should make sense that students are able to rely more on their peers in units that are less complex like thermochemistry and rely less on their peers when units are more complex like chemical kinetics.

The most interesting finding suggests that students are more confident in their ability to effectively contribute to any group chemistry discussion. The dramatic shift in students' responses to the Chemistry Group Work Aptitude test, which resulted in every student agreeing that they felt confident in their ability to effectively contribute to any chemistry group discussion, shows that students were able to overcome social and communication barriers to talk about chemistry. My anecdotal observations suggest that as students continued to work with all their peers, they began to realize that there was not one person who completely excelled at AP Chemistry and that each one of them had a unique perspective that helped themselves and others understand the content topic better. One student mentioned that having multiple perspectives was important to them because having a different person point out different reasonings for why things

worked helped them better understand the labs. Creating positive points of conflict creates trust and rapport amongst students and increases their cognitive understanding of the topic (Poort et al., 2020). As students navigated the learning of a new topic, their ability to work through sticky and complicated concepts with one another allows them to feel more connected to each other and freely communicate about their strengths and weaknesses, thus creating a positive learning environment.

Value of the Study and Consideration for Future Research

Lab groups are a necessary part of learning chemistry. After three years of observing AP Chemistry students work in predictable groups in the lab and fall into patterns of misaligned workload, miscommunication, and need for control, I needed to try a new approach. Starting the year off with the expectation that students were not going to be able to choose their partners to complete the labs was easier than allowing students to choose a partner initially and then having to change lab groups around at some point in the year. Creating the popsicle stick lab group chart assignment also decreased the amount of time I needed to spend telling students who they were working with for each unit, decreased the amount of bickering that would occur before lab time, and increased the nervous excitement before a lab in a good way. I already plan on implementing the same popsicle stick system for my AP Environmental Science course next school year.

Giving students roles to perform in the lab was also incredibly valuable. The largest challenge of teaching AP Chemistry is getting students who think they work better on their own. These students unintentionally create unproductive laboratory groups because they often will try to overtake the group by trying to do everything on their own and not sharing the workload or by communicating poorly with their partners. The ability to assign roles to all lab groups mitigates these unproductive lab groups because everyone has a role they need to fulfill. Before the

research study, there was one student in AP Chemistry that unintentionally created unproductive lab groups and the members of their group would often ask to no longer work with them. After the research study began, when this student began to start the cycle of unproductive lab time, it was easy for me to remind them that they had a role they needed to complete. Although this did not eliminate the number of times the student was off task, it was something each member of the group could point to and ask for the student to focus their attention on. This gave students the power to solve their own group work-related problems and alleviated me from stepping in and redirecting a student, thus calling more attention to the situation.

Next school year I plan to continue assigning groups for both my AP Chemistry and AP Environmental Science courses. To start the school year, I would like to administer a modified background information survey that asks students their preference and opinions on assigned group work and then readminister that same survey at the end of the year. I would also like to start the year off explaining the purpose of roles and use this year's data to support why I assign groups. As an AP science teacher, I find it important to demonstrate how science works outside of content, and using this research study as a jumping off point for small things like group work is a perfect example.

For future studies, I would like to recommend that the roles be changed slightly. I found that the student in the role of the reflector often did not know exactly what it was they were supposed to be doing. I plan to replace the role of reflector with that of the gatherer. This idea comes with rearranging how I organize my classroom's laboratory area. The gatherer's role will be to ensure that the group has all the materials and equipment necessary to complete the lab. This role will eliminate long lines at the balance and at the lab bench where solutions are kept. It will also keep the number of requests to me down because students will be expected to find the

materials necessary to complete the lab. This also modifies, slightly, the role of the facilitator. The facilitator will now not need to worry about assigning who is going to gather what materials and instruments necessary to complete the lab and can focus their attention on making sure they understand the lab procedure with the presenter, and getting questions answered if something does not make sense. The role of presenter will have a more solidified expectation of being the sole questioner of the group, distributing lab data to absent members of the group, and sharing data when the collection of class data is necessary.

The literature suggests that students be given long periods of time to work within their groups so that they feel comfortable sharing their ideas with one another (Johnson & Johnson, 2018). This year, in AP Chemistry, lab groups were changed per unit, to maximize the number of partners each student worked with. This creates a challenge in allowing students to get familiar with lab partners that they may not know as well. To remedy this, I propose three ideas. The first is to assign lab groups per quarter. This gives students a concrete expectation of how long they will be working within that group and time to get to know their partners' habits, working styles, and communication skills. The second idea is to keep the groups per unit, but to expect that students work within their group for every assignment. I like this idea less, because as my students explained in their Lab Partner Analysis, they have different preferences for when they like working in groups. It is important to let students experience all types of groupings, assigned and chosen (Mitchell et al., 2004). By forcing students to work with the same set of people repeatedly, it removes their ability to make their own choices in the course. The final idea to form groupings is to create two or three larger groups with more students and then assign smaller sets within the group. For example, in my AP Chemistry class, I could divide the class into two teams: the green and white team. The green team would consist of two groups and the white

team would consist of two groups. The teams would be held constant for the quarter, but the groupings would be created from students only within that team. At the end of the quarter, teams would be redrawn, and new groups would be created within the teams. This idea seems complex and might confuse the students, so it might be beneficial to keep teams unknown to the students but documented by the teacher.

Impact of Action Research on the Author

Completing this research with my AP Chemistry students has reinforced the positive impact of assigning students to new lab groups every unit. What I did not expect was how much the students really liked having specific roles to fulfill while working in their lab groups. After the research study had ended, I had every intention of letting students go back to working in their groups without assigned roles. However, during the first lab, post-research, when students went to the chalk board to see what groups they had been assigned to for their next lab, I told them to ignore the F, R, and P letters because the study was over. Almost every student in the room let out an audible, aww, followed by a "no can we keep them? I like getting to be the one in charge" or a "No I like knowing what I have to do during the lab". It is clear to me that, although cumbersome to initially explain, assigning roles is more impactful than assigning lab partners. Giving students responsibility beyond those required allows them to practice leading and following in an organized way.

My research study has also reminded me of the stress and anxiety of the unknown. My AP Chemistry students struggle with anxiety: anxiety from not understanding a concept perfectly the first time, anxiety from not knowing what score they made on their lab notebook or their test, anxiety from not knowing if they will work well with their assigned lab partner or not. Being a student and teacher simultaneously has made me realize the need for transparency and clear

expectations. During the initial portion of this study, the IRB approval stage, I found so much value in having a check list of things necessary to be completed. The use of checklists and rubrics throughout the courses that I have taken in my core MSSE education classes have been instrumental to reducing my anxieties of the unknown. I continue to see the importance of modeling by example. Having a model, a rubric, or a checklist of things to use when completing large assignments is so important to the learning process because it effectively communicates clear expectations.

Finally, this research project has given me the tools and the opportunity to be the creative teacher that I have always wanted to be. I always joke with my students that in a different timeline I would be a kindergarten art teacher because I love arts and crafts. It is tricky as an AP Chemistry teacher to find ways to scratch my creative urges throughout the year. Finding a new way to channel my creative energy into a research study has given me a different appreciation for teaching. Asking myself questions about what I notice to be a continuous problem in my classroom and trying to find viable solutions to the problems was fun. The cyclical process of asking a question, trying to find a solution, implementing the solution, and then asking if the question had been solved meshed the science brain inside of me with the creative problem-solving girl who just wants to be making glitter glue art all the time. Modeling the process of a research study in my classroom also showed my students that education never really ends. It is far more fun to lean into the pursuit of knowledge because you can rather than pretending that you are too cool for school.

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APPENDICES

APPENDIX A

IRB APPROVAL

Protocol Information

Version # 1

Reference Number:	1056		
Protocol Number:	2023-1056-EXEMPT		
Protocol Title:	TEACHER ASSIGNED LAB GROUPS: HOW SPECIALIZED GROUPINGS AFFECT A STUDENT'S SOCIAL CONFIDENCE AND COMMUNICATION HABITS		
Protocol Type:	Original		
Principal Investigator:	Cleary, Megan	**Approval Date:**	11/17/2023
Submittal Date:	11/16/2023	**Effective Date:**	11/17/2023
Author:	Cleary, Megan	**Renewal Date:**	11/17/2028
Status:	Approved	**Next Review Date:**	11/17/2028
Inactive Date:		**Expiration Date:**	11/17/2028

APPENDIX B

CHEMISTRY GROUP WORK APTITUDE ASSESSMENT

Chemistry Group Work Aptitude Assessment

Adapted from Fraser, Test of Science Related Attitude, 1982 and *Rees, Sheard, & Davies, Communication Skills Attitude Scale, 2002.*

On your answer sheet, select the number that best represents how you feel about the statement.
Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

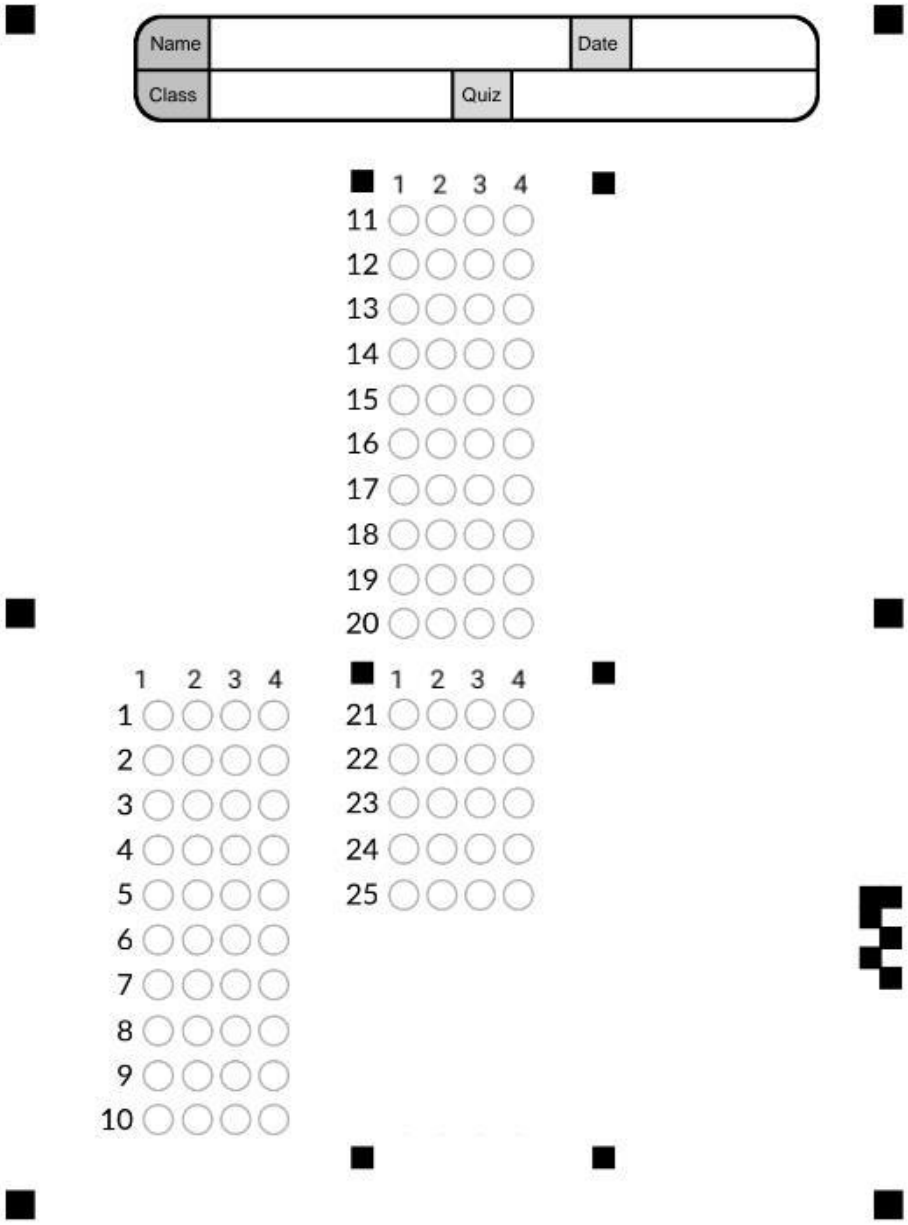
1 2 3 4

Strongly disagree Strongly agree

1. In order to be a good scientist/chemistry student I need to have good communication skills.
2. I would prefer to find out why something happens by doing an experiment than by being told.
3. I feel comfortable working with my classmates in a group setting during chemistry.
4. Doing experiments is not as informative as finding out information from other sources.
5. I prefer working in a group when tackling challenging chemistry questions rather than working alone.
6. Developing communication skills is just as important as developing my knowledge of chemistry.
7. I would prefer to do experiments than to read about them.
8. School should have more time for chemistry each week.
9. I handle constructive criticism and feedback from my peers and teachers well during laboratory experiments.
10. I would rather agree with other people than find out an answer on my own.

11. I am confident in my ability to contribute effectively to any group discussion relating to chemistry.
12. I like to listen to people whose opinions are different than mine.
13. I do not feel confident in sharing ideas about chemistry when I am paired with people who I do not know well.
14. I find it hard to admit to having some problems with my communication skills.
15. In chemistry experiments, I like to use new methods which I have not used before.
16. I really enjoy doing chemistry experiments.
17. It is better to ask the teacher the answer than to find it out by working with a group.
18. I am unwilling to change my ideas when evidence shows that my ideas are poor.
19. Learning communication skills is applicable in learning science.
20. I would prefer to do chemistry in school rather than outside of school.

21. I much prefer to work with people who I perceive to be smarter than I am.
22. I dislike listening to other people's opinions.
23. Learning communication skills is important because my ability to communicate is a lifelong skill.
24. I feel a sense of anxiety when my teacher chooses my lab group partners for me.
25. I am less likely to contribute information when a member of my group disagrees with me.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APPENDIX C

GROUP WORK BACKGROUND QUESTIONS

Group Work Background Questions

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

1. In your view, what makes a chemistry group highly effective?

2. Do you think that your social confidence has a direct impact on your chemistry learning and performance? If so, how?

3. What aspects of group dynamics do you find most challenging when working in the chemistry lab with a group?

4. How good of a communicator do you think you are? What makes you think that?

5. Do you prefer working alone or in a group when tackling challenging chemistry problems? Why?

6. How does your chemistry group work influence your overall enjoyment of the class and your motivation to excel in the class?

7. Is there anything else that I didn't ask about that you want me to know?

APPENDIX D

POST-LAB SURVEY

Post-Lab Survey

Tape this survey in your notebook after your post-lab questions. Answer the following questions relating to your social confidence and communication habits during this lab. Circle the response that best reflects your experience for questions 1-6. This is not a graded assignment and does not count toward your overall laboratory grade. Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1. How comfortable did you feel sharing ideas with your group during this experiment?

1 2 3 4

Not comfortable at all ---------- Comfortable

2. How confident were you in your ability to perform your role in your lab group?

1 2 3 4

Not confident at all ---------- Confident

3. Do you think you have a better understanding of the experiment because you were able to work with your partner(s)?

1 2 3 4

No ---------- Yes

4. Do you think you would have been as successful in completing this lab if you worked by yourself?

1 2 3 4

Extremely unsuccessful ---------- Successful

5. How often did you ask your lab group questions relating to the lab while completing it?

0-2 times 3-6 times 6-10 times 10+ times

6. How often did you ask someone outside of your lab group (including Cleary) questions relating to the lab while completing it?

0-2 times 3-6 times 6-10 times 10+ times

7. Do you have any muddiest points?

APPENDIX E

CHEMISTRY LAB PARTNER ANALYSIS

Chemistry Lab Partner Analysis

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

1. In your view, what makes a chemistry group highly effective?

2. How has your social confidence changed after being assigned to work in specific lab groups?

3. How have your communication habits changed while being assigned to work in specific lab groups?

4. How has your academic ability changed while being assigned to work in specific lab groups?

5. Do you prefer working alone or in a group when tackling challenging chemistry problems, why?

6. What do you perceive to be the benefits of working with an assigned lab partner?

7. What are the detriments of working with an assigned lab partner?

8. What do you perceive to be the benefits of working with a partner of your choice?

9. What do you perceive to be the detriments of working with a partner of your choice?

10. Is there anything else you want me to know about now that the study has been completed?